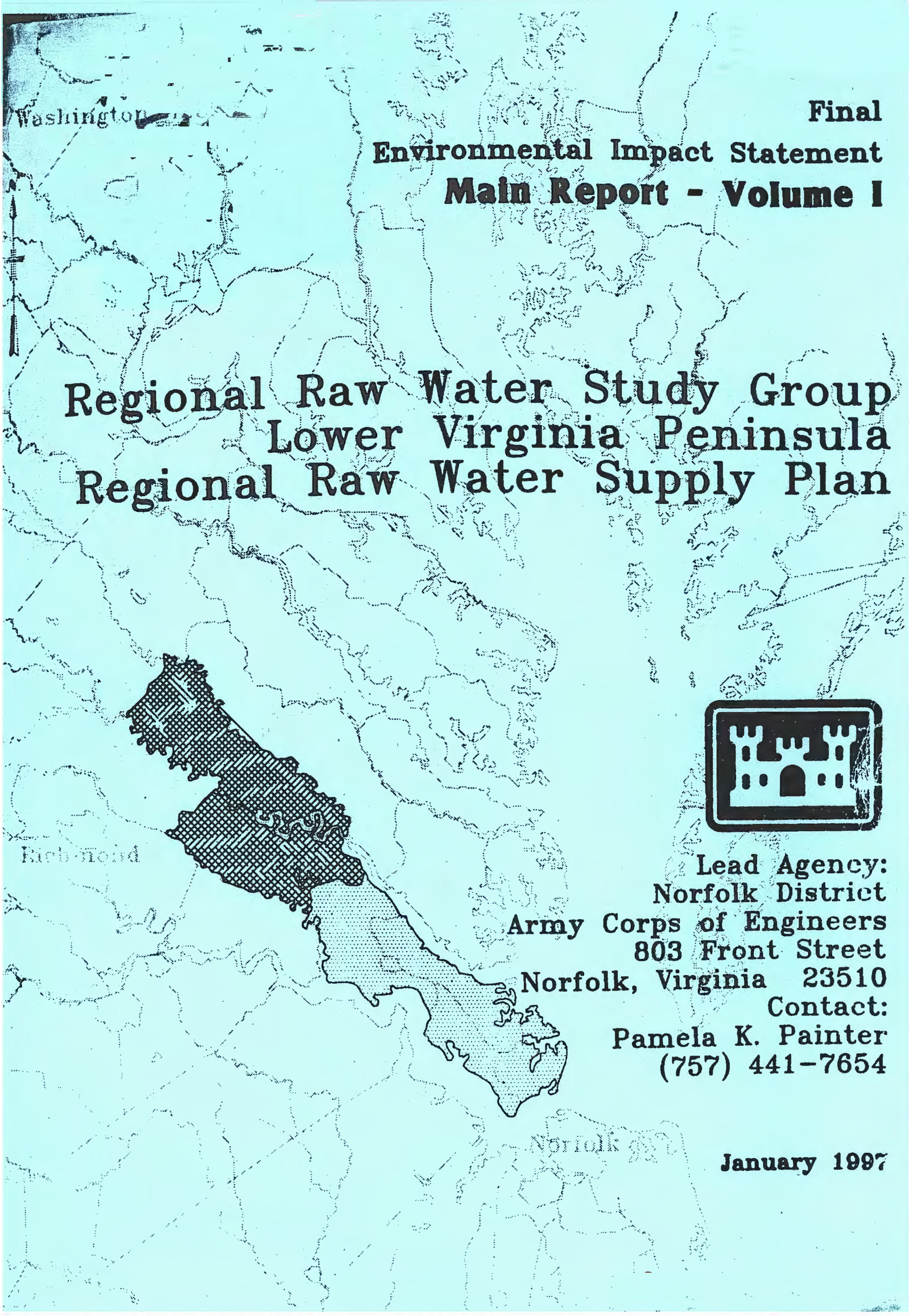

Final

Environmental Impact Statement

Main Report - Volume I

Regional Raw Water Study Group
Lower Virginia Peninsula
Regional Raw Water Supply Plan

Lead Agency:
Norfolk District
Army Corps of Engineers
803 Front Street
Norfolk, Virginia 23510
Contact:
Pamela K. Painter
(757) 441-7654

January 1997

LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY PLAN
1990-2040

FINAL ENVIRONMENTAL IMPACT STATEMENT
(VOLUME I)

Regional Raw Water Study Group:

Newport News Waterworks
City of Williamsburg
York County

Local Jurisdictions in Study Area:

Cities of Newport News, Hampton, Poquoson, and Williamsburg
Counties of York and James City

Federal Installations in Study Area:

Fort Monroe, Langley AFB, NASA Langley Research Center, Fort Eustis
Yorktown Naval Weapons Station, Camp Peary, Cheatham Annex
and Yorktown Coast Guard Reserve Training Center

JANUARY 1997

ORGANIZATION OF
FINAL ENVIRONMENTAL IMPACT STATEMENT
MAIN REPORT

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TEXT SECTIONS

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ABBREVIATIONS

ADD - Average day demand

AF - Acre-feet

AFD - Agricultural/Forestal District

ARWA - Appomattox River Water Authority

ASR - Aquifer storage and recovery

AWT - Advanced wastewater treatment

BDL - Below Detection Limit

BG - Billion gallons

BOCA - Building Officials and Code Administrators

BOD - Biological Oxygen Demand

BOVA - Biota of Virginia

CBNERRS - Chesapeake Bay National Estuarine Research Reserve System

CBPA - Chesapeake Bay Preservation Act

CBPA - Chesapeake Bay Preservation Area

CDM - Camp, Dresser & McKee

CDWR - California Department of Water Resources

CEQ - Council on Environmental Quality

CFR - Code of Federal Regulations

COD - Chemical oxygen demand

CSO - Combined sewer overflow

CWA - Clean Water Act

EDR - Electrodialysis reversal

EIS - Environmental Impact Statement

ERC	-	Equivalent residential connection
EVGMA	-	Eastern Virginia Groundwater Management Area
FHA	-	Federal Highway Administration
fps	-	Feet per second
GAC	-	Granular activated carbon
gal/min	-	Gallons per minute
gpcpd	-	Gallons per capita per day
gpf	-	Gallons per flush
gpm	-	gallons per minute
HEP	-	Habitat Evaluation Procedures
HRSD	-	Hampton Roads Sanitation District
HSI	-	Habitat Suitability Index
HU	-	Habitat Unit
HUD	-	United States Department of Housing and Urban Development
JCC	-	James City County
JCSA	-	James City Service Authority
JTU	-	Jackson turbidity unit
KWC	-	King William County
KWCPD	-	King William County Planning Department
LG&E	-	Louisville Gas & Electric
MDD	-	Maximum day demand
MED	-	Multiple effect distillation
MG	-	Million gallons
mgd	-	Million gallons per day
mg/l	-	Milligrams per liter

MHD	-	Maximum hourly demand
MHI	-	Median household income
MIF	-	Minimum in-stream flow
MRCE	-	Mueser Rutledge Consulting Engineers
MW	-	Megawatt
MWH	-	Megawatt hour
MWDSC	-	Metropolitan Water District of Southern California
MWRA	-	Massachusetts Water Resources Authority
NAPP	-	National Aerial Photography Program
NEPA	-	National Environmental Policy Act
NFA	-	No Federal Action
NHAP	-	National High Altitude Photography
NKC	-	New Kent County
NMFS	-	National Marine Fisheries Service
NPS	-	National Park Service
NTU	-	Nephelometric turbidity unit
NWF	-	National Wildlife Federation
NWI	-	National Wetlands Inventory
ODEC	-	Old Dominion Electric Cooperative
PACC	-	Powhatan, Amelia, Cumberland, and Chesterfield Counties
ppt	-	parts per thousand
RCO	-	Reasonable conservation objective
RMA	-	Resource Management Area
RO	-	Reverse osmosis
ROW	-	Right-of-way

RPA	-	Resource Protection Area
RRPDC	-	Richmond Regional Planning District Commission
RRWSG	-	Regional Raw Water Study Group
SAV	-	Submerged aquatic vegetation
SCC	-	State Corporation Commission
SCR	-	Summer conservation rate
SDC	-	System development charge
SDN	-	Smith Demer Normann
SDWA	-	Safe Drinking Water Act
SELC	-	Southern Environmental Law Center
STP	-	Sewage Treatment Plant
SWCB	-	Virginia State Water Control Board
SWMA	-	Surface Water Management Area
TDS	-	Total dissolved solids
THM	-	Trihalomethane
TKN	-	Total Kjeldahl nitrogen
TOC	-	Total organic carbon
UAW	-	Unaccounted-for water
ULF	-	Ultra-low-flow
ULV	-	Ultra-low-volume
UOSA	-	Upper Occoquan Sewage Authority
USBC	-	Uniform Statewide Building Code
USC	-	United States Code
USCOE	-	United States Army Corps of Engineers
USDC	-	United States Department of Commerce

USEPA	-	United States Environmental Protection Agency
USFWS	-	United States Fish and Wildlife Service
USGS	-	United States Geological Survey
VCOE	-	Virginia Council on the Environment
VDACS	-	Virginia Department of Agriculture and Consumer Services
VDC	-	Virginia Department of Corrections
VDCR	-	Virginia Department of Conservation and Recreation
VDEQ	-	Virginia Department of Environmental Quality
VDGIF	-	Virginia Department of Game and Inland Fisheries
VDH	-	Virginia Department of Health
VDHR	-	Virginia Department of Historic Resources
VDOT	-	Virginia Department of Transportation
VDMR	-	Virginia Department of Mineral Resources
VDWM	-	Virginia Department of Waste Management
VEC	-	Virginia Employment Commission
VGA	-	Virginia Groundwater Act
VIMS	-	Virginia Institute of Marine Science
VIP	-	Virginia Initiative Plant
VMRC	-	Virginia Marine Resources Commission
VPDES	-	Virginia Pollutant Discharge Elimination System
VRA	-	Virginia Resources Authority
VSRS	-	Virginia Scenic Rivers System
VWA	-	Virginia Wetlands Act
VWPP	-	Virginia Water Protection Permit
WET	-	Wetland Evaluation Technique

WTP	-	Water treatment plant
WWTP	-	Wastewater treatment plant

1.0 SUMMARY

This Final Environmental Impact Statement (FEIS) is a complete compilation and update of material presented previously in the U.S. Army Corps of Engineers' (USCOE) February 1994 Draft Environmental Impact Statement (DEIS) and December 1995 Supplement to the DEIS (Supplement). It also presents information to address concerns raised during the public comment periods on the DEIS and Supplement, and includes the results of additional studies conducted by the Regional Raw Water Study Group (RRWSG). The organization of this FEIS follows the numbering system used in the Main Reports of the DEIS and Supplement.

The FEIS Main Report is presented in two volumes as follows:

Volume I

- Text Sections.

Volume II

- King William Reservoir Project Conceptual Mitigation Plan for the Virginia Department of Environmental Quality.
- Comments on DEIS and Supplement along with Responses to Comments.

EIS Appendix Volumes I through VII were not revised as part of FEIS preparation. New or revised appendix reports are included in Appendix Volume VIII and include:

- Report G (Phase I Cultural Resource Survey).
- Report N (Study of Potential Erosional Impact of Scotland Landing Water Intake Structure).
- Report O (Amphibians and Reptiles of the Cohoke Mill Creek Watershed).
- Report P (Literature Review on Genetic Variability and Migration Patterns of Alewife and Blueback Herring Stocks in Chesapeake Bay Tributaries).

1.1 PURPOSE

The RRWSG was created in the Fall of 1987 to examine the water supply needs of the Lower Peninsula area of southeast Virginia and to develop a plan for obtaining a new source of supply for meeting the region's future water needs. Current members of the RRWSG include the City of Newport News (representing Newport News Waterworks and its service area), the City of Williamsburg, and York County.

The RRWSG is acknowledged by the participating jurisdictions as an appropriate regional entity to pursue the necessary engineering and environmental studies to search for the least environmentally damaging, practicable alternative(s) to meet the future water supply needs of the study area.[1] After full National Environmental Policy Act (NEPA) and public interest reviews, the USCOE will determine whether the proposed project is in the overall public interest. That determination will be published in the USCOE's Record of Decision, following the completion of the FEIS. To this end, the purpose and goal of the RRWSG is:

To provide a dependable, long-term public water supply for the Lower Virginia Peninsula, in a manner which is not contrary to the overall public interest.

<u>Problem Definition - Water Supplies, Demands & Deficits</u>

Estimated delivery capacities of the five public water supply systems on the Lower Peninsula are presented in the following table for the Year 1990.

Water System	**Raw Water Source Safe Yield (mgd)**	**Treated Water Delivery Capacity (mgd)**
Newport News Waterworks	57.0	51.9
Williamsburg	4.15	3.8
York County	0.12	0.12
James City Service Authority	4.17	4.17
U. S. Army (Big Bethel)	2.0	1.9
Lower Peninsula Total	67.4	61.9

Total regional treated water pumped to distribution in the base year 1990 was 55.2 million gallons per day (mgd). Lower Peninsula water supply system demands are projected to grow through the Year 2040. Projections of growth and the impact on future demands within the service area of each Lower Peninsula water purveyor have been estimated based on data from previous studies and system operating records.

In the DEIS and Supplement, demand reductions resulting from existing and future water conservation measures (exclusive of use restrictions) were incorporated into the regional demand projections. This approach has been revised for the FEIS. Demand projections presented in this FEIS only incorporate the effects of existing conservation measures. Additional conservation measures which may be implemented are considered as an alternative, because they are not currently in effect. Demand reductions resulting from additional conservation measures, beyond those already implemented, are presented as an alternative in Section 3.4.30.

1 Local jurisdictions in the study area: Cities of Newport News, Hampton, Poquoson and Williamsburg, and Counties of York and James City. Federal installations in study area: Fort Monroe, Langley AFB, NASA Langley Research Center, Fort Eustis, Yorktown Naval Weapons Station, Camp Peary, Cheatham Annex, and Yorktown Coast Guard Reserve Training Center.

Based on estimated population projections for the region and other applicable factors, water demand projections through the Year 2040 have been made for five categories of demand. A summary of projections through the 50-year planning horizon are presented below as total regional average daily demands.

Demand Category	2000	2010	2020	2030	2040
Residential	31.03	35.42	37.88	40.76	43.73
Commercial, Institutional, Light Industrial	12.29	13.85	14.70	15.71	16.77
Heavy Industrial	12.81	17.31	19.00	20.92	22.38
Federal Installations	4.82	5.45	5.48	5.51	5.52
Unaccounted-for Water	6.77	8.00	8.56	9.21	9.82
Lower Peninsula Total (mgd)	67.72	80.03	85.62	92.11	98.22

Comparing treated water delivery capacities with demand projections results in the following treated water delivery capacity deficit projections over the planning period:

	2000	2010	2020	2030	2040
Regional Demands	67.7	80.0	85.6	92.1	98.2
Regional Treated Water Delivery Capacity	60.3	60.3	58.4	58.4	58.4
Treated Water Delivery Capacity Deficits (mgd)	7.4	19.7	27.2	33.7	39.8

Based on these deficit projections, a regional "safe yield" deficit could occur before the Year 2000. One individual public water system, Newport News Waterworks, is expected to experience actual water supply deficits even earlier under severe drought conditions. Based on an estimate of the time required to implement a large water supply project, interim supplies and demand reductions would be necessary to augment supplies until a large, long-term project can be brought on line.

A new raw water supply project which can increase the regional treated water delivery capacity by 39.8 mgd is required to satisfy projected demands through the Year 2040.

1.2 DESCRIPTION OF THE PROPOSED PROJECT

Based on detailed practicability and environmental analyses of evaluated water supply alternatives, the following components are deemed by the RRWSG to represent the least damaging combination of practicable alternatives and the combination that will best serve the Study Group's project purpose. These alternatives are proposed as long-term components of an overall 39.8 mgd water supply plan to meet the RRWSG's water supply needs through the Year 2040. RRWSG treated water safe yield benefits associated with each alternative are shown in parentheses. The safe yield shown for groundwater alternatives represents only the amount of long-term yield that would be required from new groundwater sources. The potential yield from these groundwater alternatives would be greater in the short-term, as interim supplies pending completion of the King William Reservoir project.

- Additional Conservation Measures and Use Restrictions (10.5 mgd)
- Combination of Fresh Groundwater Development and/or Groundwater Desalination (6.1 mgd)
- King William Reservoir (KWR-IV Configuration) with Pumpover from Mattaponi River (23.2 mgd)

Assuming a 10-year time to completion for the King William Reservoir, interim groundwater supplies yielding at least 7.7 mgd would be required to satisfy projected interim water supply deficits within the region before the new reservoir becomes operational. This estimate also assumes implementation of additional conservation measures and use restrictions capable of reducing short-term demands by at least 7.1 mgd, for a total interim supply of 14.8 mgd. (Groundwater development and additional conservation measures and use restrictions would also be long-term components of the proposed project).

1.3 ALTERNATIVES

1.3.1 Alternatives Considered

The DEIS reported the results of a practicability analysis of each of the 31 water supply alternatives included in the USCOE's original scoping outline for its EIS. New alternatives, and variants of previously identified alternatives, have been identified subsequently and are evaluated in this FEIS. These analyses include evaluation of the alternatives with respect to practicability criteria including availability, cost, and technological reliability.

Brief summary descriptions of the numerous alternatives that have been evaluated in the preparation of this Regional Raw Water Supply Plan, including the RRWSG's preferred project components, are presented below.

1. Lake Genito: New dam across the Appomattox River near Genito, Virginia on the Amelia County/Powhatan County border. Controlled releases would be made from Lake Genito to Lake Chesdin. A new intake on Lake Chesdin would be required to pump water to Diascund Creek Reservoir where new pump station would be needed to pump to Little Creek Reservoir. 48.5 miles of new pipeline required.

2. Lake Chesdin: New intake structure on Lake Chesdin to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 48.5 miles of new pipeline required.

3. Lake Anna: New intake structure on Lake Anna in Louisa County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 71.5 miles of new pipeline required.

4. Lake Gaston: New intake structure on Lake Gaston in Brunswick County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 91.5 miles of new pipeline required.

5. Rappahannock River (above Fredericksburg): New intake structure on Rappahannock River in Spotsylvania County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 94.5 miles of new pipeline required.

6. James River (above Richmond) without New Off-Stream Storage: New intake structure on James River in Chesterfield County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 55.5 miles of new pipeline required.

7. City of Richmond Surplus Raw Water: New intake structure at Richmond Water Treatment Plant to pump to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 39.5 miles of new pipeline required.

8. City of Richmond Surplus Treated Water: Treated water pumped from Richmond Water Treatment Plant to Newport News Waterworks' northern distribution zone in James City County. 64 miles of new pipeline required.

9. James River (between Richmond and Hopewell): New pump station on James River in Henrico County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 30.5 miles of new pipeline required.

10. Ware Creek Reservoir: New 50-foot dam across Ware Creek on New Kent County/James City County border; 6.87 billion gallon lake draining 17.4 square miles and covering 1,238 acres at pool elevation of 35 feet. Water pumped from new 20 mgd intake structure to Newport News Waterworks raw water mains through new 3.6-mile, 30-inch pipeline. New 1.5-mile, 30-inch pipeline from Waterworks raw water mains to Ware Creek Reservoir also required.

* 11. Ware Creek Reservoir & Pamunkey, Mattaponi, and/or Chickahominy River Pumpovers ***(All three potential river pumpover sources were evaluated, but the proposed concept includes only a Pamunkey River pumpover (120 mgd pump station))***: Similar to (10) with 40 mgd pump station and 36-mile, 42-inch pipeline from Ware Creek Reservoir to Waterworks' raw water mains. New 120 mgd intake structure on Pamunkey River (11.4 miles of 66-inch pipeline and 6.2 miles of 54-

inch pipeline), 45 mgd pump station on Mattaponi River (16.8-mile, 48-inch pipeline), and/or expansion of pump station on Chickahominy River to 61 or 81 mgd (new 1.5-mile, 42-inch pipeline). Pamunkey and Mattaponi options also would require 40 mgd pump station on Diascund Creek Reservoir to pump 4.9 miles (42-inch pipeline) to Ware Creek Reservoir.

12. Ware Creek Reservoir & James River Pumpover (above Richmond): Similar to (10) with pump station on Ware Creek Reservoir to pump to Waterworks raw water mains. Pump station on James River in Chesterfield County to pump to Diascund Creek Reservoir where a new pump station would be needed to pump to Ware Creek Reservoir. 58.5 miles of new pipeline required.

13. Black Creek Reservoir & Pamunkey River Pumpover: Two dams across the Southern Branch and Eastern Branch of Black Creek in New Kent County; 6.41 billion gallon interconnected lake draining 5.47 square miles and covering 910 acres at pool elevation of 100 feet; supplemented with water pumped from new 120 mgd pump station on Pamunkey River in New Kent County through new 5-mile, 66-inch pipeline. Water pumped from new 40 mgd reservoir intake structure to Diascund Creek Reservoir through new 6.8-mile, 42-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required. 17.3 miles of new pipeline required.

14. Black Creek Reservoir & James River Pumpover (above Richmond): Similar to (13) but supplemented with new 75 mgd pump station on James River in Chesterfield County. 43-mile pipeline to Black Creek Reservoir required.

* 15. King William Reservoir & Mattaponi River Pumpover:

KWR-I Configuration (RRWSG's Originally Proposed Project): New 92-foot dam across Cohoke Creek in King William County; 21.21 billion gallon lake draining 13.17 square miles and covering 2,284 acres at 90 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Water delivered to Diascund Creek Reservoir through new 10.0-mile, 42- and 60-inch gravity flow pipeline (40 mgd capacity). Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

KWR-II Configuration (RRWSG's Preferred Project): New 92-foot dam across Cohoke Creek in King William County; 21.21 billion gallon lake draining 11.45 square miles and covering 2,222 acres at 96 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Includes a 50 mgd King William Reservoir pump station and new 10.4-mile, 42- and 48-inch pipeline to deliver water to Diascund Creek Reservoir. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

The USCOE directed consideration of the following additional upstream dam configurations for this alternative:

KWR-III Configuration: New 83-foot dam across Cohoke Creek in King William County; 16.57 billion gallon lake draining 10.33 square miles and covering 1,909 acres at 96 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Includes a 50 mgd King William Reservoir pump station and new 11.2-mile, 42- and 48-inch pipeline to deliver water to Diascund Creek Reservoir. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

KWR-IV Configuration (RRWSG's Currently Proposed Project): New 78-foot dam across Cohoke Creek in King William County; 12.22 billion gallon lake draining 8.92 square miles and covering 1,526 acres at 96 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Includes a 50 mgd King William Reservoir pump station and new 11.7-mile, 42- and 48-inch pipeline to deliver water to Diascund Creek Reservoir. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

16. King William Reservoir & Pamunkey River Pumpover: Similar to (15) but supplemented with water pumped from new 100 mgd pump station on Pamunkey River in King William County. 5.7-mile pipeline to King William Reservoir required.

17. Chickahominy River Pumping Capacity Increase: Increase pumping capacity of Waterworks' existing Chickahominy River pump station in New Kent County to 61 mgd.

18. Chickahominy River Pumping Capacity Increase and Raise Diascund and Little Creek Dams: Similar to (17) but also modifying Waterworks' Diascund Creek and Little Creek dams to increase normal pool elevations by 2 feet.

19. Aquifer Storage and Recovery, Constrained by Number of Wells: Withdraw water from Chickahominy River at full capacity when streamflow is high and demand is low; treat and store underground for later use. Treated water injected through new well system (12 wells on Waterworks property) when raw water source exceeds demand. Water recovered from same wells.

20. Aquifer Storage and Recovery, Unconstrained by Number of Wells: Similar to (19) limited only by the Chickahominy River withdrawal capacity and amount of surplus streamflow available.

* 21. Fresh Groundwater Development: New well fields in western James City County and/or eastern New Kent County; used to augment Diascund Creek and Little Creek Reservoirs when system reservoir storage is below 75 percent of total capacity.

22. Groundwater Desalination as the Single Long-Term Alternative: Large-scale withdrawals from wells located throughout the Lower Peninsula drilled into deep, brackish aquifers, treated in four or five new desalination plants.

* 23. Groundwater Desalination in Newport News Waterworks Distribution Area: Small-scale withdrawals from new wells located adjacent to Waterworks distribution facilities and drilled into deep, brackish aquifers, treated in new desalination plant(s).

24. James River Desalination: New off-shore intake, with subaqueous pipeline and pump station on James River in James City County; Pumped to a reverse osmosis desalination plant near Waller Mill Reservoir. Requires a 26-mgd capacity outfall for concentrate disposal and 29 miles of new pipeline.

25. Pamunkey River Desalination: New intake on Pamunkey River in New Kent County to pump water to new desalination plant near Waller Mill Reservoir. Requires a 21-mgd capacity outfall for concentrate disposal and 33.2 miles of new pipeline.

26. York River Desalination: New intake on York River in New Kent County to pump to a new reverse osmosis desalination plant near Waller Mill Reservoir. Requires a 41-mgd capacity outfall for concentrate disposal and 33.6 miles of new pipeline.

27. Cogeneration: Purchase drinking water produced through distillation process powered by excess steam from privately-owned cogeneration facility. Private initiative required.

28. Wastewater Reuse as a Source of Potable Water: Blending highly treated wastewater with potable raw water supplies, using advanced wastewater reclamation plant adjacent to existing Hampton Roads Sanitation District (HRSD) York River wastewater treatment plant (WWTP).

29. Wastewater Reuse for Non-Potable Uses: One to four systems, each located adjacent to an existing HRSD WWTP, and each providing advanced treatment of WWTP effluent to produce non-potable water suitable for industrial cooling and industrial process use.

* 30. Additional Conservation Measures and Use Restrictions: Additional aggressive water conservation activities applied to residential, commercial, and industrial demand categories. Contingency measures (i.e., use restrictions) beyond additional conservation measures also employed to produce short-term reductions in water demand during water supply emergencies.

31. No Action: Do nothing to provide additional raw water supply or curtail water use on the Lower Peninsula.

Additional alternatives have been evaluated as directed by the USCOE. Those alternatives are:

- Black Creek Reservoir with Mattaponi River Pumpover: Similar to (13) but supplemented with water pumped from new 75 mgd pump station on Mattaponi River in King William County. (This alternative is discussed in Section 3.4.32.)

- Ware Creek Reservoir (Three Dam Alternative) with Pamunkey River Pumpover: Similar to (11) but Ware Creek Reservoir would consist of three smaller interconnected impoundments with a combined surface area and total storage volume of 955 acres and 4.95 billion gallons, respectively. (This alternative is discussed in Section 3.4.32.)

- Side-Hill Reservoir: Long earthen embankments would be constructed at four sites located adjacent to bluffs in the Mattaponi and/or Pamunkey River valleys of King William County. The four impoundments would be interconnected and have a total storage capacity of at least 20 billion gallons, supplemented with water from new pump station on Mattaponi River or Pamunkey River in King William County. Water from the side-hill reservoirs would be pumped to Diascund Creek Reservoir through new pipeline. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir. (This alternative is discussed in Section 3.4.32.)

- Smaller King William Reservoir with Two River Pumpovers: Similar to (15) but supplemented with a second 45 mgd pump station on Pamunkey River in King William County. (This alternative is discussed in Section 3.4.32).

- Smaller Scale Surface Water Desalination: Similar to (26) but designed to provide a 10 mgd treated water safe yield benefit rather than a 30 mgd benefit. (This alternative is discussed in Section 3.4.26.)

Alternatives that are deemed practicable by the RRWSG, in terms of availability, cost, and technological reliability, are denoted above with asterisks. These alternatives have been carried forward for detailed environmental analysis in the EIS along with the Black Creek Reservoir with Pumpover from Pamunkey River alternative (13) and the No Action alternative (31).

1.3.2 RRWSG's Preferred Alternative

The RRWSG's preferred alternative is a project consisting of a combination of several practicable alternatives, as long-term components of an overall 39.8 mgd plan to meet the RRWSG's water supply needs through the Year 2040. The project components are:

- Additional Conservation Measures and Use Restrictions (Alternative 30)

- Combination of Fresh Groundwater Development and/or Groundwater Desalination in Newport News Waterworks Distribution Area (Alternatives 21 and 23)

- King William Reservoir with Pumpover from Mattaponi River (Alternative 15)

As directed by the USCOE, the following features of the King William Reservoir alternative have been modified since publication of the DEIS to avoid and minimize potential adverse environmental impacts.

The RRWSG's preferred King William Reservoir dam site (KWR-II) across Cohoke Creek has been moved approximately 2,900 feet upstream from the originally proposed location (KWR-I). Among the benefits of this change in the project configuration would be a reduction in the area of inundated wetlands and avoidance of potential impacts to an active Bald Eagle nest downstream of the proposed dam. In addition, the reduced volume of material required for dam embankment construction and the closer proximity of the proposed soil borrow area to the new dam site would result in a $7.7 million reduction in estimated Year 1992 dam embankment construction costs. To preserve the original reservoir storage capacity, the normal pool elevation would be increased from 90 to 96 feet above mean sea level (msl) at the new upstream dam site.

Proposed dead storage in the King William Reservoir has been reduced from 47 to 25 percent. This dead storage reduction would lead to larger fluctuations in reservoir operating levels and, therefore, increase the duration of periods when recreational use of the reservoir would be limited. However, using more of the total reservoir storage would offer greater flexibility in the timing of Mattaponi River withdrawals. A project safe yield benefit sufficient to meet projected RRWSG needs (in combination with other practicable project components) could be maintained under a more restrictive river minimum instream flowby (MIF) than the originally proposed 40/20 Tennant MIF. However, project safe yield could be enhanced if the 40/20 Tennant MIF were retained.

For the RRWSG's preferred KWR-II configuration, the assumed Mattaponi River MIF was made comparable to that proposed for the Pamunkey River (i.e., Modified 80 Percent Monthly Exceedance Flows MIF). Use of this MIF for the Mattaponi River (instead of the originally proposed 40/20 Tennant MIF) would better preserve the shape of the River's natural seasonal hydrograph and establish monthly MIF levels which are higher for each month of the year.

The proposed King William Reservoir pipeline discharge point on Beaverdam Creek has been extended 0.5 miles downstream in order to minimize potential erosional impacts to Beaverdam Creek above the Diascund Creek Reservoir pool.

1.3.3 RRWSG's Currently Proposed Alternative

The RRWSG's currently proposed alternative is a project consisting of a combination of several practicable alternatives, as long-term components of an overall 39.8 mgd plan to meet the RRWSG's water supply needs through the Year 2040. The project components are:

- Additional Conservation Measures and Use Restrictions (Alternative 30)
- Combination of Fresh Groundwater Development and/or Groundwater Desalination in Newport News Waterworks Distribution Area (Alternatives 21 and 23)
- King William Reservoir with Pumpover from Mattaponi River (Alternative 15)

As directed by the USCOE, the RRWSG has identified alternative King William Reservoir configurations which are based on locating the dam farther upstream than at the RRWSG's preferred KWR-II site. One of these dam sites, KWR-IV, is located 9,700 feet upstream of the RRWSG's originally proposed KWR-I site. Initial geotechnical investigations have indicated that site KWR-IV is a feasible location for the King William Reservoir Dam. For the KWR-IV configuration, wetland impacts would be 437 acres, or 216 and 137 acres less than for the KWR-I and KWR-II configurations, respectively. In addition, 39 fewer archaeological sites would be inundated with the KWR-IV configuration than with the originally proposed KWR-I configuration.

The RRWSG remains convinced that from the perspective of a long-term regional public water supply, the RRWSG's preferred KWR-II configuration would be technically superior to the alternative King William Reservoir configurations. However, given the substantial reductions in impacts possible by moving the dam upstream, the RRWSG has designated dam site KWR-IV as part of its currently proposed alternative.

The KWR-IV reservoir configuration, in combination with other practicable project components, would provide sufficient yield to meet the RRWSG's projected needs if the originally proposed 40/20 Tennant MIF were retained for the Mattaponi River pumpover. If a more restrictive MIF were imposed, then the reservoir yield would not be sufficient to meet the projected needs of the Lower Peninsula localities and host communities through the RRWSG's planning horizon.

1.4 ISSUES/AREAS OF CONTROVERSY

1.4.1 Wetlands

Approximate areas of non-tidal wetlands and open water that would be inundated by the various King William Reservoir configurations are as follows:[2]

Reservoir Configuration	Wetlands and Open Water (acres)
KWR-I	653
KWR-II	574
KWR-III	511
KWR-IV	437

Wetlands downstream of the proposed dam may be indirectly affected. The existing Cohoke Millpond already provides a substantial degree of flow moderation in the lower reaches of Cohoke Creek. In addition, the majority of Cohoke Creek below the Millpond is subject to tidal influence. Consequently, net flow reductions due to the proposed reservoir are not expected to cause dramatic changes in average Millpond water levels or floodplain hydrology in vegetated wetland areas below the dam site. A conceptual mitigation plan to mitigate for wetland impacts resulting from the project is presented in Section 3.7.

Minor wetland disturbances along concentrate pipeline corridors and at concentrate pipeline outfall sites could result from the groundwater desalination project component. No wetland losses

2 See Section 4.3.3 for discussion of wetland delineation.

anticipated as a result of the fresh groundwater or additional conservation measures and use restrictions project components.

1.4.2 Endangered/Threatened Species

No known endangered or threatened species populations would be directly impacted by construction or operation of the Mattaponi River (Scotland Landing) intake. Colonies or specimens of Sensitive Joint-vetch (*Aeschynomene virginica*), which is a federally-listed threatened plant species and has been proposed for state listing as endangered, have been recorded in five areas along a 15-mile stretch of the Mattaponi River (J. R. Tate, VDACS, personal communication, 1993). In a 1993 Sensitive Joint-vetch study, the Virginia Institute of Marine Science (VIMS) concluded that: "... it appears that no existing plant will be impacted within the primary or secondary study areas by the proposed project" (Perry, 1993). The primary study area was defined by VIMS as both sides of the Mattaponi River from just below Scotland Landing upstream to Mantua Ferry. The secondary study area was defined by VIMS as the remainder of the tidal freshwater zone of the Mattaponi River. Further studies have indicated that no impacts are expected to Sensitive Joint-vetch habitat at Garnetts Creek marsh (across the river from Scotland Landing) as a result of Mattaponi River intake operation (Basco, 1996).

Specimens of the Small Whorled Pogonia (*Isotria medeoloides*), a federally-listed threatened and state-listed endangered plant species, have been found in two areas within the pool area of the proposed King William Reservoir site. Alternatives for mitigating impacts to this species are discussed in this FEIS.

An active Bald Eagle (*Haliaeetus leucocephalus*) nest is located along Cohoke Creek below the proposed King William Reservoir dam site. The distance now separating the nest and the RRWSG's preferred dam site (KWR-II), including road and spillway, has been increased to approximately 3,000 linear feet. The largest recommended buffer zone around Bald Eagle nest sites in the Chesapeake Bay region has a radius of 1,320 feet (¼ mile). The distance separating the RRWSG's preferred King William Reservoir dam site and the eagle nest is more than twice that recommended distance. An active Bald Eagle nest is also located near the proposed Mattaponi River pump station at Scotland Landing. However, this nest is farther from all pump station facilities than the 1/4-mile outer limit of the largest recommended buffer zone.

No impacts to threatened or endangered species are anticipated as a result of the groundwater and additional conservation measures and use restrictions project components.

1.4.3 Water Quality/Hydrology

Studies have been made of potential salinity intrusion impacts on the Mattaponi River as a result of the proposed withdrawals. Excessive alterations of existing salinity concentration regimes, if they were to occur, could have adverse impacts on tidal freshwater wetland communities. An analysis conducted by VIMS concluded that little or no impact to wetland plant distributions is anticipated as a result of salinity changes caused by proposed freshwater withdrawal levels (Hershner et al., 1991). Further, the incremental salinity changes that would result from the proposed withdrawals, either individually or in combination with other existing and projected consumptive Mattaponi River Basin water uses, appear minimal compared to naturally occurring variability.

A cumulative streamflow analysis was also conducted to estimate the impact of future streamflow reductions on overall, net volumes of water flowing in the Mattaponi River. It is estimated that by the Year 2040, with all currently identified potential uses taken into account, and an estimated average withdrawal of 31.6 mgd for the King William Reservoir project (KWR-II configuration), the average Mattaponi River streamflow would be reduced by 6.4 percent from historical levels.

1.4.4 Cultural Resources

Based on Phase I cultural resource studies of the King William Reservoir project area, there appear to be a relatively large number of sites, especially within the proposed impoundment area. Most are prehistoric sites that were used as temporary hunting/gathering camps or base camps. Formal evaluations of significance (i.e., Phase II testing and assessment) would be conducted on recommended properties so that potential effects can be addressed on any sites which may be eligible for inclusion in the National Register of Historic Places.

Cultural resources also may be located in areas associated with other components of the proposed project requiring construction (i.e., fresh and/or brackish groundwater development). A site survey of areas associated with the various groundwater components would be required prior to construction, to identify (and recover or preserve) any affected cultural resources.

1.5 REQUIRED MAJOR FEDERAL, STATE, AND LOCAL PERMITS

1.5.1 Federal

The USCOE has determined that numerous components of the proposed project require permits pursuant to Section 404 of the Clean Water Act (33 U.S. Code § 1344(a)) and/or Section 10 of the Rivers and Harbors Act of 1899 (33 U.S. Code § 403). Those activities include construction of the Mattaponi River intake structure, the King William (Cohoke Creek) Dam, and pipeline crossings of various stream/wetland areas. These activities were found to constitute "discharges" or "work in or affecting" "navigable waters of the United States," within the meaning of these laws, as defined in USCOE regulations (33 C.F.R. §§ 322.2, 323.2, and Parts 328, 329).

1.5.2 State

Virginia Department of Environmental Quality - Water Division

The Virginia Department of Environmental Quality - Water Division (VDEQ Water Division) has determined that various components of the proposed project will require state permits under several provisions of federal and Virginia law. Those authorities are described below.

Pursuant to Section 401 of the Clean Water Act (33 U.S. Code § 1341(1)), issuance or waiver of a state certification that the proposed discharge will not cause the violation of specified water quality standards is required for the issuance of the USCOE permits. In Virginia, this function is administered by the State Water Control Board (SWCB) and the VDEQ Water Division under the 1989 Water Protection Permit law (Va. Code § 62.1-44.15:5). The Virginia permit program implements Section 401 of the Clean Water Act, and it imposes additional regulatory requirements as a matter of state law.

Pursuant to the Virginia Ground Water Management Act of 1992 (Va. Code §§ 62.1-254 et seq.), a Groundwater Withdrawal Permit is required to withdraw 300,000 gallons or more of groundwater a month within a designated Groundwater Management Area (GMA). The Eastern Virginia GMA includes the area east of Interstate 95 and south of the Mattaponi and York Rivers. Permits are issued by the SWCB and/or the VDEQ Water Division.

In addition, pursuant to the Clean Water Act, 33 U.S. Code § 1342, and the implementing Virginia law (Va. Code § 62.1-44.16), the VDEQ Water Division would require a Virginia Pollution Discharge Elimination System (VPDES) permit for the discharge of untreated water from the groundwater withdrawal system to the Diascund Creek and Little Creek Reservoirs; and a second such permit for discharges of concentrate produced as a by-product of a groundwater desalination treatment process. VPDES permit decisions are based on the nature of both the discharge and the receiving water.

Virginia Marine Resources Commission

Pursuant to the Virginia Wetlands Act (Va. Code §§ 28.2-1300 et seq.), either the Virginia Marine Resources Commission (VMRC), or the local Wetlands Board, must grant a permit for any project which requires building in or disturbing any waterway in the Commonwealth of Virginia or any wetland area in "Tidewater Virginia" (generally, east of Interstate 95).

Virginia Department of Health

Virginia has been granted primacy under the Federal Safe Drinking Water Act, and the Virginia Department of Health (VDH) is responsible for administering both state and federal laws applicable to waterworks operations (subject to certain oversight by the USEPA with respect to federal requirements). The VDH is responsible for issuing permits for waterworks operations, which would indicate the approved capacity of the system (Va. Code § 32.1-172).

Virginia Department of Conservation and Recreation

Pursuant to the Virginia Dam Safety Act (Va. Code §§ 10.1-604 et seq.), the Virginia Soil and Water Conservation Board (which is staffed by the Virginia Department of Conservation and Recreation (VDCR)) must issue construction permits to provide for the proper and safe design, construction, operation, and maintenance of impounding structures, to protect public safety. Construction of the proposed King William Dam would require a VDCR construction permit.

Federal Consistency Certification

Pursuant to the Coastal Zone Management Act of 1972, as amended, the project must be constructed and operated in a manner which is consistent with the Virginia Coastal Resources Management Program (VCRMP). All applicable permits and approvals listed under the enforceable programs of the VCRMP must be obtained.

1.5.3 Local

Erosion and Sediment Control

The Virginia Erosion and Sediment Control Law specifies minimum standards for control of soil erosion, sediment deposition, and non-agricultural runoff (Va. Code §§ 10.1-560 et seq.). The VDCR has responsibility for administration of this law at the state level, and it has promulgated regulations which provide a state erosion and sediment control plan that implements the statutory minimum standards. Localities must adopt a plan that is consistent with the state program and regulations for sediment and erosion control. The RRWSG will be required to submit a sediment and erosion control plan for approval by the counties in which work is conducted.

Chesapeake Bay Preservation Act

The Chesapeake Bay Preservation Act requires localities in eastern Virginia to implement land use controls to improve the condition of Chesapeake Bay waters (Va. Code §§ 10.1-2100 et seq.). That Act is administered by the Chesapeake Bay Local Assistance Department. Localities designate Chesapeake Bay Preservation Areas (CBPAs) within their respective jurisdictions. All project activities occurring within the CBPAs would be required to comply with the appropriate land use controls. These controls are adopted by the localities and enforced through the local zoning process.

Stormwater Management

The Virginia Stormwater Management Act enables local governments to establish management plans and adopt ordinances which require control and treatment of stormwater runoff to prevent flooding and contamination of local waterways (Va. Code §§ 10.1-603.2 et seq.). The law gives the VDCR the authority to promulgate regulations that specify minimum technical criteria and administrative procedures for local stormwater management programs. Local programs must meet or exceed these minimum standards. Localities enact local stormwater management ordinances, and construction activities associated with the proposed project would be required to comply with the appropriate ordinances.

Zoning Requirements

The proposed reservoir site is currently zoned as Agricultural-Conservation. As described in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), King William County would acquire and lease to the City of Newport News sufficient land to create the reservoir and its associated buffer area. Components of the proposed project also require approvals from King William and New Kent Counties under state "local consent" statutes and local Zoning Ordinances.

1.6 DOCUMENT ORGANIZATION

Remaining sections of Volume I of this FEIS Main Report are organized as described below.

- Purpose and Need for Action (Section 2) describes the formation and members of the RRWSG, their objectives, current supplies, water supply concerns, historical and projected demands, projected deficits, political/institutional considerations, and new information pertaining to current supplies and demand projections.

- Evaluation of Alternatives (Section 3) explains the evaluation methodology used, the alternatives considered, and a summary of the practicability and environmental analyses. Also, conceptual mitigation plans, the RRWSG's preferred project alternative, and the RRWSG's currently proposed project alternative are identified.

- Affected Environment (Section 4) reviews the physical, biological, cultural, and socioeconomic resources affected by candidate alternatives.

- Environmental Consequences (Section 5) details the potential impacts of candidate alternatives on physical, biological, cultural, and socioeconomic resources, as well as other environmental concerns. Additional regional needs and impacts are also addressed.

- List of Preparers (Section 6) provides a brief description of the experience and background of individuals who helped collect and prepare the information in this report and its appendices.

- Public Involvement (Section 7) provides information on the public's involvement and interaction in the alternatives selection process.

2.0 PURPOSE AND NEED FOR ACTION

2.1 INTRODUCTION

This section outlines the basis for the study area boundaries, and summarizes the water supplies, demands, and deficit projections applicable to this region. A more detailed review of these topics is contained in Report B, ***Water Supply, Demand and Deficit Projections*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document.

2.2 REGIONAL RAW WATER STUDY GROUP

The Regional Raw Water Study Group (RRWSG) was created in the Fall of 1987 to examine the long-term water supply needs of the Lower Peninsula area of southeast Virginia and to develop a plan for meeting those needs. Jurisdictions included in the regional study area are the Cities of Newport News, Williamsburg, Hampton, and Poquoson, and the counties of York and James City.

The RRWSG is acknowledged by the currently participating jurisdictions (i.e., Newport News (representing Newport News Waterworks and its service area), Williamsburg, and York County) to be an appropriate regional entity to pursue the necessary engineering and environmental studies to search for the least environmentally damaging, practicable alternative(s) to meet the future water supply needs of the study area. To this end, the purpose and goal of the RRWSG has been:

> ***To provide a dependable, long-term public water supply for the Lower Virginia Peninsula, in a manner which is not contrary to the overall public interest.***

The study area encompasses approximately 521 square miles in which more than 400,000 persons currently reside. It is bounded by the James River on the south, the York River on the north, the Chesapeake Bay on the east, and New Kent and Charles City counties on the west. Each of the RRWSG members has responsibility to provide water to its citizens. In addition, Newport News is responsible for serving the cities of Hampton and Poquoson, as well as portions of York and James City counties where most of these jurisdictions' water demands currently exist. Existing water supplies and future demands within the region have been combined and are addressed as a regional unit in this study.

The original concept for a regional raw water supply study was to issue a final Phase I Report which would identify the RRWSG's preferred alternative for meeting the region's water supply deficits over the planning horizon. The preparation of an environmental assessment and the submittal of a permit application for the RRWSG's preferred project to the USCOE would then follow during Phase II. As the Phase I planning process evolved, it became apparent that this original concept, planning period, and procedural strategy would need to change.

The USCOE required that the federal advisory agencies be involved in the identification of practicable alternatives and, further, with the evaluation of practicable alternatives relative to environmental impact. Only through detailed environmental analysis of all practicable alternatives, as part of an EIS, could the USCOE and federal advisory agencies determine which of the candidate projects would be least environmentally damaging and, therefore, most acceptable. Originally, the USCOE intended to have the EIS prepared in two tiers. However, the USCOE and federal advisory agencies were unable to agree on procedural arrangements for conducting a tiered EIS. As a result, the USCOE decided to complete the remainder of this NEPA process using the format of a conventional EIS.

Throughout the process, there has been an active exchange of information and ideas between involved federal, state, and local regulatory agencies, environmental organizations, and the RRWSG. This exchange included single and multi-agency briefing meetings, distribution of project briefing materials and many written and oral communications.

2.2.1 Regional Approach to Water Supply Management

It was recognized in the late 1980s that the continuing growth projected for the Lower Peninsula of Southeast Virginia would result in water demands which would soon exceed the capacity of existing water supply sources. Realizing that additional raw water supply for the Lower Peninsula would likely originate from outside the Newport News Waterworks service area, the City of Newport News initiated an effort to enlist the participation of surrounding communities to join in a regional approach to water supply planning.

Regional cooperation promotes the concept of more effective sharing and the preservation of existing resources, reduces the competition for remaining supplies and provides the economic benefits of single large scale water supply development projects. Most importantly, combining the resources of several jurisdictions with a common need provides the opportunity of considering many more water supply development alternatives, which, in combination, can result in the selection of a plan which has the greatest cumulative benefits and least overall impacts within the region.

The City invited participation from communities within a geographic range which would facilitate cooperation in regional water supply management. Jurisdictions were invited to participate from the Lower Peninsula, Middle Peninsula, and Richmond Planning Districts, and included the Counties of Hanover, New Kent, York, James City, Charles City, King William and Gloucester, and the Cities of Newport News and Williamsburg.

Several organizational meetings were held with potential participants to discuss formation of the group. The first organizational meeting was held on March 18, 1987. It was chaired by then City of Newport News Mayor Jessie Rattley. The following jurisdictions were represented at the meeting: the Counties of Hanover, Henrico, James City, King William, New Kent and York, and the Cities of Newport News, Richmond and Williamsburg. Representatives of the State Water Control Board (SWCB), U.S. Army Corps of Engineers (USCOE), the U.S. Geological Survey (USGS) and the Peninsula Planning District Commission were also in attendance. Subsequent meetings were held in May, June, and August of 1987. An official response regarding participation in the regional study was requested by the City of Newport News by September 15, 1987. A list of the localities requested to participate in the planning effort and their responses are summarized in Table 2-1. These locations on the Lower Peninsula are shown in Figure 2-1.

TABLE 2-1

LIST OF POTENTIAL PARTICIPANTS AND RESPONSES TO PARTICIPATION IN THE REGIONAL RAW WATER STUDY GROUP

Jurisdiction	Response	
Charles City County	No -	Board of Supervisors voted not to participate financially in the study but expressed interest in the efforts of the study group.
Chesterfield County	No -	The County indicated that, at the time, they were part of a four county study group with Amelia, Cumberland, and Powhatan Counties. They were unable to participate, but suggested that both groups maintain contact.
City of Richmond	No -	Richmond showed an overall decrease in water demand, therefore they chose not to participate.
City of Williamsburg	Yes -	The City accepted participation and agreed to contribute financially.
Gloucester County	No -	Gloucester County declined participation.
Hanover County	No -	Hanover County responded through the Pamunkey River Water Study Committee which is composed of Hanover, James City, King William, and New Kent Counties. The committee stated that they would not proceed as an entity in the study.
Henrico County	No -	Henrico County determined it was not in their best interest to participate in the study.
James City County	Yes -	James City originally declined, but has since become an active participant.
King William County	No -	King William declined participation in the RRWSG, but has entered into a project host agreement.
New Kent County	No -	New Kent declined participation in the RRWSG, but has entered into a project host agreement.
York County	Yes -	The County accepted inclusion in the study and agreed to contribute financially to the project.

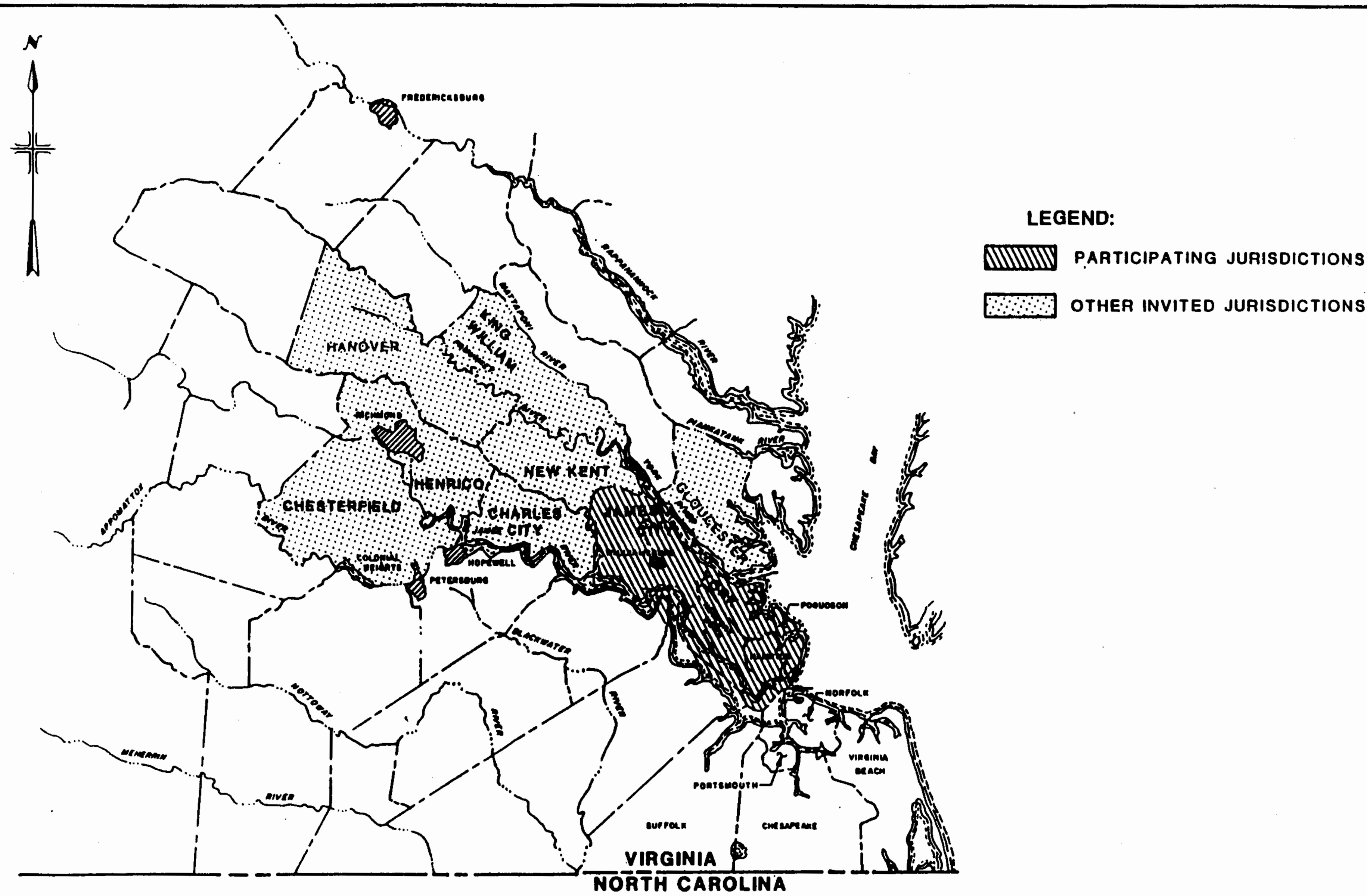


FIGURE 2-1

MALCOLM PIRNIE

LOWER PENINSULA STUDY AREA

MALCOLM PIRNIE, INC.

NOVEMBER 1991

2.3 CURRENT SUPPLIES

The Lower Peninsula is supplied by five principal public water supply systems: Newport News Waterworks, Williamsburg, York County, James City Service Authority, and the federally-owned Big Bethel Reservoir System. Figure 2-2 illustrates the geographic locations of these systems. A schematic of the Lower Peninsula water supply systems is presented in Figure 2-3.

2.3.1 Newport News Waterworks

The City of Newport News operates a regional water supply system serving approximately 350,000 people in the cities of Newport News, Hampton, Poquoson, and portions of York County and James City County. The system consists of a raw water intake on the Chickahominy River, three western storage reservoirs, two terminal reservoirs, two water treatment plants (WTP), and a distribution system with 12 finished water storage tanks. The average daily water production was 48.73 mgd in 1995.

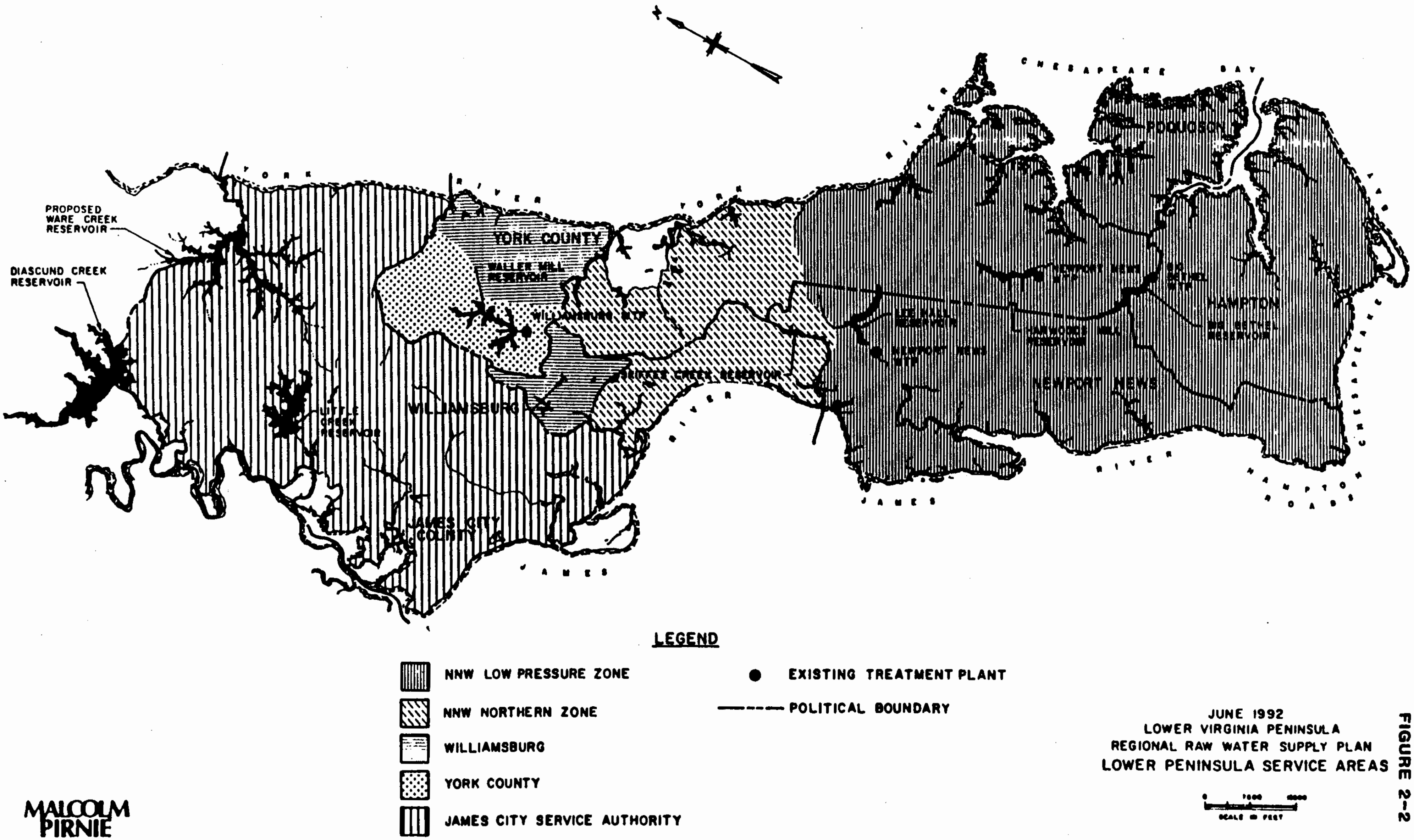
Chickahominy River Withdrawal

The Chickahominy River is the principal raw water source for the Newport News Waterworks system. Raw water from the Chickahominy River can be pumped by a 41 mgd pump station to either terminal reservoir (Lee Hall and/or Harwood's Mill), Little Creek Reservoir, Skiffes Creek Reservoir, Waller Mill Reservoir (owned and operated by the City of Williamsburg), or Big Bethel Reservoir (owned and operated by the U.S. Army). The Chickahominy River raw water intake is located above Walker's Dam, a tidal exclusion dam in New Kent County. The drainage area to the Chickahominy River above Walker's Dam is 301 square miles. The estimated average daily river flow at the intake is 202.3 mgd based on 52 years of record.

A minimum of 10 cubic feet per second (cfs) flow downstream from Walker's Dam must be maintained at all times according to current withdrawal permit requirements. In addition, when the water surface elevation upstream of the dam is less than or equal to 3 feet msl, pumping to Little Creek Reservoir is not allowed according to the Little Creek Reservoir USCOE Permit to Construct. However, water may still be pumped to the other reservoirs as long as the minimum flow-by requirement is met. Newport News also voluntarily stops pumping when chloride levels exceed 100 mg/l at the Walker's Dam intake in accordance with recommended procedures in their current Chloride Action Plan. The City may also stop pumping as a precautionary measure if chloride levels are between 70 and 100 mg/l for a week.

Western Reservoir Operations

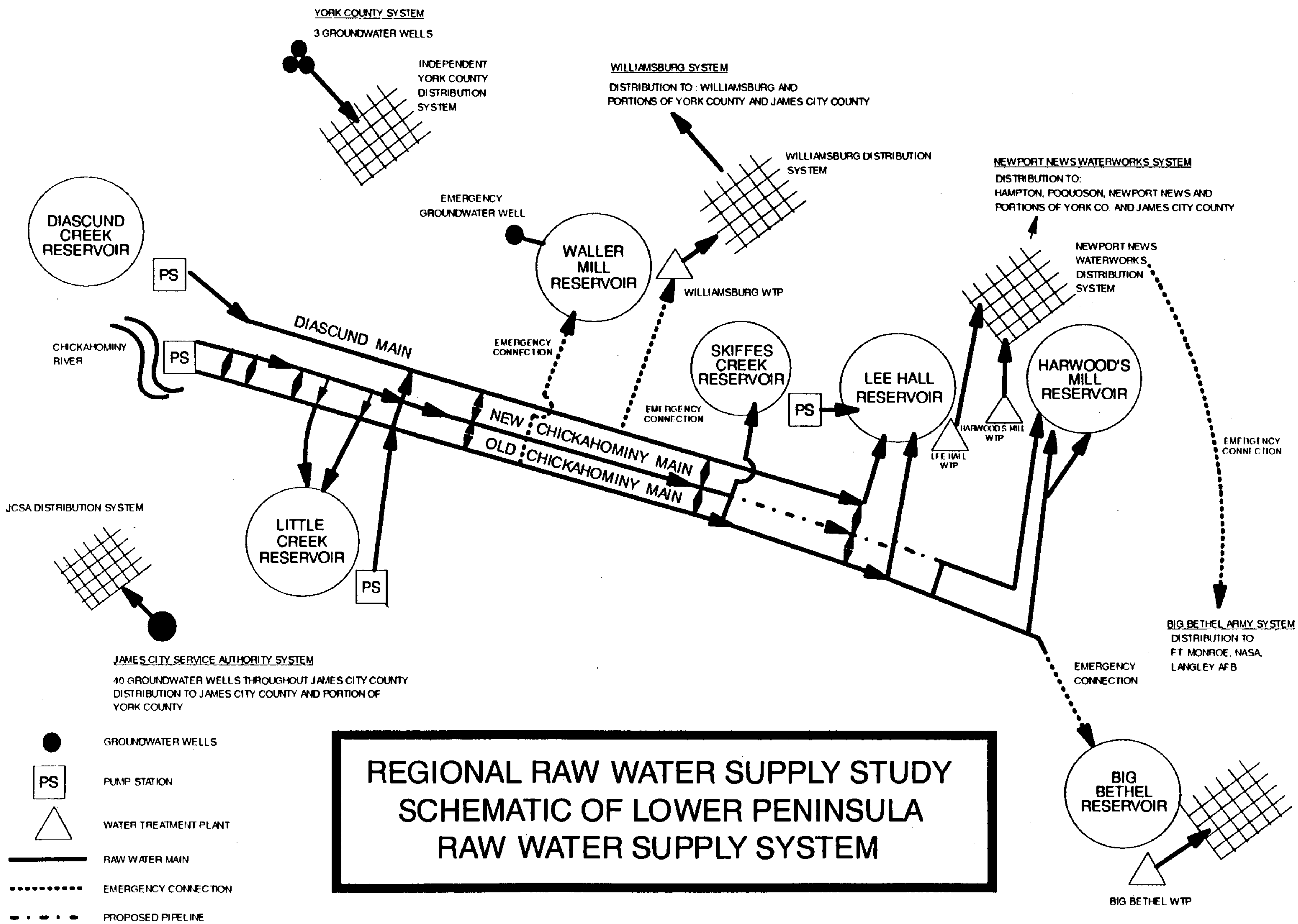
Little Creek Reservoir is the largest of the five reservoirs in the Newport News system. A December 1989 report prepared for the City indicates the total storage in Little Creek Reservoir is 7.48 billion gallons (BG) (CDM, 1989). Due to the small reservoir drainage area (4.6 square miles), pumpover from the Chickahominy River and the Diascund Creek Reservoir is required to maintain levels in the Little Creek Reservoir. The Little Creek pump station capacity is 40.4 mgd.



JUNE 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY PLAN
LOWER PENINSULA SERVICE AREAS

FIGURE 2-2

MALCOLM PIRNIE



REGIONAL RAW WATER SUPPLY STUDY
SCHEMATIC OF LOWER PENINSULA
RAW WATER SUPPLY SYSTEM

FIGURE 2-3

Little Creek Reservoir becomes drawn down when low flows in the Chickahominy River cause a curtailment of pumpover operations. Water from the Little Creek Reservoir can be pumped to five other impoundments: Skiffes Creek Reservoir, Lee Hall Reservoir, Harwood's Mill Reservoir, Waller Mill Reservoir, or Big Bethel Reservoir.

The Diascund Creek Reservoir has the largest drainage area, 44.6 square miles. The reservoir provides 3.49 BG total storage. The pump station can pump water out of the reservoir at a rate of 30.3 mgd.

Skiffes Creek Reservoir is the smallest reservoir in the Newport News system with a drainage area of 6.25 square miles and 0.23 BG of storage. This source is supplemented by a 20-inch interconnection to the main raw water transmission system from the Chickahominy River pump station. Skiffes Creek has a 3.0 mgd pump station that can only pump to the Lee Hall Reservoir.

Terminal Reservoir Operations

The Lee Hall Reservoir is a terminal reservoir used for on-site storage for the Lee Hall WTP. The impoundment has 0.88 BG of total storage, has a drainage area of 14.6 square miles, and receives water from the Chickahominy River, Diascund Creek Reservoir, Little Creek Reservoir, and Skiffes Creek Reservoir.

The Harwood's Mill Reservoir is also a terminal reservoir used for on-site storage for the Harwood's Mill Water Treatment Plant. The impoundment has 0.85 BG of total storage, a drainage area of 8.6 square miles, and receives raw water from the Chickahominy River, Little Creek Reservoir, and Diascund Creek Reservoir.

Raw Water Transmission System

Newport News Waterworks is in the process of completing the final pipeline segments in the transmission system that will increase the maximum rate of flow from the western reservoirs that can be delivered to the terminal reservoirs to 78 mgd, up from the 67 mgd available in 1996. However, since the current transmission capacity already exceeds the safe yield of the reservoirs from which water is withdrawn, these improvements will not safely increase current supply.

The Chickahominy River Pump Station at Walker's Dam discharges to the Old Chickahominy and New Chickahominy Mains. The Old Chickahominy Main consists of 10.3 miles of 34-inch main followed by 15.5 miles of 39-inch main, 5.2 miles of 34-inch main, and 1.4 miles of 30-inch main with outfalls to the Lee Hall and Harwood's Mill reservoirs.

Following the expansion of the Lee Hall WTP in conjunction with the construction of the Diascund Creek Reservoir, the 42-inch Diascund Main was installed from Diascund Creek Reservoir approximately 40 miles to Lee Hall Reservoir, with interconnections to the Old Chickahominy Main.

After expansions at Lee Hall WTP, installation of a third raw water main (the New Chickahominy Main) was begun to aid in the transmission of water from the Chickahominy River Pump Station to the Lee Hall and Harwood's Mill Reservoirs. The final segment of this main is projected to be completed in the Year 2000.

The three mains are interconnected at many points along their lengths, to provide flexibility for operations, maintenance, and flow routing. Emergency connections/outfalls to Waller Mill Reservoir, the Williamsburg Water Treatment Plant, and Big Bethel Reservoir are available. Figure 2-3 provides an illustration of the Newport News raw water transmission system and its interconnections and outfalls.

The four raw water pump stations in the Newport News system have a combined total capacity of 135 mgd. The table below lists the pump stations and their respective number of pumps and rated capacities.

Pump Station	Number of Pumps	Capacity (mgd)
Chickahominy River	10	61
Diascund Creek	2	30.3
Little Creek	2	40.4
Skiffes Creek	3	3.0

Water Treatment

The Newport News Waterworks currently operates three treatment plants. Two of these plants, Lee Hall Plants No. 1 and 2, are interconnected and have a Virginia Department of Health (VDH) combined rated capacity of 54 mgd. Their combined physical capacity, or the maximum amount they could treat, is 57 mgd. The Harwood's Mill Plant has a total VDH rated capacity of 31 mgd with a physical capacity of 40 mgd. Total VDH rated capacity of the three plants is 85 mgd with a total physical capacity of 97 mgd.

Distribution

The system finished water storage capacity currently totals 32.2 million gallons (MG) in 15 existing storage facilities. There are 7 elevated tanks, 4 remote ground storage tanks, 3 plant site ground tanks, and 1 plant site clearwell.

Pending Groundwater Applications

The City of Newport News has applied for a permit to develop a groundwater project producing 5.7 mgd of treated water safe yield, and the VDEQ has issued a draft permit for that project. This application represents a first step in the development of new groundwater supplies that were included as both interim and long-term components of the proposed project. A final state permit has not been issued, and the project has not been constructed, tested, or placed in operation. Therefore, it remains as a new groundwater supply component of the proposed project, rather than as an existing supply.

The proposed project which was described in the DEIS included a fresh groundwater component. However, due to difficulties in reaching the necessary agreements with New Kent and James City Counties to allow development of new fresh groundwater well fields in those counties, Newport News is pursuing a groundwater project which would include brackish groundwater desalination, to be located within the city limits of Newport News. It is being sized to provide adequate additional water supply over the period of time required for developing the reservoir with river pumpover component of the proposed project. The present project configuration includes a withdrawal of 7 mgd of brackish groundwater. Following treatment, this project will produce an increase in the VDH rated capacity of the system of 5.7 mgd.

2.3.2 City of Williamsburg

The City of Williamsburg Department of Public Utilities operates a water system serving approximately 17,500 people within the City, the College of William and Mary, Camp Peary in York County, and several subdivisions in James City and York Counties. The water system obtains raw water from the Waller Mill Reservoir, an augmentation well near the reservoir, and interconnections with the Newport News Waterworks raw water system.

Waller Mill Reservoir, located in York County, has 1.42 BG of total storage capacity. The watershed is approximately 7 square miles. A 505-foot deep augmentation well adjacent to the reservoir with discharge directly to the reservoir is rated at 500 gpm (0.72 mgd) and has a pumping capacity of 0.68 mgd. A 34-inch interconnecting line runs from the Newport News Old Chickahominy Raw Water Main to the Waller Mill Reservoir. An additional 12-inch line connects the 42-inch Diascund Raw Water Main directly to Williamsburg's Waller Mill WTP.

A contract for raw water supplied to Williamsburg from Newport News Waterworks allows for the purchase of 2.5 mgd during the months of June through September and 3.0 mgd for the remainder of the year. However, at times Newport News Waterworks has provided water in excess of the contracted amount when requested to do so by the City of Williamsburg.

The Waller Mill WTP has a rated treatment capacity of 7 mgd and feeds a distribution system of five finished water storage tanks with a total capacity of 3.5 MG. The City of Williamsburg has completed the design phase for rehabilitation of the Waller Mill Plant. The project will upgrade the mechanical components of the 51-year old facility, but will not increase its capacity (Regional Raw Water Study Group, 1996).

2.3.3 York County

The majority of York County's water supply needs are currently met by the Newport News Waterworks and Williamsburg water systems. Lower York County is served primarily by Newport News Waterworks while Upper York County receives its water from Williamsburg, Newport News Waterworks, several private water companies, and York County.

The York County Department of Environmental Services owns and operates three wells serving approximately 750 people in the Skimino Hills and Banbury Cross subdivisions. Well No. 1 is 305 feet deep and has a 60 gpm submersible pump that fills two 15,000-gallon storage tanks. Two 150 gpm booster pumps charge a 1,000-gallon hydro-pneumatic tank for distribution. Well No. 2 is 324 feet deep and has a 60 gpm submersible pump that discharges to a single 15,000-gallon storage tank. Two 160 gpm booster pumps charge a 1,000-gallon hydro-pneumatic tank for distribution. Well No. 3 is 283 feet deep, has a 70 gpm submersible pump, and discharges to a 30,000-gallon storage tank. Two 100 gpm booster pump charge a 2,000-gallon hydro-pneumatic tank for distribution. The system's permitted design capacity is 120,000 gallons per day with all three wells operating.

The York County Department of Environmental Services also operates two wells in the Lightfoot area of the County. The wells were completed in 1996 and have a VDEQ permitted withdrawal capacity of 0.58 mgd. It is anticipated that the Lightfoot well system will be fully operational by the Year 2000.

The County sells water supplied by the Newport News Waterworks to Sydnor and two other private water companies. In addition, the U.S. Coast Guard Reserve Training Center and the Yorktown Naval Weapons Station are also supplied by the Newport News Waterworks. Camp Peary receives its water from the City of Williamsburg, while Cheatham Annex Naval Supply Center currently obtains water from Jones Pond. Cheatham Annex has recently expressed an interest in receiving water from the Newport New Waterworks system. As of August 1996, preliminary discussions between the City of Newport News and Cheatham Annex were underway, but no agreements had been reached (E. M. Leininger, City of Newport News Waterworks, personal communication, 1996).

In January 1996, an agreement was executed between York County and the City of Newport News stating that the City will make water available to areas of the County which are not currently served by Newport News Waterworks. Availability of the water is contingent upon the City obtaining all required permits for the King William Reservoir Project. This agreement is designed to help meet the County's long-term water needs and provide a uniform, defined water supply strategy for the County (Regional Raw Water Study Group, 1996).

The safe yield planning values adopted for use in deficit projections are 0.12 mgd for Year 1990 increasing to 0.70 mgd for Year 2000 and beyond to account for the increase in yield resulting from operation of the Lightfoot well distribution system.

2.3.4 James City Service Authority

The James City Service Authority (JCSA) owns and operates a total of 31 wells within its central system. In addition, the JCSA operates six independent well systems serving small residential developments. The JCSA central system has a VDH rated system capacity of 3.92 mgd, while the capacity of the JCSA's isolated systems is 0.25 mgd.

Groundwater wells on the JCSA's central system have historically experienced water quality and operational problems. The potential exists that additional wells on the central system will also experience similar problems in the future. To decrease their reliance on the existing central system wells and replace the pumping capacity lost by removal of the standby wells, the County is currently in the process of constructing three new production wells in the Potomac Aquifer (Regional Raw Water Study Group, 1996). The JCSA is in the process of applying to the VDEQ to withdraw an additional 2.0 mgd of groundwater to meet near-term demands. To meet the additional demand through the Year 2040, James City County has entered into a Memorandum of Understanding with the City of Newport News to purchase 4.0 mgd from the City, contingent upon implementation of a proposed King William Reservoir project.

For planning purposes, it is assumed that the JCSA will rely on groundwater only to the extent that surface water supplies are not available to meet demands. Through the planning horizon, it is assumed that 2 mgd of safe yield would be provided by the JCSA's groundwater supplies.

2.3.5 U.S. Army at Fort Monroe

The Big Bethel Reservoir serves Langley Air Force Base, Fort Monroe, and the NASA Langley Research Center. The reservoir volume is 0.61 BG and the safe yield of the system is 2.0 mgd. The treatment plant has a rated capacity of 4 mgd and a finished water storage capacity of 4.85 MG. Fort Monroe, Langley Air Force Base, and NASA also purchase finished water from Newport News Waterworks when the Big Bethel system is off-line for maintenance or during drought periods.

The Big Bethel Water Treatment Plant was constructed in 1919 and has been repaired and renovated several times since its original construction. It's most recent renovations were completed in July 1996. The plant renovation has resulted in treated water of high quality which is supplied to the Army's customers. The recent renovations will allow the plant operators to meet the current requirements of the Safe Drinking Water Act (SDWA) (Sprock, 1996).

The Big Bethel Reservoir is located at the confluence of the boundaries of Newport News, Hampton and York County. Originally located in the rural, interior portion of the Lower Peninsula, the reservoir is now surrounded by suburban development, and its upstream drainage area has been developed as the Kiln Creek Development, including residential and commercial areas and an 18-hole golf course. The Oyster Point Business Center area is also located within the upstream drainage area of the reservoir. The amount of undeveloped area within the watershed has decreased drastically in recent years, from 63 percent in 1985 to approximately 33 percent in 1990 (Wiley & Wilson, 1991). This change in land use of the area surrounding the reservoir, coupled with the fact that the reservoir has only a minimal fringe of protected watershed, has the potential to adversely affect runoff and reservoir water quality.

Although the Big Bethel Water Treatment Plant is currently operating in an efficient manner and providing high quality water, concerns for the future reservoir water quality brings into question the future viability of the entire Big Bethel system. These include:

- Reservoir Water Quality - Increased loading of pollutants to reservoir from urbanized watershed area may cause degradation of overall raw water quality.

- Siltation - Increased siltation due to run-off from developed areas may accelerate losses in reservoir storage volume

- Safe Drinking Water Act - Future requirements could require the addition of new treatment processes. Although the existing treatment plant was recently renovated, the renovations do not address possible future SDWA requirements such as Stage II Disinfection By-Products or an Enhanced Surface Water Treatment Rule. It may become economically or technically infeasible to comply with future SDWA requirements.

- Big Bethel Water Treatment Plant Age - The plant was originally constructed in 1919. The age of this plant well exceeds the typical life expectancy (approximately 50 years) for water treatment plant design. As a comparison, Newport News Waterworks is already preparing to abandon Lee Hall Water Treatment Plant 1, which was built in the early 1900's.

A combination of these factors could lead to the abandonment of the Big Bethel Water Treatment Plant as a source of potable water, and the use of the Newport News Waterworks system to supply water to Langley AFB, NASA and Fort Monroe. In consideration of the factors previously noted, and the 50-year planning period of this study, the safe yield of the Big Bethel system will be projected to remain available until the Year 2010. After 2010, it is assumed that the yield will no longer be available, and the water demands of Langley AFB, NASA and Fort Monroe will be met by the Newport News Waterworks system. This is a conservative assumption for use in water supply planning and has not been officially endorsed by the U. S. Army.

2.3.6 Current Supply Summary

The characteristics of the current raw water sources for each of the five Lower Peninsula region water supply systems are summarized in Table 2-2.

2.3.7 Current Safe Yield

Table 2-3 contains a listing of reported raw water system safe yields for the Lower Peninsula's public water supply systems, with references. Adjustments to those yields are necessary to account for reservoir seepage losses, transmission losses, and water treatment plant losses.

The adopted safe yields and reliable system delivery capacities of each public water supply system on the Lower Peninsula were calculated using the accepted SWCB methodology, and they are listed in Table 2-4. A complete explanation of the safe yield determination methodology and a detailed review of the safe yield analyses is provided in Report B.

Figure 2-4 is a schematic representation of the overall regional system delivery capacity concept. The regional reliable system delivery capacity estimate of 61.9 mgd represents the estimated average daily volume of finished water available for distribution throughout a period of time in the future during which the drought of record rainfall pattern is repeated. It must be noted that the supplies are intended to satisfy average day treated water demands, not peak usage demands.

The safe yield value presented above is at best an estimate of the current capability of the Lower Peninsula's public water supply systems to meet area demands. The "safe yield" is the theoretical maximum volume of water that a water supply system could provide continuously through the drought of record without totally depleting all usable storage. Safe yield calculations invariably overstate the amount of water that actually is available for distribution during a critical drought.

Water system managers do not operate their systems in reliance on theoretical maximum safe yields, because there is no guarantee that the rated source pump capacities and transmission capacities will be available throughout a critical drought and recovery period. During these periods, water systems are stressed and cannot operate at the high levels of efficiency that are assumed in the safe yield calculations. In addition, a given drought could be longer or more severe than the drought of record used in safe yield calculations. Water system managers therefore impose mandatory use restrictions before reservoir storage drops to levels approaching total depletion, to preserve water in case estimated safe yields are wrong or the drought becomes more severe than the drought of record for the system. It would be impossible to know, until after the fact, whether or not a current drought was less or more severe than the drought used to estimate the maximum historical yield. A 58-year hydrologic record was used to estimate the safe yield of the Newport News Waterworks' existing water supply systems. However, this water supply planning study considers a 50-year planning horizon, in which there is a high risk that a more severe drought would occur.

TABLE 2-2

EXISTING RAW WATER SOURCE CHARACTERISTICS

<u>NEWPORT NEWS WATERWORKS</u>

Chickahominy River

- 61 mgd capacity pump station at Walkers Dam
- 301 square mile drainage area at the intake
- 202.3 mgd estimated average daily flow at the intake (52 years of record)
- Pumping Rules:
  - A minimum of 10 cfs flow downstream from Chickahominy Reservoir (i.e., Walkers Dam) must be maintained at all times.
  - When water surface elevation upstream of Walkers Dam is ≤3.0 feet MSL, cannot pump to Little Creek Reservoir.
  - Chloride Action Plan recommends that pumping stop when chloride levels exceed 100 mg/l at the intake, or if chloride levels are between 70 and 100 mg/l for a week (self-imposed).

Drainage Reservoirs	Total Area (sq.mi.)	Water Surface Storage (BG)	Area (Acres)
Diascund Creek	44.6	3.49	1,110
Little Creek	4.6	7.48	947
Skiffes Creek	6.25	0.23	94
Lee Hall (Terminal)	14.6	0.88	493
Harwood's Mill (Terminal)	8.6	0.85	265
TOTALS	**78.65**	**12.93**	**2,909**

Sources: CDM, 1989

TABLE 2-2

EXISTING RAW WATER SOURCE CHARACTERISTICS
(Continued)

WILLIAMSBURG

Groundwater Well No. 1

- Augments reservoir
- 505 ft. deep well
- 0.68 mgd pumping capacity

Reservoir	Drainage Area (sq.mi.)	Total Storage (BG)	Water Surface Area (Acres)
Waller Mill	7.0	1.42	308

Sources: CDM, 1989
SWCB, 1983

YORK COUNTY

Groundwater Wells, Skimino Hills/Banbury Cross No. 1, No. 2 and No. 3:

- Serves Skimino Hills and Banbury Cross Subdivisions
  - 305 ft., 324 ft. and 283 ft. deep, respectively
  - Wells have submersible pumps which operate at between 60 and 70 gpm

Groundwater Wells, Lightfoot No. 1 and No. 2:

- New wells completed in 1996
- 318 ft. and 310 ft. deep, respectively
- VDEQ permitted withdrawal capacity of 0.58 mgd

Sources: Current VDH Engineering Description Sheet
Well completion reports

TABLE 2-2

EXISTING RAW WATER SOURCE CHARACTERISTICS (Continued)

JAMES CITY SERVICE AUTHORITY

Groundwater Wells

- 31 wells on Central System; six independent well systems serving small residential developments
- Wells range in depth from 204 ft. to 725 ft. deep
- VDH Central System capacity of 3.92 mgd. VDH capacity of isolated systems is 0.25 mgd.

Source: JCSA, April, August, and October 1991; L. Foster, JCSA, personal communication, 1996.

BIG BETHEL

Reservoir	Drainage Area (sq.mi.)	Total Storage (BG)	Water Surface Area (Acres)
Big Bethel	7.9	0.61	238

Source: CDM, 1989

TABLE 2-3

REPORTED YIELDS OF EXISTING SYSTEMS *

System	Reported Raw Water Yield (mgd)	Reported Well Yield (mgd)	Reference
Newport News Waterworks			
Chickahominy River withdrawal and five storage reservoirs	57.0 60.0 57.8		SWCB-1 and USCOE VDH-1 CDM
Williamsburg			
Waller Mill Reservoir (does not include 0.68 mgd Augmentation Well No. 1)	3.0 3.08 3.5 4.5		USCOE VDH-2 SWCB-1 W&W
York County			
Skimino Hills/Banbury Cross Wells No. 1, No. 2 and No. 3	0.120		VDH-3
Lightfoot Wells No. 1 and No. 2		1.067	SWCB-2
James City Service Authority			
31 Groundwater Wells	4.17		JCC
Big Bethel			
Big Bethel Reservoir	2.0		USCOE

* The safe yield values adopted for use in this report are presented in Table 2-4. A complete explanation of the safe yield determination methodology is provided in Appendix Report B.

TABLE 2-3

REPORTED YIELDS OF EXISTING SYSTEMS
(Continued)

SOURCES:

SWCB-1	Virginia State Water Control Board, "Safe Yield of Municipal Surface Water Supply Systems in Virginia." Planning Bulletin No. 335. March 1985.
USCOE	U.S. Army Corps of Engineers, Norfolk District, "Feasibility Report and Final Environmental Impact Statement - Water Supply Study, Hampton Roads, Virginia." December 1984.
VDH-1	Virginia Department of Health, Current Waterworks Operation Permits, 1988.
VDH-2	Virginia Department of Health, Water Description Sheet, as referenced in SWCB, "James Water Supply Plan." March 1988.
CDM	Camp Dresser & McKee, "Task 7 Letter Report on Methods to Increase Safe Yield". Prepared for the City of Newport News. December 1988.
W&W	Wiley and Wilson, "Comprehensive Water System Study for the City of Williamsburg, Virginia." April 1985.
VDH-3	Virginia Department of Health, Current Waterworks Operation Permit, 1988.
SWCB-2	Virginia State Water Control Board, Certificates of Groundwater Right, March 1991.
JCC	L. M. Foster (General Manager, James City Service Authority), personal communication, 1996.

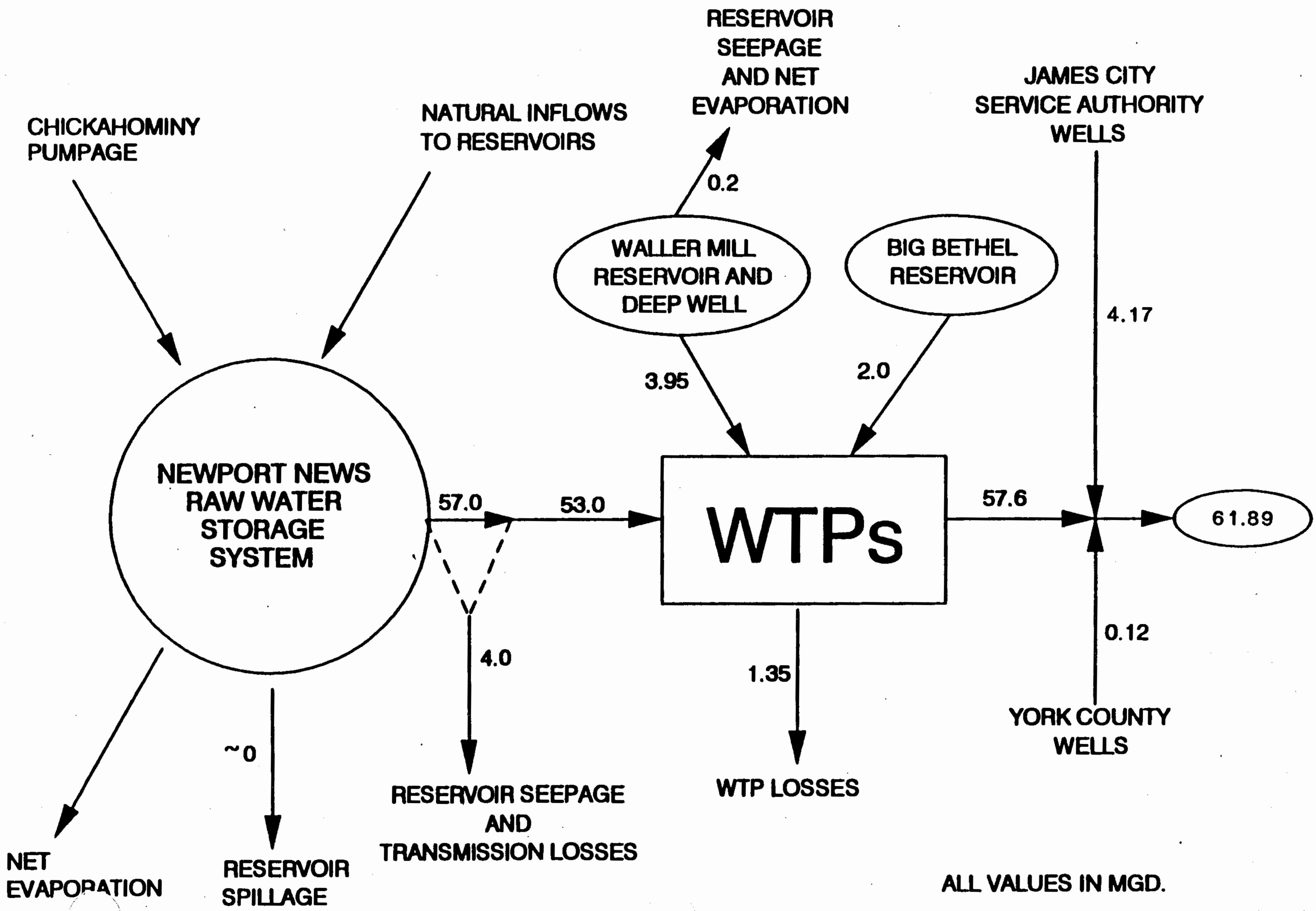
TABLE 2-4

ADOPTED YIELDS OF EXISTING SYSTEMS (MGD)

Supply System	**Raw Water Safe Yield (mgd)**	**Reliable System Delivery Capacity * (mgd)**
Newport News Waterworks	57.0	51.9
Williamsburg	4.15	3.8
York County	0.12 0.70 (2000)	0.12 0.70 (2000)
James City Service Authority	4.17 2.00 (2000)	4.17 2.00 (2000)
Big Bethel	2.0 0.0 (2011)	1.9 0.0 (2011)
TOTAL FOR LOWER PENINSULA	**67.44** **65.27 (2000)** **63.85 (2011)**	**61.89** **60.30 (2000)** **58.40 (2011)**

* Treated Water Yield

REGIONAL SYSTEM DELIVERY CAPACITY



ALL VALUES IN MGD.

FIGURE 2-4

In addition, any new surface water withdrawals developed on the Chickahominy River upstream of Walker's Dam would reduce available flow in the Lower Peninsula's principal water supply source. Further depletion of groundwater resources, and/or development in groundwater recharge areas that reduced surface water infiltration to the groundwater aquifer system, likewise would reduce the yields of area groundwater systems. Consequently, there is a risk that the region's water supply systems would be unable to provide their estimated safe yields in the future.

For purposes of this long-term water supply planning effort, a safe yield estimate for the Newport News Waterworks system was adopted, which takes into account the many uncertainties which exist, such as those outlined above. This estimate relies, in part, on the definition of minimum acceptable reservoir storage as one-third of total storage[1]. This minimum storage level was adopted to simulate the Waterworks' operating practices and, as discussed below, to afford water quality and aquatic habitat protection.

Newport News Waterworks has experienced severe water quality problems in its reservoirs when they have been drawn down below the minimum acceptable storage level. For example, the bottom sediments of Diascund Creek Reservoir act as a sink for phosphorus under normal conditions. Water quality was severely degraded, and the Reservoir was classified as highly eutrophic, as it was drawn down to levels between 20 and 25 percent of its total capacity during an 8-month period in 1983 and 1984. This drawdown triggered the release of phosphorus stored in the sediments.

If all physically available storage in the Newport News Waterworks system were depleted, large areas of the reservoir bottoms would be exposed. The remaining reservoir surface areas at the Little Creek and Diascund Creek Reservoirs, for example, would be only 23 percent of the normal areas. Such conditions could cause negative impacts to valuable resources, such as established fisheries and wetlands, which are present at the existing reservoirs.

Designation of a minimum acceptable storage level for any water system is a utility operating decision. For the Newport News Waterworks system, it was defined to closely simulate actual Waterworks operating practices and to afford water quality and aquatic habitat protection. For the reasons cited in the preceding paragraphs, minimum acceptable reservoir storage for the existing Newport News Waterworks system is defined as one-third of total storage.

2.3.8 Rate Structures

Newport News Waterworks

Water commodity rates are set to cover all capital and operating expenses incurred for the production and delivery of treated water. They are designed so that customers pay the true costs of the actual amount of water they use; and as a result, customers have a tangible incentive to conserve. A bi-monthly billing cycle allows customers to detect leaks more quickly and to recognize the cost of high seasonal water use. A bi-monthly billing cycle also allows more frequent feedback on conservation efforts.

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[1] One-third of total storage corresponds to approximately one-fourth of available storage since approximately 12 percent of total system storage is physically unavailable for withdrawal.

The Newport News Waterworks billing structure has completely transitioned from a declining rate structure to a uniform rate structure in July 1995. Under a declining block system, the unit price of water decreases as the quantity used increases. During the 1980s, Waterworks converted from a five-block to a three-block declining schedule. In 1988, Waterworks transitioned to a two-block declining rate schedule. From 1988 to July 1995, Waterworks increased the relative percentage of Block 2 to 100 percent of Block 1 rates. With this change, water rates throughout the entire core planning area are now uniform within each service area, regardless of the rate of consumption.

Newport News Waterworks also has implemented special charges to encourage water conservation. In 1989, Waterworks established a Summer Conservation Rate, which was renamed the Summer Consumption Rate (SCR) in 1993. The SCR helps to establish more equitable rates, by applying a surcharge to those who contribute toward seasonal peaking of demand on the water system. The charge theoretically applies to nonessential, outside uses of water occurring during the summer months. Average usage in winter months is used to set a threshold level. Any water used in excess of the threshold level during the summer months is deemed nonessential and is billed at the summer rate.

In addition, Newport News Waterworks has implemented a System Development Charge, as a means of charging new customers for the impacts of their additional use on the water supply system, such as the need for new water sources, increased treatment capacity, increased storage capacity, and additional distribution capability.

City of Williamsburg

Water rates are charged at a single uniform rate. The uniform rate is set to cover all capital and operating expenses incurred in the existing production and delivery of treated water.

As an action designed to apportion the cost of providing water fairly, an Availability Fee for new customers was also established. This fee is based on meter size and reflects the impact new customers will have on the water supply system and requires them to pay accordingly.

York County

Water rates are set at a uniform rate to cover all operational costs and, as a result, customers pay the true cost for the actual amount of water used.

James City Service Authority

The Authority adopted the region's only inclining rate structure effective July 1, 1996. Under this rate structure, the unit cost for water volume increases as the quantity of water used increases. A Summer Surcharge Rate is also used to charge a higher rate for water used in excess of each customer's winter average. In addition, a System Facilities Charge was implemented to charge new customers for the impact they have on the system.

2.4 WATER SUPPLY CONCERNS

Water supply concerns relative to the RRWSG's objective include the dependency of certain areas on groundwater supplies, the designation of the Lower Peninsula area as a groundwater management area, and the dependency of the RRWSG's major supplier (Newport News Waterworks) on the Chickahominy River.

Future groundwater development is restricted in the area by its identification as a groundwater management area. The VDEQ has determined that overdevelopment of groundwater in this area would cause groundwater quality deterioration and salt water intrusion into depleted aquifers.

The dependency of Newport News Waterworks and its extended service area on Chickahominy River withdrawals leaves the area vulnerable in the event of a severe drought or Chickahominy River contamination.

Some of the region's water supply systems may experience considerable problems as a result of drought conditions. For example, Waterworks has experienced considerable water quality problems in its reservoirs when they have been markedly drawn down. Water quality was severely degraded and Diascund Creek Reservoir was classified as hypereutrophic on the basis of a mean total phosphorus concentration of 0.09 mg/l, when it was drawn down to between 20 and 25 percent of total capacity during an 8-month period in 1983 and 1984. Concentrations of phosphorus are higher during reservoir drawdown because of:

- Decreased settling time for tributary inflows of phosphorus.
- Increased exposure of fine-grained, phosphorus-rich bottom sediments to resuspending forces.
- Increased algal uptake of phosphorus directly from bottom sediments (Lynch, 1992).

2.5 HISTORICAL DEMANDS

Historical treated water usage data were analyzed from various reports and studies published by the state and by the Lower Peninsula jurisdictions to determine current demand. These included the following:

- *Water Supply Study, Hampton Roads, Virginia, Feasibility Report and Final Environmental Impact Statement*, Norfolk District, U.S. Army Corps of Engineers. December 1984.
- *Safe Yield of Municipal Surface Water Supply Systems in Virginia*, Commonwealth of Virginia, Virginia State Water Control Board, Planning Bulletin No. 335. March 1985.
- *Comprehensive Water System Study for the City of Williamsburg, Virginia*, Wiley & Wilson. April 1985.

- *Comprehensive Water Study*, Buchart-Horn, Inc., Prepared for the County of York. November 1985.

- *Newport News Raw Water Management Plan*, Camp, Dresser & McKee. December 1989.

- *James Water Supply Plan, Parts 1 and 2*, Virginia State Water Control Board, Planning Bulletin No. 337. March 1988.

- *Water Distribution System Study*, Prepared for the City of Newport News, Camp, Dresser & McKee. November 1986.

In addition, treated water pumpage records and customer billing records for the past four or more years were obtained from the Lower Peninsula water purveyors to assist in this demand determination.

2.5.1 Raw Water Withdrawals

Average annual raw water withdrawals for each system in the Lower Peninsula are presented in Table 2-5. Average withdrawals for the later years presented in this table are approximately 52 to 55 mgd. (The safe yield of these systems is approximately 62 mgd).

2.5.2 Treated Water Demands

The average daily water demands for each public water supply system on the Lower Peninsula are listed in Table 2-6. The total regional finished water pumpage to distribution in the base Year 1990 was approximately 55.2 mgd. (Regional system delivery capacity is estimated to be 61.9 mgd).

A record of annual average daily metered consumption for the Newport News Waterworks system from 1968 to 1990 is presented graphically in Figure 2-5. Over this 22-year period, the average increase in demand was 2.65 percent per year.

Treated water consumption increased each year between 1983 and 1990 in the Newport News Waterworks system. However, increases in demand tapered off beginning in 1986. This moderation in demand occurred despite sizable increases in the number of connections to the system (e.g., 3,588 new connections in 1986 and 3,103 new connections in 1987). Three events may have contributed to this decline in per capita water usage.

First, in the summer of 1986, three new booster pumps were installed in the northern zone booster pump station. System pressure in the northern zone was lowered from 85 psi to 75 psi after pump replacement was complete. Main distribution system pressures were also lowered as a result of the pump installation. Pressure reduction in a service area will generally reduce water usage independent of other factors, because leaks and certain in-home water uses will decrease.

Secondly, Newport News Waterworks implemented three separate rate increases, which took effect on July 1, 1986, September 1, 1987, and September 1, 1988. Higher water prices can be expected to affect the water consumption habits of many users. In particular, large water users have decreased their consumption. Camp Dresser & McKee reported that 15 large water users, whose treated water needs are provided entirely by the Newport News Waterworks system, consumed an average daily total of 14.25 mgd in 1985 (CDM, 1986). During 1987 and 1988, these same 15 users

TABLE 2-5

AVERAGE ANNUAL RAW WATER WITHDRAWALS (1982-1990)
(mgd)

Water Supply System	1982	1983	1984	1985	1986	1987	1988	1989	1990
Newport News Waterworks[1]	39.79[2]	42.03[2]	42.15[2]	44.79[2]	47.18[2]	46.43	46.76	45.70	48.83
Williamsburg	3.04	2.98	3.15	3.42	3.66	3.36	3.54	3.63	3.49
York County	NA	0.041	0.034	0.039	0.044	0.044	0.049	0.049	0.051
James City Service Authority	0.75	0.85	0.87	0.93	1.13	1.37	1.40	1.64	1.70
Big Bethel	NA	2.75	3.04	2.93	NA	NA	2.57	--	--

NA = Not available

Notes: [1]Values for Newport News Waterworks represent terminal reservoir withdrawals.
[2]Approximate values, reliable data for 1982 to 1986 were not available for Lee Hall Reservoir.

Sources: Raw water pumpage reports provided by each water supply system.
SWCB, James Water Supply Plan, March 1988.[12]

TABLE 2-6

AVERAGE DAILY WATER VOLUMES PUMPED TO DISTRIBUTION (1984-1990)
(mgd)

Water Supply System	1984	1985	1986	1987	1988	1989	1990
Newport News Waterworks[1]	43.02	44.53	45.15	45.52	46.06	45.98[2,3]	48.41[2,4]
Williamsburg	3.04	3.33	3.58	3.26	3.44	3.52	3.39
York County	0.034	0.039	0.044	0.044	0.05	0.05	0.05
James City Service Authority	0.87	0.93	1.13	1.37	1.40	1.64	1.72
Big Bethel	2.58	2.29	2.38	2.66	2.53[5]	2.5	1.64
Total for Lower Peninsula	49.54	50.73	52.28	52.85	53.58	53.69	55.21

Notes:

[1] Values represent metered consumption for fiscal years 1984 - 1988 adjusted using a 6 percent unaccounted for treated water loss estimate, unless otherwise noted.

[2] Values represent calendar year finished water pumpage metered at the WTPs.

[3] May be low due to meter inaccuracies.

[4] Corrected using results of Pitometer Meter Tests.

[5] Fiscal year October 1 to September 30.

[6] Big Bethel WTP was down for part of 1990 and did not operate to full capacity.

Source: System pumpage records provided by each water supply system, unless noted otherwise.

NEWPORT NEWS WATERWORKS ANNUAL AVERAGE METERED CONSUMPTION (1968-1990)

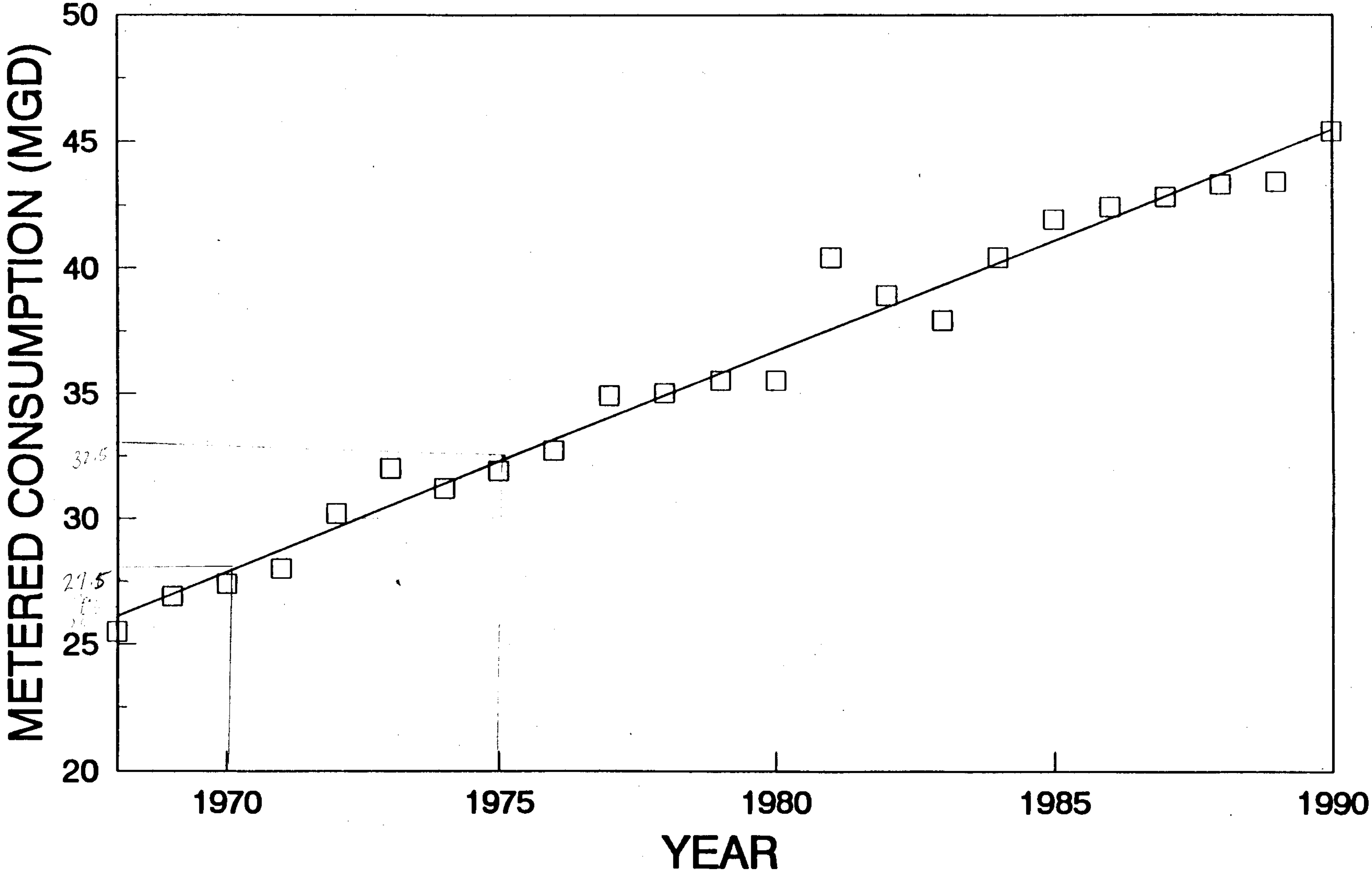


FIGURE 2-5

consumed an average of 12.94 mgd. This change represents a 9.2 percent decrease in demand for these customers.

Finally, in July 1986, Newport News Waterworks implemented voluntary water use restrictions. Voluntary "odd/even" watering and recommended periods for lawn watering were promoted in order to enhance water conservation during the 1986 drought. The 1983 Comprehensive Water System Study for the City of Williamsburg by Wiley & Wilson presented data from a review of billing records which revealed the water demand for the City alone was 2.8 mgd. The 1990 average daily demand for the entire Williamsburg service area was approximately 3.4 mgd.

York County residents, including those living on federal installations, receive water supplies from several public water systems. The following table lists these systems and the demand that each supplied in York County in 1990.

Water System	Water Supplied to York County Users (1990)
York County	0.05 mgd
Newport News Waterworks	6.00 mgd
Williamsburg	0.53 mgd
TOTAL	**6.58 mgd**
Source: Purveyor Billing Records, 1990	

James City County residents are also served by several public water supply systems. The following table lists the public systems supplying water to customers within James City County and the demand that each supplied in the County in 1990.

Water System	Water Supplied to James City County Users (1990)
JCSA	1.72 mgd
Newport News Waterworks	7.13 mgd
Williamsburg	0.20 mgd
TOTAL	**9.05 mgd**
Source: Purveyor Billing Records, 1990	

The majority of the Lower Peninsula population is served by municipal water systems. The following table lists each jurisdiction and the percentage of the 1983 and 1990 population that was served by a public water system. Both York County and James City County are expected to have approximately 90 percent of the users in their jurisdictions served by public systems by the Year 2010.

Jurisdiction	Percentage of Population Served	
	1983	1990
City of Newport News	100	100
City of Hampton	100	100
City of Poquoson	100	100
City of Williamsburg	100	100
York County	75	80
James City County	56	70
Source: SWCB, 1988		

The existing water demands for each public water supply system in the Lower Peninsula, identified as average daily water volumes pumped to distribution, are presented graphically in Figure 2-6. Total regional finished water pumpage to distribution in the base Year 1990 was approximately 55.2 mgd. From 1984 - 1990, the average rate of increase per year was approximately 1.8 percent.

2.5.3 Large Water Users

A list of large treated water users on the Lower Peninsula and their current average daily consumption is presented in Table 2-7. The largest users are Anheuser-Busch, Langley AFB and NASA, Fort Eustis, Newport News Shipbuilding, and American Oil Company (Amoco).

2.5.4 Daily and Seasonal Demand Variations

The average daily demand (ADD) is the total amount of water pumped to distribution in a year, divided by the number of days in that year. For the Newport News system, the maximum day demand (MDD) averages about 1.4 times the average daily demand. The maximum hourly demand (MHD) is the highest single hour of water usage during the year. The MHD for the Newport News system is 1.8 to 1.9 times the ADD.

Seasonal variations of water demands are substantial in the Lower Peninsula. Williamsburg and James City County experience large tourist demands during the summer months. The Williamsburg water treatment plant currently treats between 3.5 to 4.6 mgd in the summer months compared with 2.6 to 3.3 mgd in the winter months. The James City County Commercial tourist demand is estimated to range form 0.1 mgd in the winter to 0.8 mgd in the summer. This range is 1.5 percent to 10.1 percent of the total water usage in James City County.

The variation in water usage in the Newport News system is presented in Table 2-8. The monthly water usage was calculated as a percentage of the annual average and averaged for the 4-year period, 1987 to 1990. The highest water demands for this period occurred in July and September. Seasonal variations in areas that do not have large tourist influxes are typically due to increased consumer usage in response to temperature variations.

AVERAGE DAILY WATER VOLUMES PUMPED TO DISTRIBUTION (1984-1990)

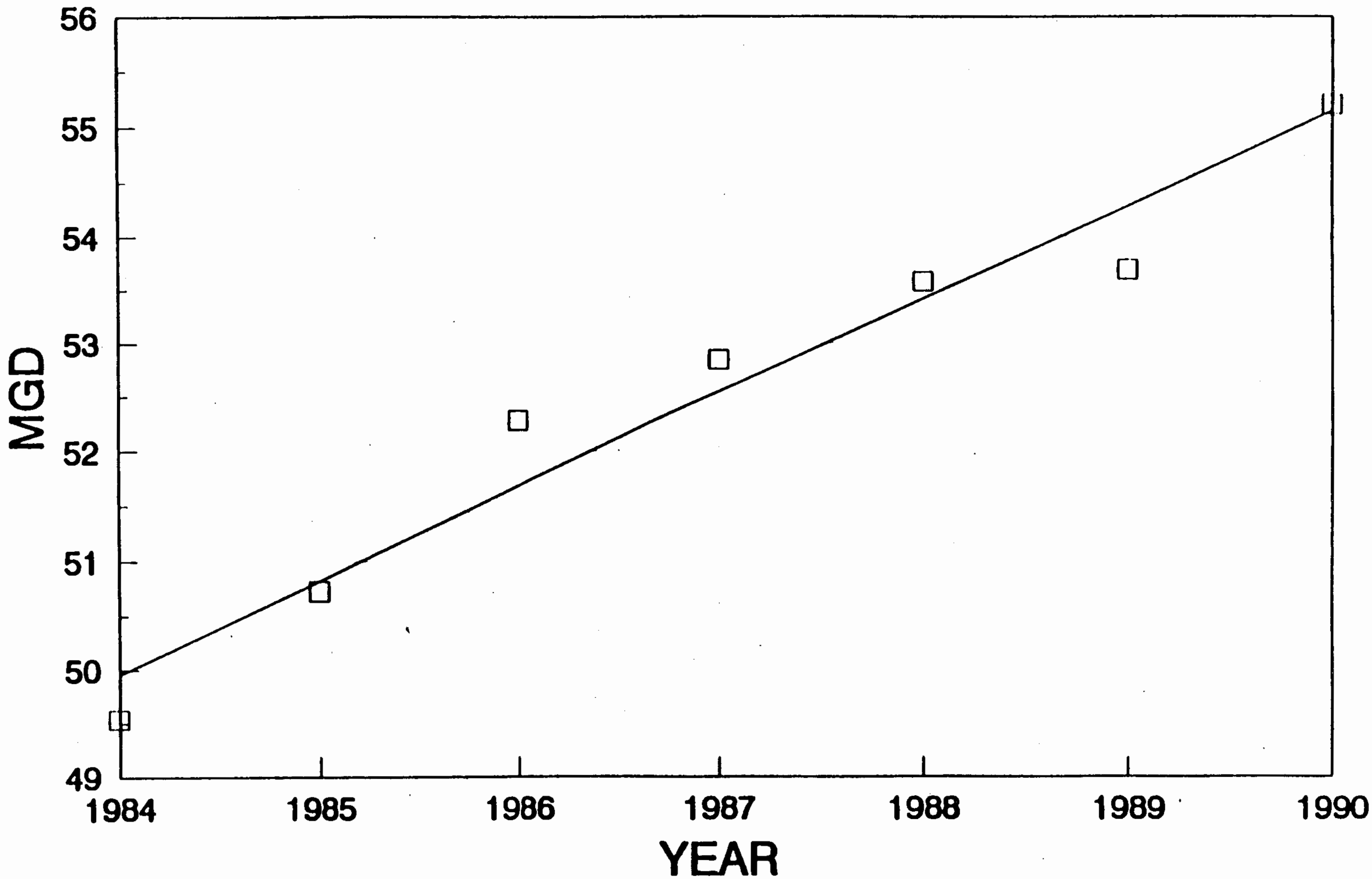


FIGURE 2-6

TABLE 2-7

LARGE USER WATER CONSUMPTION (1990)

User	Current Number of Employees	Daily Operations Days/Wk	Daily Operations Hrs/Day	Average Daily Consumption (mgd) Potable Use	Non-Potable Use	Total	Metered Public Supply
Newport News							
Union Carbide Industrial Gases	11	7	24	0.001	0.041	0.042	0.042
Dominion Terminal Associates	110	7	24	0.006	0.221	0.227	0.084
Pier IX Terminal Company	81	7	24	0.049	0.165	0.214	0.049
Siemens Automotive	800	7	24	0.026	0.030	0.056	0.056
CEBAF	628	--	--	0.024	0.035	0.059	0.059
Peninsula Hospital Services	44	5	8	0.045	0.0	0.045	0.045
Mary Immaculate Hospital	595	7	24	0.042	0.0	0.042	0.042
Riverside Regional Medical Center	2,000	7	24	0.131	0.010	0.141	0.141
Marva Maid Dairy	150	7	24	0.105	0.0	0.105	0.105
Neptune Fisheries, Inc.	135	5	12	0.183	0.0	0.183	0.183
Newport News Shipbuilding	26,500	5	8	2.403	6.497	8.900	2.403
Hampton							
Fort Monroe	4,000	7	24	--	--	0.587	0.587
Langley AFB	--	7	24	--	--	1.234	1.234
NASA	4,454	7	24	0.062	0.203	0.265	0.265
Sentara-Hampton General Hospital	1,000	7	24	0.075	0.025	0.100	0.100
DVA Medical Center	1,214	7	24	0.095	0.028	0.123	0.123
Howmet Turbine Corporation	1,152	6	24	0.163	0.0	0.163	0.163

TABLE 2-7

LARGE USER WATER CONSUMPTION (1990)
(Continued)

User	Current Number of Employees	Daily Operations: Days/Wk	Daily Operations: Hrs/Day	Average Daily Consumption (mgd): Potable Use	Non-Potable Use	Total	Metered Public Supply
Williamsburg							
Colonial Williamsburg	3,500	7	24	--	--	--	0.734
William and Mary	1,300	7	24	--	--	--	0.535
Camp Peary	--	7	24	--	--	--	0.071
York County							
Virginia Power	254	7	24	0.002	0.564	0.566	0.566
Amoco Oil Company	250	7	24	1.066	0.0	1.066	1.066
U.S. Coast Guard Training Center	1,292	7	24	0.075	0.004	0.079	0.075
U.S. Naval Weapon Station	3,394	5	10	0.197	0.460	0.657	0.657
James City County							
Anheuser Busch, Inc.	1,100	7	24	4.083	1.017	5.100	5.100
Eastern State Hospital	1,500	7	24	0.147	0.0	0.147	0.147

Sources: City of Newport News, Department of Public Utilities, January 1989.
Large Water User's Survey Forms, April 1991.

TABLE 2-8

NEWPORT NEWS WATERWORKS AVERAGE MONTHLY DEMAND VARIATION (1987 - 1990)

Month	Percent of Annual Average
January	105
February	96
March	95
April	88
May	87
June	103
July	111
August	108
September	124
October	100
November	98
December	89
Source:	Newport News Waterworks WTP Pumpage Reports.

2.6 PROJECTED DEMANDS

Population growth is the single most important predictor of future water demands. Population projections provided by the Lower Peninsula jurisdictions were reviewed, and projections for each jurisdiction were adopted by the RRWSG.

While population growth is a key indicator of future water demands, other factors can greatly impact demands. Demand management, through the implementation of effective conservation programs, can sizably reduce future demands.

The demand projections provided are based on the most recent data available and are presented in 10-year increments for the planning period 1990 to 2040 for each of the Lower Peninsula jurisdictions. The 50-year planning period for water supply planning was chosen due to long project implementation schedules and the life expectancy of the facilities once constructed. The 50-year planning period has been accepted by the U. S. Environmental Protection Agency (USEPA) as appropriate for such recent proposals as the Two Forks Reservoir project and the Ware Creek Reservoir project. Projections have been made for residential, commercial, industrial, and federal usage taking into account existing conservation measures.

2.6.1 Conservation

Water conservation is the conscious effort by a utility, business or individual to save water. Every gallon of water not used is one less to be stored, purified, and distributed. It also represents one less gallon that must be heated for washing or bathing, thus saving energy costs, or one less gallon of water that must pass through some form of wastewater treatment before it is returned to the environment.

Different levels of conservation measures can be implemented including: (1) existing conservation measures, (2) additional conservation measures, and (3) use restrictions. Existing and additional conservation practices will provide long-term benefits by permanently reducing water demands during normal operating conditions. Use restrictions usually are applied as part of a water management plan during severe droughts or other extreme water shortages or emergencies. Such restrictions are imposed to produce temporary, short-term reductions in water demands, and they inevitably result in adverse economic and other undesirable impacts. Additional conservation measures and use restrictions are evaluated as an alternative to new source development projects (see Section 3.4.30). Existing water conservation measures in effect on the Lower Peninsula are discussed in this section.

The City of Newport News adopted a water conservation management plan and ordinance in April 1995 to document current water conservation practices and provide a structure for proposed future actions. It incorporates the RRWSG's water conservation objectives, and reflects the requirements of state and federal agencies for water conservation programs. Report L, ***Water Conservation Management Plan*** (City of Newport News, 1995) is incorporated herein by reference and is an appendix to this document. The Plan is in effect throughout the Waterworks' service area, including those portions of the service area located in other jurisdictions.

Following adoption of the Newport News Water Conservation Ordinance in July 1995 (included in Report L), a draft ordinance was sent to each of the jurisdictions within the planning area requesting that they also adopt the ordinance. The City of Hampton adopted a resolution in

September 1995 (see Report L) endorsing the ***Water Conservation Management Plan*** and ordinance. The current water agreement between the City of Williamsburg and the City of Newport News (see Report L) includes a provision for the implementation of water conservation and use restrictions by the City of Williamsburg upon written notification from the City of Newport News that restrictions have been imposed (City of Newport News and City of Williamsburg, 1992). James City County is currently developing an ordinance. The Poquoson City Council approved a resolution endorsing the ***Water Conservation Management Plan*** in September 1996. York County has not yet specifically endorsed the Conservation Plan. However, in a Water Agreement dated January 3, 1996 between the County and the City of Newport News, the County committed to full support for the King William Reservoir Project, which includes support for any associated conservation and mitigation measures that may be required.

A variety of water conservation programs have been undertaken in the Lower Peninsula to reduce existing water demands. Water purveyors, commercial, institutional and light industrial users, heavy industrial users, and federal installations in the region implement varying forms of conservation programs. Existing programs implemented in the Lower Peninsula are discussed in Report A, ***Water Demand Reduction Opportunities*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document. A summary of the measures currently implemented by water consumers in the Lower Peninsula is presented in Table 2-9.

One type of conservation measure used in the Lower Peninsula is non-potable reuse. Non-potable reuse is considered a conservation measure, because it is designed to reduce the demands on conventional treated water supplies by providing treated wastewater or partially treated raw water as an alternative supply source for non-potable uses. Such measures can be applied to residential, commercial, and institutional water users, but they have been employed more commonly to reduce industrial water demands on potable water systems.

The viability of non-potable reuse is dependent on the water use characteristics of a particular user and cannot be applied to all users effectively. When applicable, non-potable reuse projects are likely to result in positive economic benefits to industries which require large volumes of water. The amount of money invested will depend on the complexity of the treatment process required, which varies with the specific characteristics of the recycled water and of each industry.

Some industrial facilities on the Lower Peninsula are making efforts to reuse water for non-potable uses. The costs of treatment and the expenses of changes to existing pipe systems are primary concerns for existing industries considering non-potable reuse. The costs of changes to existing pipe systems can be avoided in new industrial facilities, so new or expanding industries are more likely to implement non-potable reuse.

Newport News Waterworks, the Newport News Department of Parks & Recreation and the Hampton Roads Sanitation District (HRSD) have been working together on a wastewater reuse project. The proposed project would provide highly treated wastewater, rather than potable water from Waterworks' system, for irrigation of ballfields at the Riverview Farm Park. The park is located at the mouth of the Warwick River, adjacent to an HRSD wastewater treatment facility. Initially, Waterworks approached HRSD about using treated effluent as irrigation water for part, and eventually all of, the Riverview Farm Park. The HRSD's latest proposal for the project includes a unit cost for water which is less than the current cost of Waterworks' drinking water. The proposal indicates that the cost of reuse water will remain constant over time until the park expands and more water would be used, or until HRSD recovers its capital investment. At that time, the unit cost would

TABLE 2-9

CONSERVATION PRACTICES CURRENTLY IMPLEMENTED ON THE LOWER PENINSULA

Purveyor or Water User Category	Conservation Measure
Newport News Waterworks	Adoption of Water Conservation Management Plan Adoption of Water Conservation Ordinance Pressure Reductions Pipeline Replacement Program Recycling of Treatment Plant Process Waste Stream Meter Calibration and Change-out Program BOCA National Plumbing Code Enforcement Water Rates Set to Reflect the True Cost of Water Summer Conservation Rate System Development Charge Conversion to Uniform Water Rate Wastewater Reuse for Irrigation of City Park On-going Public Information Program Outreach Program for Business and Industry Leadership , Funding, and Active Participation in HRWET
City of Williamsburg	Meter Calibration and Change-out Program Metering of All Customer Connections BOCA National Plumbing Code Enforcement Water Rates Set to Reflect the True Cost of Water Funding and Active Participation in HRWET Availability Fee Water Plant Renovation Outreach Programs for Water Customers
York County	Metering of all Connection Water Rates Set to Reflect the True Cost of Water BOCA National Plumbing Code Enforcement Funding and Active Participation in HRWET Outreach Programs for Water Customers
James City Service Authority	Intensive Metering of Water Use Meter Replacement and Testing Program Leak Detection Surveys BOCA National Plumbing Code Enforcement Water Rates Set to Reflect the True Cost of Water Summer Surcharge Rate System Facilities Charge Adoption of Region's First Inclining Rate Structure Public Education Program Outreach Program for Water Customers Funding and Active Participation in HRWET

TABLE 2-9

CONSERVATION PRACTICES CURRENTLY IMPLEMENTED ON THE LOWER PENINSULA
(Continued)

Purveyor or Water User Category	Conservation Measure
Commercial, Institutional and Light Industrial Users	Retrofitting in Hospitals and Hotels/Motels Closed Loop Mechanical Systems in Hospitals Use of Non-Public Water Supplies for Irrigation BOCA Code Compliance Non-Potable Well Water Supplies used in Mechanical Systems
Heavy Industrial	Minimized Use of Public Water for Non-Potable Uses Closed Loop, Recycling Cooling Towers and Mechanical Systems Used Widely In-House Water Treatment Systems Use of Non-Potable Supplies for Irrigation and Dust Suppression Education and Training Programs to Increase Employee Awareness of Water Use

decrease. A more detailed discussion of non-potable reuse and its applicability to the Lower Peninsula is included in Report A.

The jurisdictions within the study area are also members of the Hampton Roads Water Efficiency Team (HRWET). This Team includes representatives of local government, water suppliers and public information offices with the common interest of building and promoting a water efficiency ethic in Hampton Roads. Each locality involved with HRWET, which includes all localities within the study area, contributes financially to the Team. The Team's mission statement is "to develop and implement a regional approach to communicating water efficient practices by all residents, businesses and industries in Hampton Roads."

The HRWET is involved in numerous conservation activities. Current programs include the development of a regional water use data bank, regional water use survey, initiation of pilot conservation programs within residences, business and industry outreach program, and an intense public outreach and education program.

As an indication of the success of conservation measures employed in the Lower Peninsula to date, an analysis was made of the Newport News Waterworks system using all 5/8-inch meter connections (the majority of which are residential) between 1982 and 1990. An active conservation program was implemented in 1986, which included system-wide pressure reductions, rate increases and implementation of voluntary use restrictions. A substantial decrease in per connection usage was observed in the years following implementation of these conservation measures.

2.6.2 Conservation and Growth Management

This subsection summarizes the philosophies of the U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), National Wildlife Federation (NWF), Southern Environmental Law Center (SELC), and the Virginia State Water Control Board (SWCB) (now Virginia Department of Environmental Quality) concerning conservation and growth management as they may affect future demand.

<u>U.S. Fish and Wildlife Service</u>

Concerning conservation and growth management the USFWS has recommended that the RRWSG incorporate conservation measures and mandatory use restrictions into any water demand projections. In a letter dated August 20, 1990, addressed to Colonel Richard C. Johns of the Norfolk District, Corps of Engineers, the USFWS provided a succinct summary of their philosophy as follows:

> "The Service recommends that, in developing their water demand projections, the RRWSG incorporate conservation measures and mandatory use restrictions. Conservation measures should serve as a long-term approach to reducing municipal water demands and should include such measures as public education on water conservation practices and xeriscaping, rates based on consumption rather than base rates, and promoting the use of conservation plumbing fixtures. Mandatory use restrictions which reduce or eliminate withdrawal for unnecessary water uses such as car washing, lawn watering, swimming pools, and fountains should be implemented during droughts. All localities participating in the RRWSG should agree on the specific criteria that would constitute a drought and agree to concurrently implement the

conservation measures as well as the mandatory use restrictions. Furthermore, as a means of conserving water, the Service recommends that localities focus on attracting non-water intensive development. In return, the Service will work toward promoting and implementing the conservation of water on federally-owned properties. As project demand projections rely on predictions about development in the Lower Peninsula area through the Year 2030, the Service also recommends that the RRWSG consider Chesapeake Bay Preservation Act and Clean Water Act regulations in their development predictions."

U.S. Environmental Protection Agency

It is the USEPA's recommendation, as stated in a letter dated March 6, 1990, to Colonel J. J. Thomas of the Norfolk District, Corps of Engineers, that "Conservation measures should be a very critical aspect in reducing water demand for the region as a whole." The USEPA further recommends that any water supply decisions should incorporate conservation measures to the greatest extent possible, and address planned growth and development scenarios within the region's control.

National Wildlife Federation

The NWF recommended a "... strong water conservation program as a complete or partial alternative to the proposals for diversions and dams and reservoirs." They further recommended an efficient allocation of the water resource at every stage of distribution and use. Such a planned allocation should incorporate the following:

- An audit of each system's current use for each season, class of user, and unaccounted-for water.
- A description and evaluation of the current pricing policies and schedule for each of the communities in the RRWSG.
- The institution and evaluation of a demand management pricing schedule.
- A stronger plumbing code with an estimation of the resulting water savings.
- The development and implementation of water use efficiency programs for industrial and commercial users.
- The institution of an effective public education program on water conservation.

These recommendations were included in a letter, dated September 27, 1990, to Colonel J. J. Thomas, District Engineer, USCOE.

Southern Environmental Law Center

The SELC recommended an aggressive water conservation program that would use pricing, education, incentives, industrial reuse, drought period restrictions, system pressure reduction, and plumbing efficiency requirements to reduce the proposed deficit. They further recommended that the RRWSG consider having equal water management requirements in each jurisdiction so that localities are not competing with each other to provide cheap or inefficiently provided water to attract industry or commerce. These recommendations were presented in a letter, dated August 17, 1990, to Colonel Richard C. Johns, District Engineer, Norfolk District, Corps of Engineers.

Virginia State Water Control Board

The SWCB recommended a close review of various pumpover options as a viable means of satisfying future demands. There were no comments specifically citing the impact conservation could have on water supply management in any letters received from the SWCB.

Summary

In response to the comments received from the regulatory agencies described above, the RRWSG has evaluated the potential for demand reductions resulting from the implementation of aggressive conservation measures. Existing conservation measures are included in the demand projections while additional water conservation measures and use restrictions are evaluated as an alternative, and are discussed in Section 3.4.30.

2.6.3 Population Projections

The primary step in developing demand projections was to estimate projected population growth. Population projections for each of the Lower Peninsula jurisdictions were developed through a review of various studies and data sources that estimate future population, and from consultation with local planners.

Local planning agencies were interviewed to obtain data and to discuss their respective growth patterns and projections. Projections made by local planning agencies include the number of persons residing within federal installations in their respective localities.

For purposes of this report, it has been assumed that local planning departments are the most reliable sources of information on past trends and future projections of population and development potential. For this reason, the RRWSG has relied heavily on information obtained from these departments.

The Virginia Employment Commission (VEC) projections (March 1990) were also reviewed. The VEC is vested with the authority to prepare official short- and long-term population projections for use by State agencies and the General Assembly. Population projections were obtained from the VEC in 10-year increments to the Year 2030. Projections to the Year 2000 were taken from the VEC report ***Virginia Population Projections, 2000*** (April 1990). This report estimated future population using a cohort component method of projecting demographic changes. This method recognizes that changes in population are the result of three factors: birth, death and migration. Each of these factors were projected separately and then combined to produce population projections (VEC, 1990). Projections from the Year 2000 to the Year 2030 are a linear extension of the 1980 through 2000 data reported in ***Virginia Population Projections, 2000*** and were computed by the VEC in March 1990. These unpublished data are primarily used as a reference point with which to compare projections developed by local planners.

The population predictions for each jurisdiction in the Lower Peninsula are summarized in Table 2-10 and presented graphically in Figure 2-7. Comparison of these data with state projections provides support to the adopted population projections. Table 2-11 presents the population

TABLE 2-10

SUMMARY OF ADOPTED REGIONAL POPULATION PROJECTIONS BY JURISDICTION

Jurisdiction	Existing	Projected				
	1990	2000	2010	2020	2030	2040
Newport News	170,045	184,000	213,000	223,000	238,000	254,500
Hampton	133,793	146,200	155,940	166,410	177,570	188,085
Poquoson	11,005	14,328	17,061	20,187	23,215	26,243
Williamsburg	11,530	12,800	14,000	15,200	16,400	17,700
York County	42,422	50,950	57,580	64,580	71,580	78,580
James City County	34,859	51,700	61,700	64,700	67,800	71,200
TOTALS	**403,654**	**459,978**	**519,281**	**554,077**	**594,565**	**636,308**

ADOPTED REGIONAL POPULATION PROJECTIONS

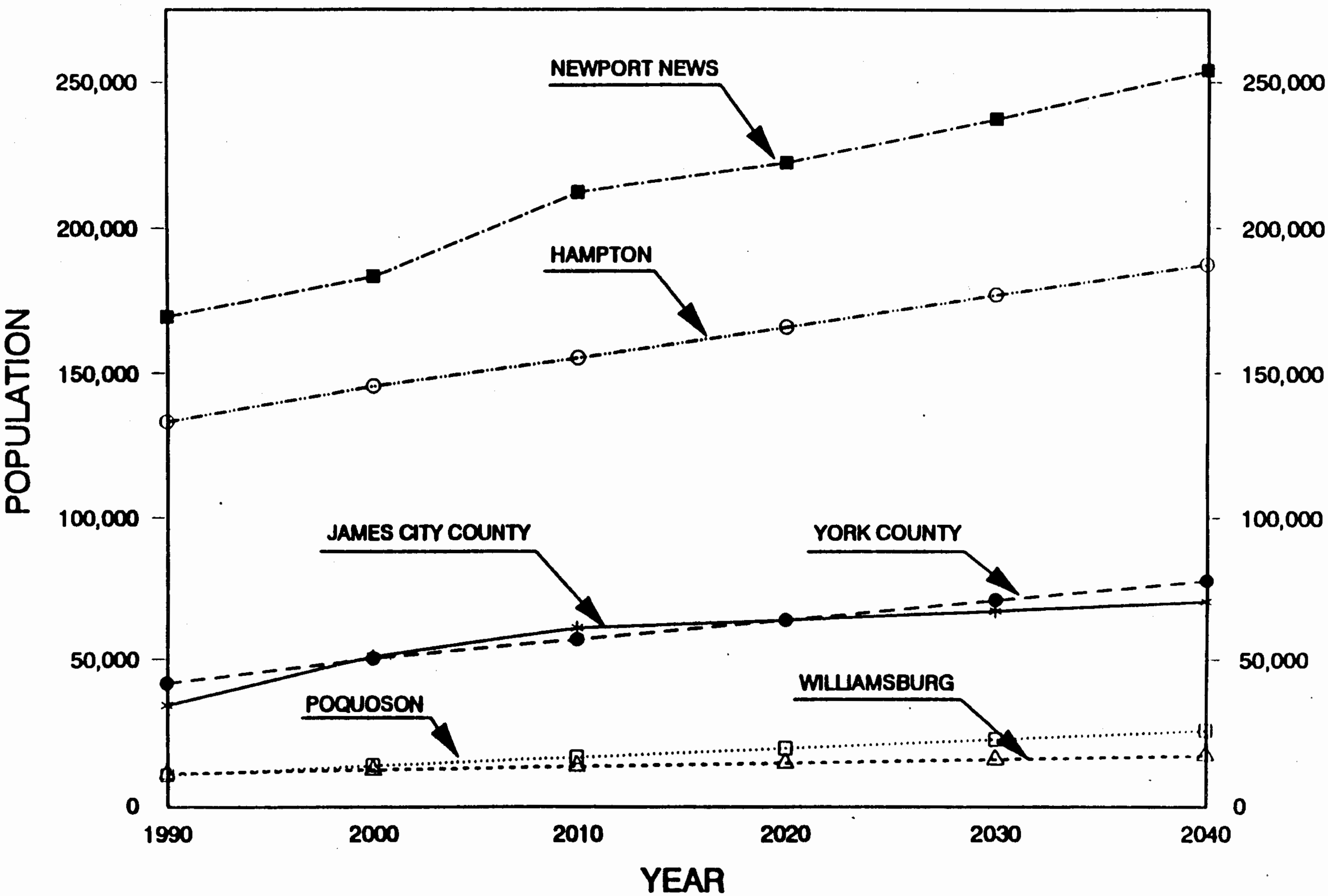


FIGURE 2-7

TABLE 2-11

COMPARISON OF LOCAL AND NEW STATE POPULATION PROJECTIONS

Year	Lower Peninsula		Virginia
	RRWSG	VEC *	VEC *
1990	405,189	405,189	6,189,314
2000	459,978 (1.3)	446,108 (1.0)	6,896,557 (1.1)
2010	519,218 (1.2)	482,538 (0.8)	7,451,158 (0.8)
2020	554,077 (0.7)	518,968 (0.7)	8,034,150 (0.8)
2030	594,565 (0.7)	555,398 (0.7)	8,617,142 (0.7)
2040	636,308 (0.7)		
Average Annual Growth (%)	0.91	0.79	0.83

( ) Values in parentheses represent the average annual rate of change in the preceding decade.

* Source: VEC, 1993.

projections for the study region adopted by the RRWSG, and also estimates of future study area population and total state population, as projected by the VEC.

The rate of population change projected for the Lower Peninsula by the RRWSG is 0.1 percent lower than the rate of population change projected by the VEC for both the study area and the state. It is likely that the differences can be attributed to the variations in methodologies used to estimate population between the VEC and the local planning departments. The VEC data are a linear extrapolation of population data for the period from 1980 to 2000. Therefore, these data do not take into account the effects of build-out on population growth. The projections adopted by the RRWSG do incorporate the impacts of build-out. If the VEC data were to incorporate build-out, they would more closely compare to the adopted projections.

The majority, but not all, of the total population in the Lower Peninsula is served by public water. Therefore, it was necessary to provide estimates of that portion of the population that would require public supply throughout the planning period. For York and James City Counties, the SWCB's (1988) assumed percentages of population served by the public water systems to the Year 2030 were applied to the projections. It was then assumed that the values presented in the report for population served in 2030 were applicable to the estimates of population served in the Year 2040. Table 2-12 presents the projections of regional civilian population served which are used in calculating future demands. The Year 1990 population served estimate is 363,230; the adopted Year 2040 population served estimate is 599,848. These estimates also include adjustments deducting the portion of the total regional population that lives on local federal installations, since their water demand is counted as part of the federal installation demand.

Several external influences were identified as having an impact on estimating future population in the Tidewater area. The Chesapeake Bay Preservation Act (CBPA) limits development within areas designated as Resource Management Areas (RMAs) and/or Resource Protection Areas (RPAs). A study conducted for localities in the Virginia Peninsula estimated that approximately 10 percent of the region (excluding Williamsburg) would be designated as an RPA. Approximately 65 percent would be designated as an RMA (SDN Market Research, 1990).

This issue was discussed with representatives from local planning agencies. The general consensus was that the Act will probably not affect the total number of persons locating in the area. However, it is anticipated that the layout of development will change. Because development will be restricted in shoreline areas, it is likely that it will become intensified in other regions. One technique which may become more widely used is cluster zoning. This zoning methodology allows for more intense development in certain areas so that adjacent areas may be preserved. This technique could be used to protect the RPAs and RMAs while allowing for some level of development. There are also proposed changes to federal wetland delineation procedures that could, if implemented, dramatically reduce the acreage of federally regulated non-tidal wetlands in the area. These changes would also reduce the area regulated under the Chesapeake Bay Preservation Act.

2.6.4 Water Demand Projections

Demand projections can be derived by several methods, all of which begin with a study of historical information to develop basic data applicable to the method used, and to determine trends in the data thus developed. Forecasts are then based on anticipated population and employment growth, or on growth in the number of water accounts served, with due regard to differences among water user categories.

TABLE 2-12

PROJECTED CIVILIAN POPULATION SERVED BY PUBLIC WATER SYSTEMS

Jurisdiction	Year					
	1990	2000	2010	2020	2030	2040
Newport News	160,078 (100)	174,033 (100)	203,033 (100)	213,033 (100)	228,033 (100)	244,533 (100)
Hampton	128,798 (100)	141,205 (100)	150,945 (100)	161,415 (100)	172,575 (100)	183,090 (100)
Poquoson	11,005 (100)	14,328 (100)	17,061 (100)	20,187 (100)	23,215 (100)	26,243 (100)
Williamsburg	11,530 (100)	12,800 (100)	14,000 (100)	15,200 (100)	16,400 (100)	17,700 (100)
York County	27,418 (80)	39,335 (90)	45,302 (90)	51,602 (90)	57,902 (90)	64,202 (90)
James City County	24,401 (70)	43,945 (85)	55,530 (90)	58,230 (90)	61,020 (90)	64,080 (90)
TOTAL	**363,230**	**425,646**	**485,871**	**519,667**	**559,145**	**599,848**

( ) Values in parentheses represent the assumed percentage of total population served in a given year as reported in the SWCB's James Water Supply Plan, 1988.

Most methods used to project demand are multi-variable approaches that desegregate the total water demand into different user groups. Emphasis is often placed on segregating heavy industrial and commercial needs from residential usage, as their comparative rates of growth are not directly related, and the quantity of water used varies between groups.

For the purposes of this study, demand estimates have been developed for the following five water demand categories:

- Residential: This is the water demand of the general population living in the areas served. It does not include the military personnel living on federal installations or military dependents living off base in military housing served by a master meter.

- Commercial, Institutional and Light Industrial: This is the water demand created by employment at the workplace in the jurisdictions served, excluding those workplaces that are located on federal installations served by master meters. This category also includes light industrial establishments whose water use is similar to commercial demands, with little to no process water usage.

- Heavy Industrial: This is the demand imposed by large industrial water users in the systems. The demands for employee sanitary uses and process water are included.

- Federal Installations: This is the demand imposed by the federal installations located in the Lower Peninsula. It covers demand for installations serviced by a master meter and includes all uses at these locations, regardless of usage category.

- Unaccounted-for Water (UAW): This is the difference between a water utility's finished water production and all metered water usage (e.g., unmetered use from fire hydrants, distribution system leakage, etc.). In this report, it is presented as a percentage of the total of all demand categories.

Data Sources

The following data sources were used in calculating projections of water demand in the Lower Peninsula:

- Utility Records from each Purveyor within the Lower Peninsula.

- Large Water User's Survey.

- Survey of New Heavy Industry.

- IWR-MAIN Water Use Forecasting System - Planning and Management Consultants, Ltd., 1988.

- Report on Pitometer Master Meter Tests, Newport News, Virginia - Pitometer Associates, 1991.

- Comprehensive Water Study - Buchart-Horn, Inc., prepared for the County of York, November 1985.

- "Water Use Projections for James City County to 2040," James City County Staff, March 1986.

Demand Projection Methodologies

The RRWSG has adopted Lower Peninsula water demand projections through the Year 2040, based on current population and water demand information and projections of future populations. Population projections were developed using the following information:

- 1990 Census data.
- Consultations in 1991 with the planning departments of each of the six Lower Peninsula jurisdictions.
- Consultations in 1991 with the Hampton Roads Planning District Commission.
- Virginia Employment Commission (VEC) population projections through the Year 2030, which were developed in March 1990.

The base year for the population and water demand projections is the Year 1990.

The residential demand projections were developed using current population projections in conjunction with per-capita use figures calculated from actual metered residential billing records and the total population served on the Lower Peninsula in the Year 1990. The per-capita use rate is 72.9 gallons per capita per day (gpcpd) and includes the effect of existing conservation measures. The RRWSG's adopted demand projections do not reflect demand reductions possible through implementation of additional water conservation measures. Demand reductions possible through implementation of additional conservation measures and water use restrictions during droughts are evaluated as an alternative in Section 3.4.30.

Commercial, institutional, and light industrial demand projections were developed using 1990 VEC employment figures in conjunction with per-employee use figures calculated from actual Year 1990 metered commercial, institutional, and light industrial billing records. The total regional employment was projected to increase in direct proportion to total population throughout the 50-year planning period. The per-employee use rate is 70.4 gallons per employee per day (gpepd).

Heavy industrial and federal installation demands were projected based on metered billing records for 1990 and information obtained from a survey of large water users in the Lower Peninsula (those with average daily water use in excess of 40,000 gallons) conducted by the RRWSG during the summer of 1991. The RRWSG also conducted an extensive analysis of projected water demands as a result of new heavy industry on the Lower Peninsula. This analysis was based on the results of a survey of local planning and development agencies.

Actual Year 1990 Unaccounted-for Water (UAW) demand on the Lower Peninsula represented 5.7 percent of total demand. The 1990 UAW demand for Newport News Waterworks, which provided 88 percent of the total finished water pumped to distribution in that year, was 5.5 percent. Review of operating records for Newport News Waterworks for the period January 1993 through June 1996 indicates that the annual average UAW percentage has fluctuated from 2.1 percent to 11.0 percent. It is assumed that the regional average UAW has fluctuated in a similar manner since

Newport News Waterworks provides the majority of the total finished water pumped to distribution (88 percent in 1990).

For comparison, the average UAW percentage for water utilities within USEPA Region III, which includes the Lower Peninsula study area, has been estimated at 13.7 percent, while the national average of UAW for systems serving 100,000 to 500,000 persons is estimated at 12.2 percent (van der Leeden, 1990). The estimates of UAW for the Lower Peninsula are low in comparison to these regional and national average estimates.

Any projection of future UAW percentages must take into account the low current value, as well as the likelihood that this value can be maintained over a long period of time. The RRWSG has an aggressive proactive program to minimize water loss which is described in Appendix Report A. To provide an indication of the efforts which are expended to identify water losses, operating budget data for Newport News Waterworks were reviewed.

Newport News Waterworks estimates that $790,000 will be spent by their meter shop crews to inspect, replace, and calibrate more than 7,200 meters in the system in Fiscal Year (FY) 1997. Similarly, in Fiscal Year 1995, $250,350 was spent to initiate the large meter replacement/calibration program. Meters at the water treatment plants are also inspected and calibrated quarterly by in-house staff in conjunction with the manufacturer. Distribution system improvements target aging or inadequate pipelines, which lowers the probability of leaks. The cost of this program in FY 1996 was $1.35 million, while the FY 1997 budget for the same program is $1.25 million. An additional $50,000 is budgeted in FY 1997 for specialized leak detection equipment. These data indicate that the financial and program support provided by Newport News Waterworks to minimize UAW is substantial. Although the RRWSG intends to continue its aggressive efforts to maintain the current low levels of UAW, several factors may cause an increase in UAW in the future. These factors include:

- Increasing age of some portions of the water system, increasing the likelihood and the frequency of breaks and leaks.
- Increasing demands may necessitate increased system pressures, thereby causing higher leakage rates at any leaks that do occur.
- Increased flushing of distribution system to meet increasingly more stringent Safe Drinking Water Act (SDWA) requirements.
- Drought conditions may coincide with periods of above average UAW.

A combination of these factors could cause the UAW percentage to rise to or above the national averages presented above. However, considering the cost of producing the water that is lost, and the continued emphasis planned for leak detection and repair activities, the likelihood of the Lower Peninsula's UAW rising above 10 percent is low. Therefore, the percentage of UAW in the Lower Peninsula is assumed to be 10 percent throughout the planning horizon.

The UAW percentage value used in projecting demands for the Lower Peninsula has been compared to UAW planning values used by other areas in Virginia to project demands. Spotsylvania County's ***Long-Term Water Conservation Program*** (CDM, 1993) defines the County's UAW as 15 percent of average day demand, which is 50 percent greater than the RRWSG's UAW allowance of 10 percent. Demand projections documented in the ***Metropolitan Richmond Regional Water***

Resources Plan for Planning District 15 (RRPDC, 1992), which includes the Richmond, Virginia area jurisdictions, include UAW percentage assumptions varying from 10 to 20 percent throughout the planning period (1990 to 2030). Unaccounted-for water demands equivalent to 9 percent of average day demands have been projected for Northern Virginia communities (SWCB, 1988). Analysis of the UAW projections for other regions in Virginia indicates that the Lower Peninsula UAW planning value of 10 percent is at least comparable to, if not lower than, planning values used in other metropolitan regions of Virginia.

Lower Peninsula Totals

The adopted Lower Peninsula demand projections are summarized in Table 2-13, desegregated by jurisdiction. Unaccounted-for water is disaggregated to each jurisdiction based on the jurisdictions subtotal of metered demands. Figure 2-8 illustrates historical and projected Lower Peninsula system demands.

The relative distribution of demand between user categories is projected to change slightly over the planning period. The demand projections in Table 2-13 show heavy industrial demand showing the greatest increase, from 19 percent to 23 percent of metered demands. In comparison, residential, commercial, and federal installation demands are, over time, projected to represent smaller percentages of total Lower Peninsula demand.

An additional use of water in the Lower Peninsula is for irrigation. The U.S. Bureau of the Census' ***1987 Census of Agriculture*** is the most reliable published source of current data on irrigated land in the study area (U.S. Department of Commerce, 1987). According to this report, York and James City Counties are the only jurisdictions within the study area that contain irrigated agricultural acreage. York County was listed as having 41 irrigated acres as of 1987. This acreage had decreased from 63 acres in 1982. Assuming a typical value of eight inches of water per year applied to these 41 acres, this represents a water usage of 8.91 million gallons per year or 0.025 mgd. James City County was listed as having 40 irrigated acres in 1987, which is equivalent to an annual demand of 8.69 million gallons per year, or 0.024 mgd. These demands are exclusive of water demands used for irrigation at nurseries within the Lower Peninsula. Irrigation demands at nurseries are included in the commercial category of demand.

Water used for agricultural irrigation in the Lower Peninsula represents approximately 0.048 mgd on an annually averaged basis, the majority of which is supplied from private sources. Thus, agricultural irrigation represents a very small portion of total water demand in the study area and would have little impact on the projections of demand on public water systems. In addition, it is unlikely that the number of irrigated acres will increase in the future due to anticipated future development pressures.

2.6.5 Water Demand Projections By Purveyor

The demand projections made in Section 2.6.4 were presented by jurisdiction since they are based on population and employment projections made by the jurisdictions. To be more useful to the purveyors on the Lower Peninsula, these demand projections by jurisdiction have been aggregated and/or desegregated to conform to the current and projected future service area boundaries for each purveyor.

TABLE 2-13

PROJECTED LOWER PENINSULA DEMANDS BY JURISDICTION

(MGD)

YEAR / JURIS.	RESIDENTIAL	COMMERCIAL/ INSTIT./ LT. IND.	HEAVY INDUSTRIAL	FEDERAL INSTALL.	SUBTOTAL OF METERED DEMANDS	UAW	TOTAL
1990 (METERED)							
NEWPORT NEWS	11.90	3.37	2.74	1.30	19.31	1.14	20.44
HAMPTON	9.15	2.92	0.21	2.08	14.36	0.92	15.27
POQUOSON	0.77	0.06	0.00	0.00	0.83	0.05	0.88
WILLIAMSBURG	0.58	1.78	0.00	0.10	2.46	0.15	2.61
YORK COUNTY	2.34	1.41	2.18	0.64	6.57	0.38	6.94
JAMES CITY COUNTY	2.04	1.35	5.16	0.00	8.55	0.51	9.06
TOTAL	26.78	10.89	10.28	4.12	52.07	3.13	55.20
2000							
NEWPORT NEWS	12.69	3.80	2.94	1.80	21.23	2.36	23.59
HAMPTON	10.29	3.30	0.78	2.12	16.48	1.83	18.32
POQUOSON	1.04	0.07	0.02	0.00	1.14	0.13	1.26
WILLIAMSBURG	0.93	2.01	0.00	0.12	3.06	0.34	3.40
YORK COUNTY	2.87	1.59	2.96	0.78	8.20	0.91	9.11
JAMES CITY COUNTY	3.20	1.52	6.12	0.00	10.84	[illegible]	12.05
TOTAL	31.03	12.29	12.81	4.82	60.95	6.77	67.72
2010							
NEWPORT NEWS	14.80	4.29	3.53	2.40	25.02	2.78	27.80
HAMPTON	11.00	3.71	1.44	2.13	18.29	2.03	20.32
POQUOSON	1.24	0.08	0.05	0.00	1.37	0.15	1.53
WILLIAMSBURG	1.02	2.26	0.00	0.14	3.42	0.38	3.80
YORK COUNTY	3.30	1.79	4.06	0.78	9.93	1.10	11.04
JAMES CITY COUNTY	4.05	1.72	8.23	0.00	13.99	1.55	15.55
TOTAL	35.42	13.85	17.31	5.45	72.03	8.00	80.03
2020							
NEWPORT NEWS	15.53	4.55	3.67	2.40	26.15	2.91	29.05
HAMPTON	11.77	3.94	1.82	2.14	19.67	2.19	21.85
POQUOSON	1.47	0.08	0.07	0.00	1.62	0.18	1.80
WILLIAMSBURG	1.11	2.40	0.00	0.16	3.67	0.41	4.08
YORK COUNTY	3.76	1.90	4.59	0.78	11.03	1.23	12.26
JAMES CITY COUNTY	4.24	1.82	8.86	0.00	14.93	1.66	16.59
TOTAL	37.88	14.70	19.00	5.48	77.06	8.56	85.63
2030							
NEWPORT NEWS	16.62	4.86	3.82	2.40	27.71	3.08	30.78
HAMPTON	12.58	4.21	2.25	2.15	21.19	2.35	23.55
POQUOSON	1.69	0.09	0.09	0.00	1.87	0.21	2.07
WILLIAMSBURG	1.20	2.57	0.00	0.18	3.94	0.44	4.38
YORK COUNTY	4.22	2.03	5.18	0.78	12.22	1.36	13.57
JAMES CITY COUNTY	4.45	1.95	9.58	0.00	15.98	1.78	17.75
TOTAL	40.76	15.71	20.92	5.51	82.90	9.21	92.11
2040							
NEWPORT NEWS	17.83	5.19	3.99	2.40	29.41	3.27	32.67
HAMPTON	13.35	4.50	2.57	2.16	22.57	2.51	25.08
POQUOSON	1.91	0.09	0.10	0.00	2.11	0.23	2.34
WILLIAMSBURG	1.29	2.74	0.00	0.18	4.21	0.47	4.68
YORK COUNTY	4.68	2.17	5.62	0.78	13.25	1.47	14.73
JAMES CITY COUNTY	4.67	2.08	10.10	0.00	16.85	1.87	18.72
TOTAL	43.73	16.77	22.38	5.52	88.40	9.82	98.22

HISTORICAL AND PROJECTED LOWER PENINSULA SYSTEM DEMAND

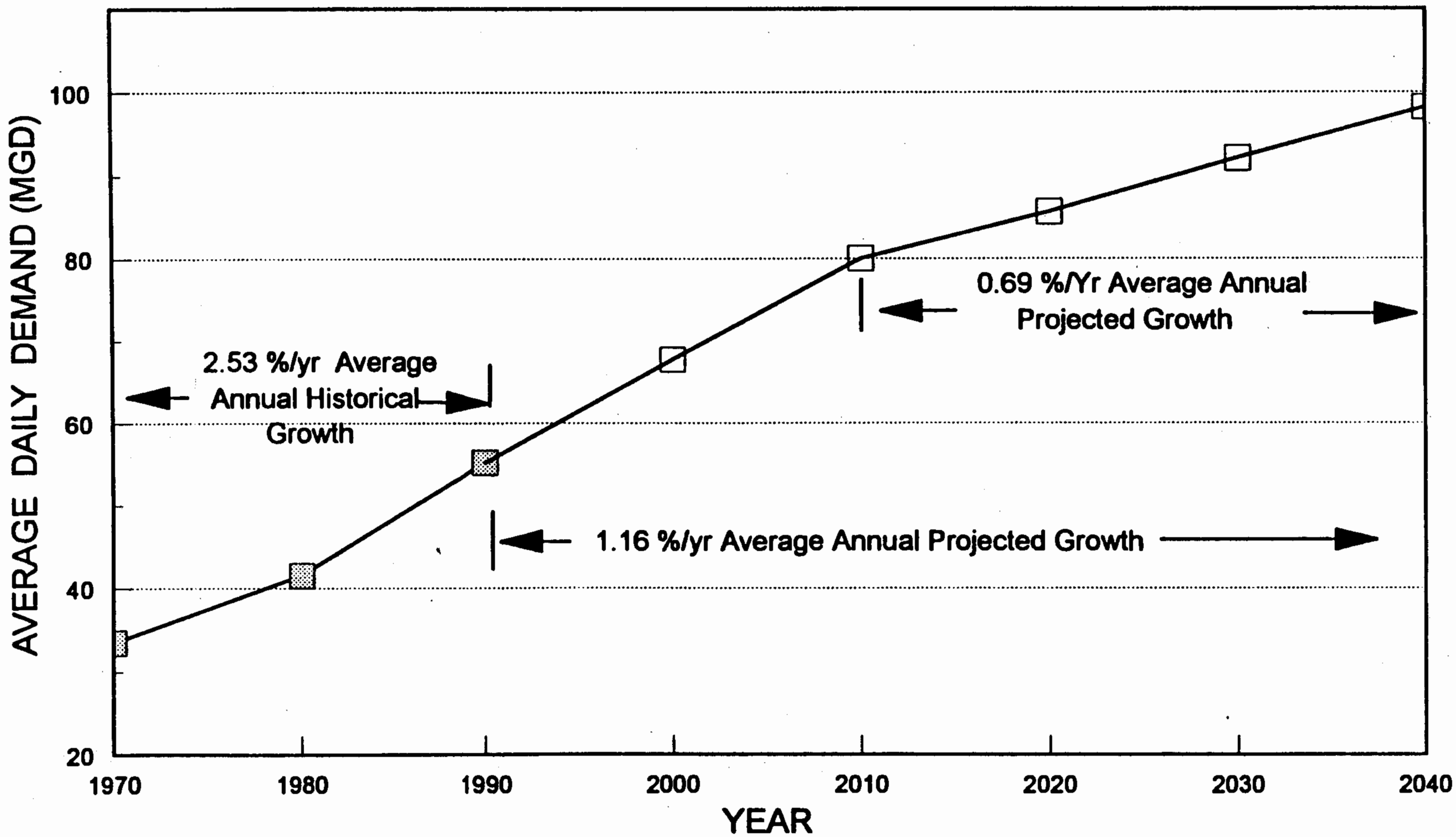


FIGURE 2-8

Disaggregation/Aggregation Methods

A major portion of the Lower Peninsula is currently served by Newport News Waterworks. The Waterworks' service area includes Lower York and James City Counties west to approximately Route 199, and the Cities of Newport News, Poquoson and Hampton, except for NASA/Langley AFB and Fort Monroe, which are currently served by the Big Bethel system.

The Williamsburg system serves the City of Williamsburg and portions of York and James City Counties. The James City Service Authority and York County systems serve the western or "upper" areas within the Counties, with the remaining "lower" county areas served by Newport News Waterworks or Williamsburg.

To project demands for the Waterworks service area, the demands projected for York and James City Counties must be desegregated by the purveyors that service each of the counties. These desegregated jurisdictional demands are then aggregated for each purveyor to produce total demand projections by purveyor. The remainder of this section describes the methods used to desegregate demands in James City and York Counties.

The total James City County demand must be desegregated to the James City Service Authority, Newport News Waterworks and Williamsburg water systems, because all three of these purveyors currently serve parts of James City County, and are expected to continue to do so in the future. The demand supplied by the Williamsburg system is projected to remain constant into the future, because the areas of the County served by Williamsburg are already developed. The demand supplied by the Newport News Waterworks system is generally all the demand in Census Tract 801. A 1986 study (JCC, 1986) presented projected James City County demands by census tract. The table that follows shows a percentage breakdown of demand between Census Tract 801 and the remainder of the County based on the breakdown in the 1986 study.

DEMAND AS PERCENT OF TOTAL JAMES CITY COUNTY DEMAND				
	1990		2030	
User Category	Census Tract 801	Remainder of County	Census Tract 801	Remainder of County
Residential	29%	71%	20%	80%
Commercial	65%	35%	50%	50%
Industrial	95%	5%	80%	20%

Source: James City County, 1986.

The values for the residential and commercial demand split were used as a starting point in desegregating demand between the James City Service Authority and Waterworks. However, these values were adjusted so that the demand on the Newport News Waterworks system due to those users did not substantially decrease. The industrial split in the preceding table was not used. Instead, a 90 percent Newport News Waterworks, 10 percent James City Service Authority split in the Year 2040 was used, since it better represents the current land use planning for the County presented in the 1991 draft Land Use Plan Map for James City County.

The York County demand was desegregated similarly to the James City County demand. The demand supplied by the Williamsburg system was projected to remain constant, and the York County well system was projected to serve the increase in demand that is expected to occur in Census Tract 508, in excess of the demand currently supplied by the Williamsburg system. (A 1985 study by Buchart-Horn presented demand projections for the County by census tract). The following table shows the percentage breakdown of demand between Census Tract 508 and the remainder of the County, based on the 1985 study.

DEMAND AS PERCENT OF TOTAL YORK COUNTY DEMAND				
	2000		2010	
User Category	Census Tract 508	Remainder of County	Census Tract 508	Remainder of County
Residential	8	92	8.2	91.8
Commercial	26	74	26	74
Industrial	0	100	0	100

As discussed in Section 2.3.3, an agreement has been executed between the City of Newport News and York County which includes a provision for Newport News Waterworks to provide services to the entire County. If all conditions of the contract are met, all of York County's demands after the Year 2015 would be met by Newport News Waterworks.

Desegregated Demands

Using the percentage splits for demand in York and James City Counties presented in the preceding tables, and assuming the Williamsburg system supplies increased demands only within the City of Williamsburg and constant demands in those areas of York and James City Counties currently served, the demand projections by purveyor presented in Table 2-14 result. Approval of the proposed contract between York County and the City of Newport News would have the effect of increasing Waterworks' demand for the Years 2020 through 2040 presented in Table 2-14. Consequently, demands presented for those years for Williamsburg and York County would decrease.

The JCSA has recently indicated that the Year 2040 demand projection for the JCSA may underestimate future demands, given the rapid growth occurring in the County (L. M. Foster, JCSA, personal communication, 1997).

2.6.6 Summary of Adopted Regional Projections

This section presents population and demand projections in a summary format, whereas Sections 2.6.1 through 2.6.5 provide more detailed breakdowns of population and demand projections and a description of the methods and assumptions used to produce these projections.

TABLE 2-14

PROJECTED LOWER PENINSULA DEMANDS BY PURVEYOR

(MGD)

YEAR / PURVEYOR	RESIDENTIAL	COMMERCIAL/ INSTIT./ LT. IND.	HEAVY INDUSTRIAL	FEDERAL INSTALL.	SUBTOTAL OF METERED DEMANDS	UAW	TOTAL
1990(METERED)							
NEWPORT NEWS WATERWORKS	24.57	8.39	10.22	2.48	45.66	2.75	48.41
WILLIAMSBURG	0.90	2.20	0.00	0.10	3.20	0.19	3.39
JAMES CITY SERVICE AUTHORITY	1.26	0.30	0.06	0.00	1.62	0.10	1.72
BIG BETHEL	0.00	0.00	0.00	1.54	1.54	0.10	1.64
YORK COUNTY	0.05	0.00	0.00	0.00	0.05	0.00	0.05
TOTAL	26.78	10.89	10.29	4.12	52.08	3.13	55.21
2000							
NEWPORT NEWS WATERWORKS	27.37	9.30	12.57	2.58	51.82	5.76	57.58
WILLIAMSBURG	1.15	2.33	0.00	0.12	3.60	0.40	4.00
JAMES CITY SERVICE AUTHORITY	2.37	0.61	0.18	0.00	3.16	0.35	3.52
BIG BETHEL	0.00	0.00	0.00	2.12	2.12	0.24	2.36
YORK COUNTY	0.13	0.05	0.06	0.00	0.24	0.03	0.27
TOTAL	31.03	12.29	12.81	4.82	60.95	6.77	67.72
2010							
NEWPORT NEWS WATERWORKS	30.90	10.39	16.74	3.18	61.20	6.80	68.00
WILLIAMSBURG	1.24	2.58	0.00	0.14	3.96	0.44	4.40
JAMES CITY SERVICE AUTHORITY	3.04	0.76	0.41	0.00	4.20	0.47	4.67
BIG BETHEL	0.00	0.00	0.00	2.13	2.13	0.24	2.37
YORK COUNTY	0.25	0.12	0.16	0.00	0.53	0.06	0.59
TOTAL	35.42	13.85	17.31	5.45	72.03	8.00	80.03
2020							
NEWPORT NEWS WATERWORKS	32.80	10.95	18.11	5.32	67.18	7.46	74.64
WILLIAMSBURG	1.43	2.62	0.00	0.16	4.21	0.47	4.68
JAMES CITY SERVICE AUTHORITY	3.31	0.84	0.62	0.00	4.77	0.53	5.30
BIG BETHEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YORK COUNTY	0.34	0.29	0.28	0.00	0.91	0.10	1.01
TOTAL	37.88	14.70	19.00	5.48	77.06	8.56	85.63
2030							
NEWPORT NEWS WATERWORKS	35.30	11.52	19.55	5.33	71.69	7.97	79.66
WILLIAMSBURG	1.52	2.79	0.00	0.18	4.48	0.50	4.98
JAMES CITY SERVICE AUTHORITY	3.56	0.93	0.96	0.00	5.45	0.61	6.06
BIG BETHEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YORK COUNTY	0.39	0.47	0.41	0.00	1.28	0.14	1.42
TOTAL	40.76	15.71	20.92	5.51	82.90	9.21	92.11
2040							
NEWPORT NEWS WATERWORKS	37.95	12.13	20.81	5.34	76.22	8.47	84.69
WILLIAMSBURG	1.61	2.96	0.00	0.18	4.75	0.53	5.28
JAMES CITY SERVICE AUTHORITY	3.74	1.04	1.01	0.00	5.79	0.64	6.43
BIG BETHEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YORK COUNTY	0.44	0.64	0.56	0.00	1.64	0.18	1.82
TOTAL	43.73	16.77	22.38	5.52	88.40	9.82	98.22

Population Projections

Total population within the Lower Peninsula is projected to increase over the 50-year planning period from a Year 1990 value of 403,654 to a Year 2040 value of 636,308. The greatest projected rate of increase is for James City County, which is projected to increase in population by 104 percent by the Year 2040, as compared to the projected regional increase of 58 percent.

Water demand projections for the region's public water systems do not depend directly on the region's total population. Rather, they depend on the population served by these systems. Table 2-15 presents projected total population and civilian population served by jurisdiction. The population served values do not include those people who live on federal installations or in base housing areas. This is necessary to prevent double counting of residential demands in both the Federal Installation and Residential demand categories.

Water Demand Projections

With existing water conservation, total demand on public water supply systems within the Lower Peninsula Region is projected to increase 78 percent over the 50-year planning period from a Year 1990 value of 55.2 mgd to a Year 2040 value of 98.2 mgd. This is equivalent to an average annual demand growth rate of 1.16 percent. For comparison, total metered consumption in the Lower Peninsula water system increased an average of 2.53 percent per year between Years 1970 and 1990. As this comparison demonstrates, water demand in the region is projected to increase at a much slower rate than has occurred historically.

The projected average annual demand growth rate for the Lower Peninsula of 1.16 percent also compares favorably to those projected for other Virginia regions. For example, water demands in the Richmond, Virginia region are projected to increase at an annual average rate of 1.26 percent through the Year 2030 (RRPDC, 1992). Average demands (with conservation) in Spotsylvania County are projected to increase at a rate of 2.44 percent per year through the Year 2040. This is more than two times the average annual rate of growth projected by the RRWSG (1.16 percent) over a 50-year planning horizon. In addition, the RRWSG growth rate does not incorporate the effects of additional water conservation activities planned in the region, while Spotsylvania County's rate does. Water conservation will reduce demand in the Lower Peninsula region even further, which will reduce the annual average rate of growth as well. The potential for demand reductions resulting from the implementation of additional conservation measures and use restrictions is discussed in Section 3.4.30.

Projected demands presented by jurisdiction and purveyor are included in Table 2-16. Table 2-17 presents the projected demands for the region and includes a summary description of the calculations used to project demands for each user category.

2.7 PROJECTED DEFICITS

72.9

Based on demand projections summarized in Section 2.6, a Lower Peninsula water demand of 98.2 mgd is expected in the Year 2040. This demand projection assumes continuation of existing conservation programs such that per capita usage rates would remain at their existing level through the planning period. Section 2.3 concluded that the total reliable system delivery capacity (i.e., treated water yield) is currently 61.9 mgd, and is expected to decrease to 60.3 mgd by 2000 and to 58.4 mgd by 2020. Based on the demand projection methodology presented herein, and assuming

TABLE 2–15
ADOPTED REGIONAL TOTAL POPULATION AND CIVILIAN POPULATION SERVED PROJECTIONS BY JURISDICTION

	EXISTING		PROJECTED									
	1990		2000		2010		2020		2030		2040	
JURISIDICTION	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED
NEWPORT NEWS	170,045	160,078	184,000	174,033	213,000	203,033	223,000	213,033	238,000	228,033	254,500	244,533
HAMPTON	133,793	128,798	146,200	141,205	155,940	150,945	166,410	161,415	177,570	172,575	188,065	183,090
POQUOSON	11,005	11,005	14,328	14,328	17,061	17,061	20,187	20,187	23,215	23,215	26,243	26,243
WILLIAMSBURG	11,530	11,530	12,800	12,800	14,000	14,000	15,200	15,200	16,400	16,400	17,700	17,700
YORK COUNTY	42,422	27,418	50,950	39,335	57,580	45,302	64,580	51,602	71,580	57,902	78,580	64,202
JAMES CITY COUNTY	34,859	24,401	51,700	43,945	61,700	55,530	64,700	58,230	67,800	61,020	71,200	64,060
REGIONAL TOTAL	403,654	363,230	459,978	425,646	519,281	485,871	554,077	519,667	594,565	559,145	636,308	599,848

TABLE 2-16

ADOPTED LOWER PENINSULA DEMAND PROJECTIONS BY JURISDICTION AND PURVEYOR

(MGD)

JURISDICTION	EXISTING	PROJECTED				
	1990 *	2000	2010	2020	2030	2040
NEWPORT NEWS	20.44	23.59	27.80	29.05	30.78	32.67
HAMPTON	15.27	18.32	20.32	21.85	23.55	25.08
POQUOSON	0.88	1.26	1.53	1.80	2.07	2.34
WILLIAMSBURG	2.61	3.40	3.80	4.08	4.38	4.68
YORK COUNTY	6.94	9.11	11.04	12.26	13.57	14.73
JAMES CITY COUNTY	9.06	12.05	15.55	16.59	17.75	18.72
TOTAL	55.20	67.72	80.03	85.63	92.11	98.22
PURVEYOR						
NEWPORT NEWS WATERWORKS	48.41	57.58	68.00	74.64	79.66	84.69
WILLIAMSBURG	3.39	4.00	4.40	4.68	4.98	5.28
JAMES CITY SERVICE AUTHORITY	1.72	3.52	4.67	5.30	6.06	6.43
BIG BETHEL	1.64	2.36	2.37	0.00	0.00	0.00
YORK COUNTY	0.05	0.27	0.59	1.01	1.42	1.82
TOTAL	55.21	67.72	80.03	85.63	92.11	98.22

* Differences between the Year 1990 Jurisdiction and Purveyor totals are a result of rounding.

TABLE 2-17

CALCULATION OF PROJECTED LOWER PENINSULA TOTAL WATER DEMAND WITH EXISTING CONSERVATION MEASURES (2000-2040)

(mgd)

		RESIDENTIAL			COMM./INST./LIGHT. IND.			HEAVY WATER USE INDUSTRY								FEDERAL INSTALL.	SUBTOTAL DEMAND	UAW		TOTAL DEMAND
								INDUSTRIAL EMPLOYMENT				EXIST. IND.	NEW INDUSTRY		TOTAL IND.					
								TOTAL	NEW											
YEAR	TOTAL REGION. POP.	CIVILIAN POP. SERVED	REG. AVG GPCPD	DEMAND	TOTAL COMM. EMPL.	REG. AVG. GPEPD	DEMAND		TOTAL	EXIST.	NEW	DEMAND	GPEPD	DEMAND	DEMAND	DEMAND		%	DEMAND	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
2000	459978	425646	73	31.03	174511	70	12.29	37275	4564	746	3818	10.37	640	2.44	12.81	4.82	60.95	10.00	6.77	67.72
2010	519281	485871	73	35.42	196654	70	13.85	42081	9370	1106	8264	12.02	640	5.29	17.31	5.45	72.03	10.00	8.00	80.03
2020	554077	519667	73	37.88	208717	70	14.70	44901	12190	1411	10779	12.10	640	6.90	19.00	5.48	77.06	10.00	8.56	85.62
2030	594565	559145	73	40.76	223125	70	15.71	48182	15471	1816	13655	12.18	640	8.74	20.92	5.51	82.90	10.00	9.21	92.11
2040	636308	599848	73	43.73	238170	70	16.77	51565	18854	3121	15733	12.31	640	10.07	22.38	5.52	88.40	10.00	9.82	98.22

[shaded box] PROJECTED VALUES USED IN ARRIVING AT TOTAL DEMAND

LEGEND:

A -TOTAL PROJECTED POPULATION ON LOWER PENINSULA, FROM TABLE 2-10.
B -TOTAL PROJECTED RESIDENTIAL POPULATION SERVED ON LOWER PENINSULA, FROM TABLE 2-12.
C -EXISTING RESIDENTIAL USAGE RATE (GALLONS PER CAPITA PER DAY).
D -PROJECTED DEMAND, COLUMN B*C.
E -TOTAL PROJECTED EMPLOYMENT ON LOWER PENINSULA MINUS EMPLOYMENT IN HEAVY WATER USE INDUSTRY AND MILITARY EMPLOYMENT.
F -EXISTING COMMERCIAL/INSTITUTIONAL/LIGHT INDUSTRIAL USAGE RATE (GALLONS PER EMPLOYEE PER DAY).
G -PROJECTED DEMAND, COLUMN E*F.
H -TOTAL PROJECTED EMPLOYMENT IN HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA INCREASE IN THIS EMPLOYMENT IS DIRECTLY PROPORTIONAL TO INCREASE IN TOTAL POPULATION.
I -TOTAL NEW EMPLOYEES WORKING IN HEAVY WATER USE INDUSTRIES, COLUMN H-32,711 (NUMBER. OF EMPLOYEES IN YEAR 1990).
J -NEW EMPLOYEES HIRED BY EXISTING HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA DUE TO GROWTH OF THESE INDUSTRIES. SELF-PROJECTED BY EXISTING INDUSTRIES, FROM APPENDIX REPORT B, TABLE 4-11.
K -NEW EMPLOYEES HIRED BY FUTURE NEW HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA COLUMN I-J.
L -PROJECTED DEMAND, SELF-PROJECTED BY EXISTING HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA
M -PROJECTED HEAVY WATER USE INDUSTRIAL USAGE RATE (GALLONS PER EMPLOYEE PER DAY), FROM APPENDIX REPORT B, SECTION 4.
N -PROJECTED DEMAND, COLUMN M*K.
O -PROJECTED TOTAL HEAVY WATER USE INDUSTRIAL DEMAND, COLUMN L+N.
P -FEDERAL INSTALLATIONS DEMAND, FROM APPENDIX REPORT B, TABLE 4-23.
Q -SUBTOTAL OF PROJECTED METERED DEMANDS, COLUMN D+G+O+P.
R -PROJECTED UNACCOUNTED-FOR WATER PERCENTAGE EXPRESSED AS PERCENT OF TOTAL FINISHED WATER PUMPED INTO THE DISTRIBUTION SYSTEM.
S -PROJECTED DEMAND, COLUMN Q*(R/(100-R))
T -TOTAL PROJECTED LOWER PENINSULA DEMANDS, COLUMN Q+S.

linear growth in demands from 1990 to the Year 2000, demand is projected to equal the reliable system delivery capacity before the Year 2000.

Reliable system delivery capacity, demand, and deficit projections for the Lower Peninsula are summarized in Table 2-18 by purveyor. Regional reliable system delivery capacity and demands for each user category are presented graphically in Figure 2-9. Year 2040 deficit projections are shown in Figure 2-10 by purveyor service area.

Lower Peninsula water supply deficit projections are discussed further in the following sections.

2.7.1 Interpretation of Regional Totals

The reliable system delivery capacity presented in Figure 2-9 assumes that source sharing would be implemented as needed. Inspection of the difference between supply and demand for each purveyor reveals that all will have a deficit in the Year 2040.

Summing the individual purveyors' demands and supplies assumes that worst case conditions occur simultaneously for all of the individual purveyors. This is a reasonable assumption given the relatively close proximity of the surface source watersheds and the prolonged duration of yield-controlling drought conditions.

The uncertainties associated with the safe yield analyses of the reservoir systems must also be considered. In particular, future droughts could be more severe than the drought of record used in estimating system safe yields. Conjunctive losses in the supply and treatment of raw water could also reduce current and near future system yields below the estimates adopted for this planning effort.

2.7.2 Interpretation of Purveyor Totals

An examination of the deficit values in Table 2-18 shows that none of the Lower Peninsula public water supply systems are currently in a deficit situation, and the Lower Peninsula area as a whole has a 6.7 mgd surplus. By the Year 2000, Newport News Waterworks, Big Bethel, Williamsburg, JCSA, and York County are all projected to have deficits. York County is projected to have a slight surplus of 0.43 mgd in the Year 2000.

Newport News Waterworks, Williamsburg, JCSA, and York County are projected to have deficits in the Year 2040 of 32.8, 1.5, 4.4, and 1.1 mgd, respectively. The projected 85 mgd Waterworks demand in the Year 2040 includes demands from the current Big Bethel service area. This is based on the assumption that the Big Bethel plant will be abandoned in the Year 2010, as discussed in Section 2.3.5.

2.7.3 Adequacy of Supply Versus Deficit

Year 1990 demands on public water supplies in the Lower Peninsula averaged 55.2 mgd and are projected to increase throughout the planning period. The Year 1990 demand represents 89 percent of the region's 61.9 mgd reliable system delivery capacity. Under current VDH regulations, water purveyors represented by the RRWSG now have a clear duty to develop plans for expansion of their raw water supplies.

TABLE 2-18

LOWER PENINSULA SUPPLY, DEMAND AND DEFICIT PROJECTIONS BY PURVEYOR

(MGD)

PURVEYOR / YEAR	SUPPLY (1)	DEMAND (2)	DEFICIT (3)
1990(METERED)			
NEWPORT NEWS WATERWORKS	51.90	48.41	-3.49
WILLIAMSBURG	3.80	3.39	-0.41
JAMES CITY SERVICE AUTHORITY	4.17	1.72	-2.45
BIG BETHEL	1.90	1.64	-0.26
YORK COUNTY	0.12	0.05	-0.07
TOTAL	61.89	55.21	-6.68
2000			
NEWPORT NEWS WATERWORKS	51.90	57.58	5.68
WILLIAMSBURG	3.80	4.00	0.20
JAMES CITY SERVICE AUTHORITY	2.00	3.52	1.52
BIG BETHEL	1.90	2.36	0.46
YORK COUNTY	0.70	0.27	-0.43
TOTAL	60.30	67.72	7.42
2010			
NEWPORT NEWS WATERWORKS	51.90	68.00	16.10
WILLIAMSBURG	3.80	4.40	0.60
JAMES CITY SERVICE AUTHORITY	2.00	4.67	2.67
BIG BETHEL	1.90	2.37	0.47
YORK COUNTY	0.70	0.59	-0.11
TOTAL	60.30	80.03	19.73
2020			
NEWPORT NEWS WATERWORKS	51.90	74.64	22.74
WILLIAMSBURG	3.80	4.68	0.88
JAMES CITY SERVICE AUTHORITY	2.00	5.30	3.30
BIG BETHEL	0.00	0.00	0.00
YORK COUNTY	0.70	1.01	0.31
TOTAL	58.40	85.63	27.23
2030			
NEWPORT NEWS WATERWORKS	51.90	79.66	27.76
WILLIAMSBURG	3.80	4.98	1.18
JAMES CITY SERVICE AUTHORITY	2.00	6.06	4.06
BIG BETHEL	0.00	0.00	0.00
YORK COUNTY	0.70	1.42	0.72
TOTAL	58.40	92.11	33.71
2040			
NEWPORT NEWS WATERWORKS	51.90	84.69	32.79
WILLIAMSBURG	3.80	5.28	1.48
JAMES CITY SERVICE AUTHORITY	2.00	6.43	4.43
BIG BETHEL	0.00	0.00	0.00
YORK COUNTY	0.70	1.82	1.12
TOTAL	58.40	98.22	39.82

(1) RELIABLE SYSTEM DELIVERY CAPACITY OF EACH PURVEYOR'S SYSTEM.
(2) PROJECTED DEMANDS ON EACH PURVEYOR'S SYSTEM.
(3) REQUIRED NEW RELIABLE SYSTEM DELIVERY CAPACITY TO MEET PROJECTED DEMANDS. NEGATIVE VALUES INDICATE SURPLUS.

PROJECTED REGIONAL WATER DEMAND VS. RELIABLE SYSTEM DELIVERY CAPACITY

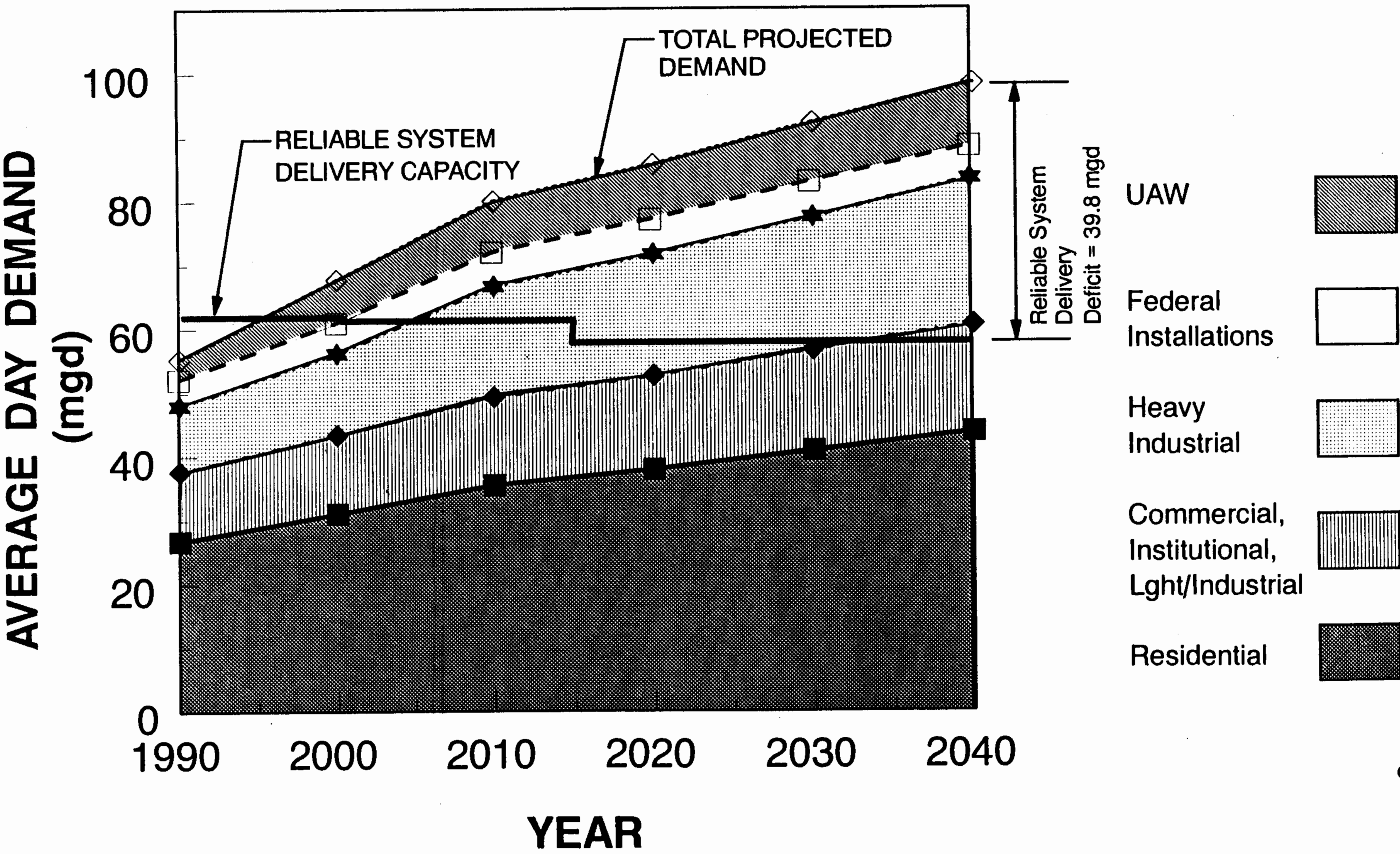
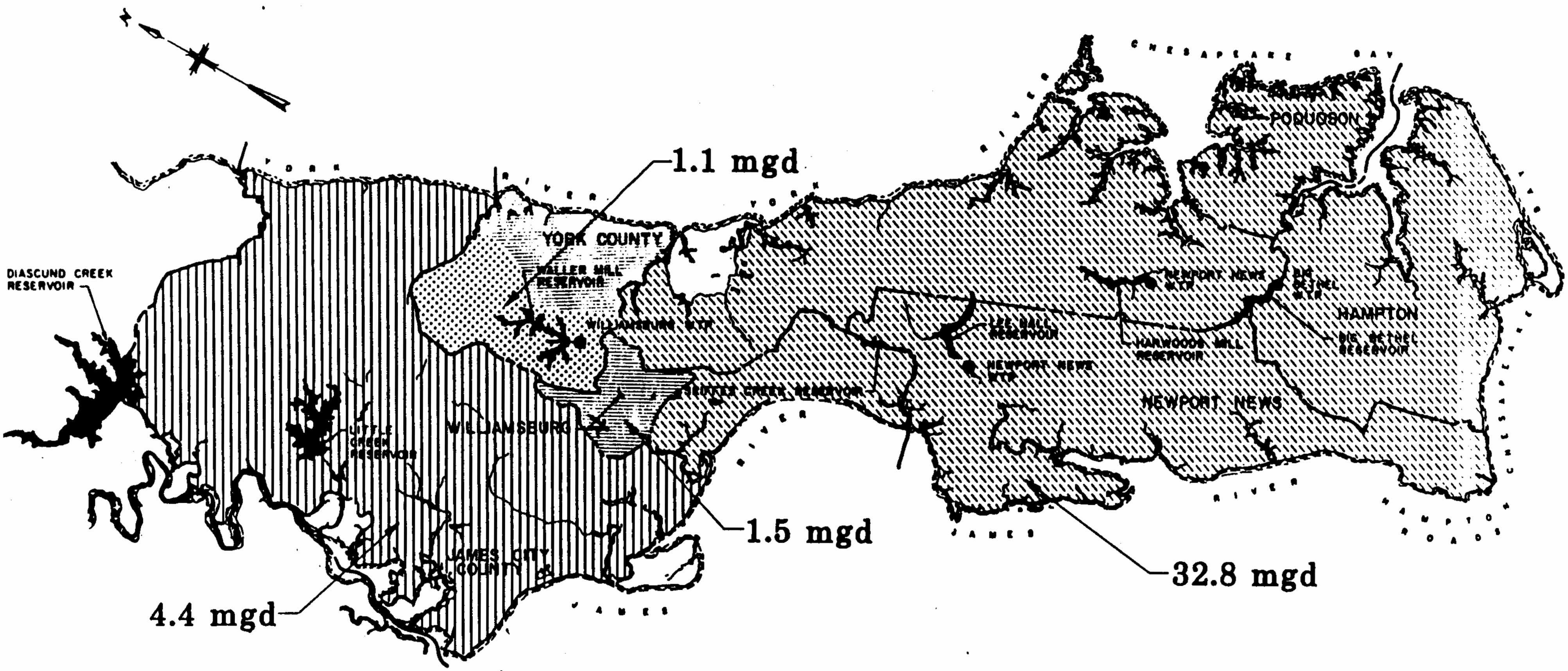


Figure 2-9

YEAR 2040 SERVICE AREA DEFICIT PROJECTIONS



LEGEND

LEGEND

- NEWPORT NEWS WATERWORKS
- WILLIAMSBURG
- YORK COUNTY
- JAMES CITY SERVICE AUTHORITY
- POLITICAL BOUNDARY
- EXISTING TREATMENT PLANT

MALCOLM PIRNIE

OCTOBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY

LOWER PENINSULA TOTAL
TREATED WATER DEFICIT
(WITH EXISTING CONSERVATION MEASURES)
39.8 mgd

0 7800 15000
SCALE IN FEET

FIGURE 2-10

The Lower Peninsula public water supply systems are currently under stress and will be inadequate to meet the total projected regional demand during a severe drought before the Year 2000 as presented in Figure 2-9. It is estimated that the total available regional reservoir storage would be depleted in 5½ months during a hypothetical worst-case drought in which no Chickahominy River withdrawals or reservoir inflows from runoff occur. This assumes that the Lower Peninsula's reservoirs are full at the onset of the drought.

Planning, permitting, designing, and constructing new large-scale raw water supply facilities may take many years. Consequently, the projected deficit in the near future demonstrates the importance of investigating and implementing both interim and long-term water supply augmentation measures. The comparison of supply and demand shown in Figure 2-9 indicates that a treated water deficit of 39.8 mgd is expected in the Year 2040.

New water supply alternatives which can increase the Lower Peninsula's reliable system delivery capacity by approximately 40 mgd are needed to satisfy the 98.2 mgd projected Year 2040 average day demand during a drought equivalent to the worst drought of record. This deficit does not account for losses between a new raw water source and the Lower Peninsula distribution systems. These could include transmission losses in future raw water pipelines, seepage losses from new reservoirs, internal water use at new WTPs, or concentrate discharges from membrane treatment processes. These losses would have to be subtracted from the raw water source yield of any new or expanded supply systems in order to determine the reliable system delivery capacity of such systems.

For example, the raw water source yield of a new reservoir must be adjusted to account for related raw water transmission pipeline losses, any reservoir losses not included in the basic safe yield analysis, and WTP usage. Based on current estimates for the Newport News Waterworks system, these losses are estimated as at least 10 percent of the raw water source yield. A new reservoir, for example, would therefore have to have a raw water yield of approximately 44 mgd to assure a reliable system delivery capacity of approximately 40 mgd.

Different types of raw water supply systems will have different types and magnitudes of losses. The 44 mgd source safe yield value described above does not apply to groundwater, desalting, or conservation alternatives. This value also does not account for any demands outside the Lower Peninsula such as supply commitments that may be necessary with new project host jurisdictions.

As discussed above, the value that must be used to compare alternative supply systems is the reliable system delivery capacity (or treated water yield). The new reliable system delivery capacity required to satisfy projected Lower Peninsula demands through the Year 2040, assuming the existing level of conservation occurs throughout the planning period, is 39.8 mgd. The new capacity required by year is presented in Table 2-19.

2.8 POLITICAL/INSTITUTIONAL CONSIDERATIONS

As part of the review and approval process, the Commonwealth of Virginia must approve any raw water supply project selected by the RRWSG. Historically, the state has provided only limited support for water supply development beyond its role of review and approval. In performing this role, state government has relied primarily on control created by a federal statute, the Section 401 Certification Program mandated by the Clean Water Act (CWA).

TABLE 2-19

LOWER PENINSULA WATER SUPPLY, DEMAND AND DEFICIT PROJECTIONS *
(mgd)

YEAR	SUPPLY	DEMAND	DEFICIT
	REGIONAL RELIABLE SYSTEM DELIVERY CAPACITY	REGIONAL DEMAND	REQUIRED NEW RELIABLE SYSTEM DELIVERY CAPACITY
1990	61.9	55.2	-6.7
2000	60.3	67.7	7.4
2010	60.3	80.0	19.7
2020	58.4	85.6	27.2
2030	58.4	92.1	33.7
2040	58.4	98.2	39.8

* Negative values of deficit represent a regional surplus.

Newport News Waterworks' newest water supply source, Little Creek Reservoir constructed in 1979, was permitted under federal and state regulations dating from the early 1970s. Regulations have since changed considerably and are discussed below.

2.8.1 Current State Role

In order to identify the current role of the state, a review of the current situation is needed. Although water supply development advocacy on the state level is limited, several state water management activities do relate to water supply provision. These activities can be grouped into the four categories of: delegation of local government water supply development authority, water supply planning, financial and technical assistance, and regulation as discussed below.

<u>Delegation of Local Government Water Supply Development Authority</u>

Virginia is a "Dillon Rule" state. Simply put, the Dillon Rule means that local government can only do those things that they have been specifically empowered to do. Local powers depend on specific delegation of authority within local government charters and/or through enabling legislation. Virginia enabling legislation provides broad authority for local governments to develop water supplies. Localities generally have power to develop water supplies individually, or through formal arrangements for multi-jurisdictional participation such as water authorities.

Authority to develop water supplies generally exists for projects both inside and outside the boundaries of the project's owner. However, projects outside the boundaries of the owner usually require the consent of the host jurisdiction (or the approval of a special three-judge court to which appeals can be taken in the event consent is denied). Thus, extra-territorial projects generally cannot be undertaken on a unilateral basis but must involve agreements among the affected parties.

<u>Water Supply Planning at the State Level</u>

State legislation authorizes the Virginia State Water Control Board (SWCB) (now incorporated into the Virginia Department of Environmental Quality) to conduct general water supply planning for each of the State's major river basins and sub-basins. Planning assistance is also available to local governments, upon request.

For much of the time since 1972, when this responsibility was transferred to the SWCB from the Department of Conservation and Economic Development, state water supply planning efforts have appeared to receive less emphasis than water quality management activities. More recently, however, publicity over water supply shortages and conflicts at some locations have encouraged a greater emphasis on water supply issues.

Recent water supply planning in Virginia has included the completion in 1988 of eleven River Basin Plans by the SWCB. The Basin Plans provide inventories of water resources and water demand centers. Possible supply alternatives to meet future demands also were reviewed, but the SWCB did not indicate its preferences or provide any assistance in the development of alternatives.

The SWCB also has authority to conduct more specialized water supply planning and management through various regulatory programs. One such program was created by the Virginia Groundwater Act (VGA) of 1973. The VGA authorized special studies of geographic areas proposed for designation as groundwater management areas. The entire Lower Peninsula now falls within the Eastern Virginia Groundwater Management Area. The Virginia Ground Water Management Act

(VGMA) of 1992 replaced the VGA and added additional measures for the management and control of groundwater resources by the SWCB. Groundwater withdrawal regulations pursuant to that Act became effective June 1993 (VR 680-13-07).

The Virginia Surface Water Management Areas Act (SWMAA) is a more recent statute directing water supply management. The focus of the SWMAA is on identification of geographical areas that have suffered, or are likely to suffer, injury to instream water use activities as a result of water withdrawals. Designation of a SWMAA is dependent upon a general assessment of existing and projected water use in relation to the available supply within the various surface waters of the State. Adopted SWMA regulations became effective on June 3, 1992 (VR 680-15-03).

A related measure is the Virginia Water Protection Permit Act (VWPPA). A Virginia Water Protection Permit (VWPP) constitutes the State's certification under Section 401 of the federal Clean Water Act that a federal permit for a proposed activity involving discharges to surface waters will not cause the violation of state water quality standards. It also authorizes the imposition and enforcement of additional permit conditions as a matter of state law, an authority that is not granted under Section 401 of the Clean Water Act. Adopted VWPP regulations became effective on May 20, 1992 (VR 680-15-02). In the absence of a SWMA, the VWPP is the State's primary permit for allocating water supplies for major new projects. The State works with the USCOE to coordinate instream flow and water withdrawal conditions. The VWPP approval is contingent upon protection of instream beneficial uses.

State Financial and Technical Assistance

The Virginia Resources Authority (VRA) administers the Virginia Water Supply Revolving Fund. The Fund is used primarily for loans to local governments for the costs of wastewater projects. Interest rates and repayment terms are set by the Virginia Board of Health. VRA is authorized to issue bonds to raise money for the Fund, with the total principal bond amount at any time not to exceed $400 million without prior approval by the General Assembly.

Water Supply Regulatory Powers of the State

Water supply development is an intensely regulated activity. Regulations applicable to municipal water supply development can be classified as health protection, resource allocation, and environmental protection.

Regulation of water quality to protect the health of waterworks customers is a long-established practice but has been intensified by enactment of the Federal Safe Drinking Water Act (SDWA) and subsequent amendments. Virginia has been granted primacy under the SDWA, with the effect that the Virginia Department of Health (VDH) is responsible for administering both state and federal laws applicable to waterworks operations (subject to certain oversight by the USEPA with respect to federal requirements). In addition to regulation of the quality of drinking water provided, Waterworks' regulations also control the source of supply by imposing minimum yield requirements. The VDH is responsible for issuing permits required for waterworks operation. The permit indicates the approved capacity of the system. The capacity is rated based on the least capacity of the individual components required for providing a reliable water supply. These include: raw water yield, water treatment capability, treated water storage, and water distribution capability. In addition, the VDH requires that improvements be planned when demands for three consecutive months are 80 percent or more of the capacity of that particular part of the operation.

Regulation of water supply development to achieve a desirable resource allocation is authorized by two previously described state statutes (i.e., VGMA and SWMAA). Both statutes can restrict withdrawals for public water supply purposes, but operate only within designated management areas.

The primary regulatory authority related to environmental protection is exercised by federal rather than state government. The principal regulatory measure is the permit required under Section 404 of the CWA for discharges of dredged or fill material into waters of the United States. The scope of coverage of this provision brings most water development activities (such as construction of dams and water intakes) within its coverage. General administrative responsibility for the Section 404 permit program rests with the USCOE, but the USEPA has the authority to veto issuance of a USCOE permit where it finds unacceptable adverse environmental impacts. The state must certify through the issuance of a VWPP that it has reviewed the permit application and found the project consistent with its water quality management programs.

The primary state regulatory measure concerning conservation is through the Building Officials and Code Administrators (BOCA) codes. The BOCA organization is a nonprofit organization which develops a series of performance-oriented model codes (BOCA, 1990). These codes were adopted by the Commonwealth of Virginia as part of the Uniform Statewide Building Code (USBC) (DHCD, 1987). These codes directly specify the use of water conservation fixtures, such as conservation type flushometer valves in water closets.

These codes apply to all new construction and some remodeling of existing structures. The USBC requires that:

> "When reconstruction, renovation, or repair of existing buildings is undertaken, existing materials and equipment may be replaced with materials and equipment of similar kind or replaced with greater capacity equipment in the same location when not considered a hazard; however, when new systems, materials, and equipment that were not part of the original existing building are added, the new systems, materials, and equipment shall be subject to the edition of the USBC in effect at the time of their installation. Existing parts of such buildings not being reconstructed, renovated, or repaired need not be brought into compliance with the current edition of the USBC."

BOCA sets maximum flow standards for a variety of fixtures and appliances. These standards set a maximum limit of 3.0 gallons per minute (gpm) at 80 pounds per square inch (psi) for showers, lavatories, and sinks. While conservation type showerheads are not directly called for in the BOCA codes, the maximum limit of 3.0 gpm precludes the use of most conventional showerheads, which have a flow rate of 7.0 gpm. Water closets are limited to 4.0 gallons per flushing cycle and urinals are limited to 1.5 gallons per cycle. In addition, lavatories in public facilities are limited to 0.5 gpm for those with standard valve or spring faucets and 0.25 gallons per cycle for self-closing metering valves (BOCA, 1990).

The plumbing codes currently in use in Virginia employ measures which are considered conservation-oriented. Advanced plumbing codes, as referred to in this document, are more restrictive plumbing codes than those already in place. This would probably include a requirement for the use of ultra-low-volume (ULV) toilets. In the Commonwealth of Virginia, plumbing codes can only be implemented at the State level of government and not by individual jurisdictions or water purveyors.

The USBC in Virginia was adopted from the BOCA National Plumbing Code. States are permitted to develop plumbing codes that implement stricter measures than those imposed by the National Plumbing Codes. However, localities in Virginia must obtain State authorization to develop a stricter code.

There are other legal incentives for developing a sound conservation program. For example, regulatory provisions exist for incorporating instream flow conditions in VWPPs. These instream flow conditions may require water conservation and reductions in water use by the permittee.

Likewise, the SWMA regulations stipulate that SWCB-approved conservation or management plans be included in Surface Water Withdrawal Permits. An approved conservation program must include:

- Use of water saving plumbing fixtures in new and renovated plumbing as provided under the Uniform Statewide Building Code.
- A water loss reduction program.
- A water use education program.
- Ordinances prohibiting waste of water generally and providing for mandatory water use restrictions, with penalties, during water shortage emergencies.

Proposed Groundwater Withdrawal Regulations also would require that applications for new Groundwater Withdrawal Permits include a water conservation plan approved by the SWCB. Conservation plan elements required would be similar to those required by the SWMA regulations.

2.8.2 State and Local Constraints

Constraints on water supply development activities imposed by Virginia law consist of direct and indirect control measures. Direct controls include specific regulatory measures applicable to public water supply operations, groundwater withdrawals, and the construction and maintenance of dams. Indirect controls include the state environmental review process, the state antiquities protection program, the state project notification and review process, and state constraints on floodplain use.

The Commonwealth's political subdivisions (local governments) and Circuit Courts exercise considerable authority of relevance to the construction and operation of water supply facilities. Local controls attain their principal importance in situations where a political subdivision desires to construct and operate facilities outside its boundaries, thereby potentially subjecting itself to regulation by the political subdivision where the facilities are to be located. In addition, different levels of government may simultaneously apply controls to an individual water resource project, and the project may be subjected to conflicting requirements. Major conflicts regarding water management can develop between state and local laws.

The relationship between state and local governments is derived from the fact that local governments are creatures of the State. In the approach employed in Virginia (Dillon's Rule), local governments have only those powers enumerated in state enabling legislation. They have no inherent authority independent of such legislation. If a conflict occurs between state and local action, the concept of preemption applies, and local authority must yield. There are, therefore, considerable legislative constraints relative to water resource development and conservation that would be difficult to change.

Circuit Courts

Procedures exist through which the circuit courts of the state can authorize certain water resource development projects. Primary mechanisms of this type include one pertaining to construction of milldams and related facilities and another concerning facilities for the storage of flood water.

Legislation applicable to milldams provides that any person desiring to construct a dam or canal to utilize a stream for operation of a water mill may request authorization from the circuit court of the county where the construction is proposed. Where such authorization is requested, the court is required to appoint five freeholders in the county who are charged with the duty of making a complete investigation of the site and reporting the likely impact of the proposed construction. If it appears that the proposed structure will result in obstructed fish passage, navigation disruptions, property loss, or health impacts, the court may not grant permission. Otherwise, permission is in the discretion of the court.

Riparian owners desiring to store water above average streamflow for later use may also request authorization from the circuit court of the county or city where the impoundment is proposed, providing the construction involved does not come within the jurisdiction of the milldam act, the water power development act administered by the State Corporation Commission (SCC), or the federal government.

Unlike the milldam act, the enabling legislation for storage of flood water provides for input from a state agency to the judicial proceedings for approval. In addition to general notice regarding each application, the applicant is required to send a copy of the application to SWCB. The mechanism for state-level input is a report by SWCB to the circuit court that addresses the following matters:

- The average flow of the stream at the point from which water for storage will be taken.

- Whether the proposed project conflicts with any other proposed or likely developments on the watershed.

- The effect of the proposed impoundment on pollution abatement to be evidenced by a certified statement together with such other relevant comments as the Board desires to make.

- Any other relevant matters which the Board desires to place before the court.

The final decision regarding a particular application is made by the court on the basis of the report and other evidence, including that obtained at a required public hearing. Legislative criteria to guide the court in its determination provide that the application be denied if it appears that other riparian owners will be injured or other justifiable reasons exist. It is specified that approval not be granted where SWCB indicates that reduction of pollution will be impaired or made more difficult.

Land Use Controls (Zoning and Comprehensive Planning)

By longstanding tradition and practice, authority for land use planning and control in Virginia has been delegated to the State's political subdivisions. Since 1976, Virginia law has required the governing body of each county and municipality to create a planning commission, an action that was optional under prior legislation (Virginia Code § 15.1-427.1). A local planning commission is to consist of at least five but not more than 15 members, who are appointed by the governing body of the county or municipality.

The principal duty of each local planning commission is the preparation and enforcement of a comprehensive plan for the physical development of land within its jurisdiction. Statutory guidelines for such plans provide for a survey of natural resources during plan preparation and specify that the plan may include the designation of areas for various types of public and private development and use. This legislation appears to authorize incorporation of water and other natural resource considerations into the local planning process, but it leaves such matters largely to the discretion of the local commissions.

Public utilities projects must conform generally to the local comprehensive plan in each applicable locality. The local planning commission has approval authority for such projects, and the governing body of the jurisdiction (board of supervisors or city council) has authority to override the planning commission's decision (Virginia Code § 15.1-456). Denial of a local government's approval under that law must be challenged in an action in the local Circuit Court.

Local governments also are authorized to implement land use controls in the form of local Zoning Ordinances (Virginia Code §§ 15.1-486, *et seq.*). This legislation both authorizes enactment of local Zoning Ordinances and specifies the purposes of such ordinances and the extent of the regulatory authority delegated. The legislation does not focus on matters relating to water resources or their development and use; however, it does require that local Zoning Ordinances give reasonable consideration to the public's need for water and to conservation of natural resources, and it allows localities to include reasonable provisions to protect surface water and groundwater. Under most local Zoning Ordinances, special (or conditional) use permits would be required to construct major components of a new public water supply project.

Land use controls serve as a potential mechanism through which a political subdivision could oppose water supply facilities proposed within its jurisdiction by a second political subdivision. If such controls are applicable to a proposed facility, they may provide a basis for prohibition or imposition of conditions on the location, construction or operation of that facility.

Local Consent Laws

Numerous provisions of Virginia law provide local consent authorities applicable to public water supply projects. Those statutes include the following:

- Virginia Code § 15.1-37 (construction of dams for providing public water supply) requires local consent prior to acquisition of land which would be used for the purposes of providing a public water supply source.

- Virginia Code § 15.1-37.1 (construction of dams across navigable streams) requires local consent prior to acquisition of any lands which would be used for the construction of any dam across a navigable waterway

- Virginia Code § 15.1-332.1 (impoundment of waters) requires local consent prior to impounding waters within another locality through any means (including dam construction)

- Virginia Code § 15.1-875 (water supply systems) requires local consent for the operation of any water supply systems within another locality's boundaries

- Virginia Code § 15.1-1250.1 (water supply impoundment systems) requires local consent prior to construction or operation of any water supply impoundment system within another locality's boundaries

These statutes merely require local consent or approval; they provide no explicit standards to regulate or govern local government decisions. Reviews of denials of local consents under each of those statutes are conducted by a three-judge special court, which must "balance the equities" and "determine the necessity for and expediency of the . . . proposed action and the best interests of the parties," and which has the authority to "determine the terms and conditions of the action" (Virginia Code §§ 15.1-37.1:2, 15.1-37.1:3).

An additional statute which provides a local consent authority which may be applicable to water supply projects is the Agricultural and Forestal District (AFD) Act (Virginia Code §§ 15.1-1506 through 15.1-1513). This Act is designed to implement "the policy of the Commonwealth to conserve and protect and to encourage the development and improvement of the Commonwealth's agricultural and forestal lands..." and to "conserve and protect agricultural and forestal lands as valued natural and ecological resources...." The Act requires that any political subdivision with intent to acquire land within these districts must file a "notice of intent" with the local governing body to include justification for the project and a description of alternatives evaluated. In consultation with the local planning commission and the local agricultural and forestal districts advisory committee, the local governing body reviews the proposed action to determine its effect on the agricultural and forestal resources within the district and the policy of the AFD Act, and to "determine the necessity of the proposed action to provide service to the public in the most economical and practicable manner." If the political subdivision is denied by the local governing body, an appeal may be made to the circuit court in that jurisdiction.

Wetlands Zoning Ordinances

The Virginia Wetlands Act (VWA) provides authority for political subdivisions in the coastal areas of the state to adopt a special wetlands zoning ordinance contained in the act. After adoption of the ordinance and creation of the required administrative board, non-exempted alteration of wetlands as defined in VWA is unlawful without a permit from the board. Local permit decisions can be reviewed and modified by the Virginia Marine Resources Commission (VMRC), and VMRC is authorized to administer a wetlands permit program in those political subdivisions in Tidewater that do not develop a local program.

Although the controls imposed by VWA constitute an important restriction on many development activities affecting coastal wetlands, public water supply projects are not likely to be restricted because VWA focuses on marine wetlands.

Riparian Doctrine

Virginia, like other southeastern states, applies the riparian doctrine to water withdrawals by landowners adjoining surface water bodies. Owners of property bordering or crossed by a watercourse have the right to the reasonable use of the water in the watercourse, provided that the flow is not unreasonably diminished for use by downstream riparian owners. The Virginia Supreme Court stated the following in a 1925 case concerning riparian rights:

> A proprietor may make any use of the water of the stream in connection with his riparian estate and for lawful purposes within the watershed, provided he leaves the current diminished by no more than is reasonable, having regard for the like right to enjoy the common property by other riparian owners.

There are two basic variations of the riparian right, one known as the natural flow or English doctrine, and one known as the reasonable use or American doctrine. The natural flow doctrine assumes that, regardless of any showing of actual injury, a downstream owner has the legal right to prevent an upstream owner from diminishing the natural flow in the stream. The reasonable use doctrine, on the other hand, requires that before a downstream riparian owner may institute legal action for diminution of the riparian right, he must first show actual injury from the upstream withdrawal. Although the Virginia Supreme Court has not clearly stated which doctrine applies, the court has applied a reasonable use standard in the few riparian cases decided in Virginia.

With respect to withdrawals for municipal water supply, two important considerations apply. First, the Virginia Supreme Court has ruled that municipal withdrawals for water supply purposes are not a riparian right. The reason for this is that the water is transferred to other properties that are not riparian to the stream, whereas the riparian right recognizes use of water only on riparian property. The other consideration applicable to municipal water supply projects in riparian states is that withdrawal of surface water by a municipality for water supply, particularly if the water is transferred to another watershed, is not a recognized right of use under the riparian doctrine. However, under the reasonable use doctrine, it would be necessary for a downstream user to show actual injury from such a diversion before relief could be granted.

2.9 ADDITIONAL INFORMATION PERTAINING TO CURRENT SUPPLIES AND DEMAND PROJECTIONS

This section identifies new information which has become available since the completion of the analyses presented in the DEIS. It also discusses the potential impacts of this new information on the supply, demand, and deficit data and projections presented in Sections 2.3, 2.6, and 2.7 of the DEIS. Further discussion of the conservation objectives used in developing the RRWSG's demand and deficit projections in response to comments on the DEIS is also provided.

2.9.1 Description of New Demand and Deficit Information

The demand and deficit projections presented in Sections 2.6 and 2.7 of the DEIS were developed for the 50-year planning period from 1990 through 2040 using the best information available at that time. This Section reviews the following new information, which could potentially affect these projections:

- Revisions to 1990 Census data by the U.S. Department of Commerce, Bureau of the Census.

- Revised population projections by local planners.

- Long-range population projections developed by the Virginia Employment Commission (VEC) (June 1993).

- The Federal Energy Policy Act of 1992.

- Current information regarding the potential effects of pending or proposed military downsizing and resulting employment fluctuations.

Revisions to 1990 Census Data

The population data presented for the Year 1990 in Section 2.6.3 of the DEIS were based on preliminary 1990 Census data, which estimated total population in the Lower Peninsula study area to be 403,654. Changes to these data have since been made by the U.S. Department of Commerce, Bureau of the Census. The total population in the study area in 1990 is now estimated to have been 405,189, which is 1,535 persons higher than presented in the DEIS. Because of this slight change to the population served estimates, the residential per capita usage rate calculated for 1990 should be decreased by 0.4 percent (0.3 gpcpd).

The population projections for the Lower Peninsula which were used to estimate future demands have not been revised as a result of the new 1990 Census data. While the populations of individual jurisdictions within the study area changed slightly, the change was not enough to warrant revision of the future projections of population. Therefore, the revised 1990 Census values affect the 1990 data but not the long-term projections presented in Sections 2.6 and 2.7.

Population Projections by Local Planners

As discussed in Section 2.6.3, the RRWSG relied heavily on the population projections provided by local planners. Prior to preparation of the FEIS, local planners were again contacted to verify that the population projections previously provided for the DEIS were the most up-to-date projections developed by those jurisdictions for use in water supply planning. Local planners in the Cities of Newport News, Hampton and Poquoson indicated that the projections previously provided are still the most up-to-date projections for use in water supply planning (E. Chen, City of Newport News, personal communication, 1996; D. Vest, City of Poquoson, personal communication, 1996; Ms. Mason, City of Hampton, personal communication, 1996). The City of Williamsburg has included new projections as part of its *Comprehensive Plan Update* (Draft 3/6/96) which has not been adopted by the Planning Commission or City Council (City of Williamsburg, 1996). The projections contained in that document do not vary appreciably from the previous projections provided by the City.

Both York County and James City County have developed new population projections as part of their revisions to their Comprehensive Plans. Neither of the plans has been adopted, however, the projections are being used by the planning departments. Projections have been made for both Counties through the Year 2010. The new projections are compared to those used in demand projections below:

Year	Previous Projections	New Projections
York County		
2000	50,950	58,400
2010	57,580	74,500
James City County		
2000	51,700	49,036
2010	61,700	67,947

The recent projections by both of these Counties indicate a much higher population in the Year 2010 than was used in projecting demands. If these data were used in demand projections, it would have the effect of increasing the demand and deficit projections for the Lower Peninsula. However, because the new projections had not been adopted by the Counties, as of January 1, 1997 (C. Guiliano, James City County, personal communication, 1997; P. Morris, York County, personal communication, 1997), demand projections have not been revised based on the new numbers.

The population projections made by each of the jurisdictions within the Lower Peninsula are done so in consideration of the unique development characteristics of each jurisdiction. Factors which are considered include development restrictions, such as zoning regulations and the Chesapeake Bay Preservation Act, as well as the effects of buildout.

Near-term population projections adopted by the RRWSG were compared to provisional Year 1995 Lower Peninsula population estimates developed by the University of Virginia's Weldon Cooper Center for Public Service (WCC) (Martin and Tolson, 1996). The WCC estimates are based on state estimates developed by the U.S. Bureau of the Census. The RRWSG population projections assumed an average annual growth rate of 1.32 percent for the period 1990 through 2000. The Weldon Cooper Center estimates indicate that actual population growth in the Lower Peninsula has occurred at an average annual rate of 1.54 percent for the period 1990 through 1995. Actual growth is occurring at a higher rate than was predicted by the RRWSG. Therefore, RRWSG demand projections may underestimate actual demand.

VEC Long Range Population Projections

The Virginia Employment Commission (VEC) continually updates its state and local population projections based on new information. The most recent projections obtained from the VEC (VEC, 1990) for the DEIS were higher than those adopted by the RRWSG. For example, the VEC's (1990) projected Year 2030 Lower Peninsula population was 632,800, or 6.4 percent higher than the RRWSG's corresponding projection of 594,565. Likewise, the VEC's projected average annual growth rate for the period 1990 through 2040 (1.12 percent) was much higher than that projected by the RRWSG (0.91 percent).

The VEC has presented updated projections for the period from 1990 through 2010 in ***Virginia Population Projections, 2010*** (VEC, 1993). The VEC also made long-range projections through the Year 2030, based on a linear extension of the 1980 and updated 1990 through 2010 data. The VEC uses these unpublished long range projections primarily for comparison with projections developed by local planners. Table 2-11 presents the RRWSG's population projections for the study area and the VEC's new projections for both the study area and the state as a whole. The average annual rate of population growth projected by the RRWSG for the Lower Peninsula (0.91 percent) is approximately 0.1 percent higher than the new rates projected by the VEC for both the study area and the state as a whole.

The differences can be attributed to variations in the methodologies used by the VEC and the local planning departments to estimate population. The VEC projections for the Year 2030 are simply a linear extrapolation of population data and projections for the period 1980 through 2010, which do not take into account the anticipated future growth patterns of the individual localities. As previously discussed, each local planning department considers anticipated future development activities when calculating its future population estimates.

Local planners in each of the localities in the Lower Peninsula were contacted to determine their preference for population projections. All of the localities indicated that they prefer to use the population projections developed by their own planning departments, as opposed to the VEC projections, for the reasons cited above (E. Chen, City of Newport News, personal communication, 1996; Ms. Mason, City of Hampton, personal communication, 1996; D. Vest, City of Poquoson, personal communication, 1996; M. King, York County, personal communication, 1996; M. Maxwell, James City County, personal communication, 1996; City of Williamsburg, 1996). Since the local projections are considered more accurate than the more general VEC projections, the RRWSG's population projections have not been revised as a result of the new VEC projections.

Federal Energy Policy Act

The Federal Energy Policy Act (FEPA), which was enacted in 1992, established national water efficiency requirements for plumbing products manufactured after January 1994. The requirements will be administered by the U.S. Department of Energy. Under the Act, states may adopt more stringent requirements, but state requirements must be at least as stringent as the federal standards. A summary of the water use standards for plumbing fixtures required by the FEPA are listed below:

Product	Maximum Water Use
Showers	2.5 gallons/minute (80 psi)
Faucets	2.5 gallons/minute (80 psi)
Toilets	1.6 gallons/flush
Urinals	1.0 gallons/flush

Exemptions to the new standards were allowed for products such as safety showers and toilets and urinals used in prisons, which require unique designs and higher flow rates. Blowout flushometer commercial toilets are allowed a higher water use rate until they can be redesigned to operate reliably at a lower volume. Gravity tank-type toilets used in commercial settings will not be required to meet the 1.6 gallons per flush (gpf) maximum use standard until 1997 (Vickers, 1993).

A toilet standard of 3.5 gpf was used in developing the residential and commercial Reasonable Conservation Objectives (RCOs) presented in the DEIS. This standard was also used to estimate water use in conserving households as part of a survey of water fixture use conducted for the U.S. Department of Housing and Urban Development (Brown and Caldwell, 1984). The FEPA requires that low-flow toilets that use no more than 1.6 gpf be installed in new construction and in renovations of existing structures. The extent to which future water demands will be affected by the FEPA and the changes in toilet and other fixture standards is uncertain. For the reasons discussed below, the adopted RCOs remain unchanged.

First, the FEPA applies only to plumbing fixtures manufactured after January 1994. Those fixtures will be placed in new construction, but the Act does not require replacement of older fixtures in existing construction. Likewise, the Virginia Uniform Statewide Building Code (VR 394-01-21 Section 117.0) does not require replacement of plumbing fixtures in existing construction. Only additions, alterations, or repairs of plumbing fixtures themselves would trigger the need for new low flow fixtures to be installed in existing construction (Virginia Department of Housing and Community Development, 1994). Therefore, no reduction in demands in existing construction will be realized until buildings are changed out or retrofitted. It is not possible to determine how long that process will take.

Second, estimates of the potential for water use reductions resulting from the use of low flow fixtures mandated by the FEPA must be viewed with caution. Development of the RCO for the residential demand category presented in Section 2.6 of the DEIS was based on the assumption that people flush their toilets 5 times per day and use the shower for 5 minutes per day. These figures were multiplied by the fixture usage rates to estimate existing residential usage. In those calculations, plumbing fixture usage rates were assumed to be the maximum usage rates. Actual average usage rates, however, are less than the maximum. Therefore, estimates of existing residential usage are higher than actual average usage. Using these figures to calculate the potential for water savings from retrofitting with ultra low flow fixtures will result in higher estimates of reductions in water usage than would actually be realized (Anderson et al., 1993).

Anderson et al. (1993) reported on the results of a study of 25 single family residences in Tampa, Florida, which were monitored before and after retrofitting with ultra low flow toilets (1.6 gpf) and low flow showerheads (2.5 gal/min). The actual measured per-capita water use reduction was 30 to 45 percent less than the savings projected using engineering estimates for retrofit programs with shower and toilet replacements. Because of the overestimation of existing residential usage rates, projected reductions were greater than were actually achieved by the use of low flow fixtures.

Third, as described in Section 2.6 of the DEIS, the RRWSG set the expected percentage reduction for the Commercial, Institutional, and Light Industrial category RCO equal to the percentage reduction to be achieved in the Residential demand category. Upon further examination, this seems to be an overestimation of possible water savings. Commercial locations are not often used for 24 hours per day. Further, most commercial establishments do not have bathing facilities, which would have showerheads subject to regulation.

Fourth, typical engineering calculations also are based on estimates of per capita water usage which may overstate actual usage. Studies have suggested that water usage in household fixtures is less today than it has been in the past. With pressures to reduce water demands due to water shortages and restrictions, and increasing water and sewer fees, homeowners are reducing water use on their own (Anderson et al., 1993). This overestimation of existing residential usage rates leads to estimated reductions that are greater than can actually be achieved by the use of low flow fixtures.

Fifth, little data is available concerning actual changes in water usage characteristics with the use of low-flow fixtures. Some recent studies have indicated, however, that low-flow toilets may not be as efficient as conventional fixtures. The Tampa, Florida study (Anderson et al., 1993) indicated that flushing frequency increased in some homes after the installation of low-flow toilets. A similar study in California indicated the same result (Stevens Institute of Technology, 1991). The use of low-flow toilets therefore may not result in notable water savings since repeat flushing may sometimes be necessary.

While it is anticipated that the FEPA will have some effect on future water demands in Virginia, for the reasons stated above, the degree to which demands will be reduced is unknown. Due to the uncertainties concerning actual reductions in demands resulting from the use of low-flow fixtures, the demand and deficit projections presented in Sections 2.6 and 2.7 of the DEIS have not been revised as a result of the FEPA.

Military Downsizing

In September 1993, the U.S. Department of Defense (USDOD) proposed a new force structure for the U.S. Armed Forces. As a result of this proposal, there was concern that military bases within the RRWSG study area may be closed or restructured. A report published by the Virginia Senate Finance Committee (VSFC), ***Report of the Special Subcommittee on Defense Base Closure*** (December 1993), analyzes the impacts of recent defense restructuring on military populations and employment within the study area. The VSFC reports a relatively small decrease in defense-related employment on the Lower Peninsula as a result of 1993 Base Realignment and Closure (BRAC) actions -- a loss of only 212 jobs would be expected on the Lower Peninsula, out of a total loss of 10,187 jobs statewide.

In March 1995, the USDOD released a new set of recommendations for future military force reductions and consolidations. No Lower Peninsula defense installations are on the USDOD's recent list of proposed closures or realignment activities. A net increase in defense-related employment of 2,400, due to base closings elsewhere and military force consolidations locally, would be expected in the entire Hampton Roads area (Northside and Southside) (HRPDC, 1996). Increased employment on the Southside inevitably increases the demand for housing on the Northside (the Lower Peninsula) as well.

In Northside Hampton Roads, increases in military-related employment are anticipated. Fort Eustis, located within the City of Newport News, was also affected by the 1995 recommendations. A helicopter unit was relocated to the base from Maryland. The unit includes 200 soldiers and 25 civilian jobs (HRPDC, 1996). In addition, the consolidation of the Strategic Air Command and Tactical Air Command at Langley Air Force Base has added military jobs to the Lower Peninsula. These data demonstrate that military downsizing would not necessarily result in a reduction in military employment in the Hampton Roads - Lower Peninsula region.

Based on the USDOD's recommendations, the State of Virginia would have a total gain in defense-related employment of 3,843 (Plunkett, 1995). The 1995 USDOD's recommendations were accepted by the President in July 1995. As indicated above, implementation of the current USDOD directives probably would not reduce, and might even increase, defense-related employment and housing demands on the Lower Peninsula, as noted above.

As discussed in Section 2.3.3, Cheatham Annex, located in York County, has recently approached Newport News Waterworks as a possible supplier of treated water. The demands of Cheatham Annex have not been included in the demand projections presented in Section 2.6. Therefore, the sale of water to Cheatham Annex would result in an increased demand projection for the Lower Peninsula.

Employment Changes Resulting from Military Downsizing

Military downsizing on a national level might affect employment levels at military suppliers, such as Newport News Shipbuilding. Newport News Shipbuilding has historically experienced wide fluctuations in employment. These are primarily due to changes in the quantity of prime contract awards received by the industry. Recent data show that the value of prime contract awards declined steeply from 1988 to 1994, but has rebounded in 1995 (HRPDC, 1996). These data are indicative of the fluctuating nature of the industry.

The current outlook for defense-related employment in the Lower Peninsula is improving as employers diversify operations and become less dependent on the USDOD (HRPDC, 1996). In the long-term, the outlook is positive for Newport News Shipbuilding. The USDOD will likely require new aircraft carriers, and Newport News Shipbuilding is the only shipyard capable of producing them. There is also a possibility that they will continue to build submarines for the Navy. Several contracts for overhauls of existing ships have been received by area shipyards, including Newport News Shipbuilding. In addition, the company has been marketing its abilities to foreign countries. In fact, they expect that 20 percent of their annual sales will come from international military sales by 1999. They have also converted capacity for building, maintenance, and rehabilitation to commercial shipping interests. All of these activities should lend to economic stability for the industry.

As discussed above, the on-going military restructuring is not expected to reduce military or industrial employment in the Lower Peninsula. Even if reductions were to occur, at the same time, rapid industrial expansion (not military-related) has also occurred on the Lower Peninsula since the RRWSG first developed its deficit projections for the DEIS. Many major businesses which have recently located or expanded on the Lower Peninsula are identified in Table 2-20.

The location or expansion of these industries in the area will increase employment in the Lower Peninsula. Several of these companies have projected high levels of employment once they are fully operational. For example, MCI Telecommunications, Inc. and Gateway 2000 are each expected to employ 1,300. West Telemarketing is planning to employ 1,500 persons (J. K. Watson, Virginia Peninsula Economic Development Council (VPEDC), personal communication, 1996).

Based on the information presented above, there is no justification at this time for reducing the long-term projections developed by the RRWSG in response to speculative impacts of pending military force reductions and consolidations on potential short-term employment trends.

2.9.2 Summary

The demand projections presented in Section 2.6 of the DEIS were based on the best information available at the time they were developed. Since that time, additional information has become available that could affect the demand projections (e.g., residential demands). Proposed revisions to the population projections developed by local planners in York County and James City County could increase demand projections. However, since these projections have yet to be adopted by the individual localities, demand projections have not been revised.

The Federal Energy Policy Act will require installation of water-saving plumbing fixtures in new construction and in renovations of existing structures. However, for the reasons stated herein, it is not likely that the RRWSG's overall deficit projection would be affected to the extent that revisions in the RRWSG's projections would be warranted.

TABLE 2-20

NEW AND EXPANDING INDUSTRIES ON THE LOWER PENINSULA

Year	Industry Name	Number of Employees
1989	New Industry	
	Lockheed	450
	Edison Plastics	55
	Nippon Express	15
	Expanding Industry	
	Pressure Systems	25
	Master Machine & Tool	5
	Mid Atlantic Coca-Cola	50
1990	New Industry	
	Takaha America	220
	W.W. Grainger	15
	O&K Escalators	100
	Road Fabric	5
	Polymax A/S	7
	Expanding Industry	
	Edison Plastics	100
	Opton, Inc.	50
	Kinyo Virginia, Inc.	20
	Siemens Automation	25
	Grapha Manufacturing	30
	Munck Automation	35
	IDAB, Inc.	150

TABLE 2-20
NEW AND EXPANDING INDUSTRIES
ON THE LOWER PENINSULA
(Continued)

Year	Industry Name	Number of Employees
1991	New Industry	
	Tyrolit Abrasives	280
	Wacker Chemical	10
	Business Funding	25
	Aqua-Cool	20
	Jewel Rina, Inc.	20
	Lucas Industries	400
	Expanding Industry	
	Riverside Hospital	15
	C.I. Travel	10
	Wagner Lighting	75
	Chamber Waste Systems	25
	Symbiont	5
	Recovery Management	110
1992	New Industry	
	Greystone Metal Plate	200
	Ridgway's Inc.	5
	B.F. Saul Mortgage	5
	Anstaett Medical	5
	Jay Plastics	150
	Expanding Industry	
	Riverside Hospital	52
	SAIC - Science Applications	115
	Waterway Cruises, Inc.	10

TABLE 2-20
NEW AND EXPANDING INDUSTRIES ON THE LOWER PENINSULA
(Continued)

Year	Industry Name	Number of Employees
1993	New Industry	
	Tex Tech	50
	United Solar Systems	500
	CALJAN	17
	Vision Technology	25
	Johnston Pump Co.	24
	Intermech	10
	California Feather & Down	100
	Military Benefits	15
	Expanding Industry	
	Paul Business/Denka	15
	Blessings Corp	35
	PMI	29
	Chase Packaging	122
	Ferguson Enterprises, Inc.	180
1994	New Industry	
	Lockheed IMS	37
	VA Hardwood Int'l	75
	Commonwealth Yarn	200
	A Better Airfare	260
	Ensafe	12
	Remarque	35
	Expanding Industry	
	Tex Tech	50

TABLE 2-20
NEW AND EXPANDING INDUSTRIES
ON THE LOWER PENINSULA
(Continued)

Year	Industry Name	Number of Employees
1995	New Industry	
	U.S. Postal Service	475
	J.L. Associates	35
	United Parcel Service	1,000
	King of Switzerland	10
	Mergetech	30
	Solarex	80
	Gateway 2000	1,300
	MCI	1,300
	Expanding Industry	
	Howmet	100
	Phillip Morris	130
	Custom Integrated Tech.	70
1996	New Industry	
	Harris Select	700
	PSC Fabricating	25
	West Telemarketing	1,500
	Faber-Castell Consulting	50
	Iceland	250
	Twinpak	60
	Expanding Industry	
	Dynamic Engineering	100
	Opton	200

Source: J. K. Watson, VPEDC, personal communicantion, 1996.

Finally, data indicate that recent military downsizing on a national level would not reduce, and may even increase the number of military personnel stationed in the Lower Peninsula, as well as defense-related employment. The best information currently available indicates that nationwide military force reductions are not likely to lead to reduced water demands in the region. To the contrary, base consolidations may lead to increased regional water demands. At present, however, those impacts also are too speculative to be used in the development of population projections for Lower Peninsula water supply planning efforts.

3.0 EVALUATION OF ALTERNATIVES
(Including the Proposed Action)

3.1 INTRODUCTION

This section outlines the legal background for the analysis of the alternatives identified, explains the alternatives analysis methodology used, and describes the results of the alternatives analysis.

3.2 CLEAN WATER ACT - SECTION 404 SITING CRITERIA

Federal regulations under Section 404 of the Clean Water Act (CWA) are designed to protect wetlands against developmental pressures, to the extent consistent with the overall national interest. One portion of the Section 404 regulations deals with practicable alternatives to development within wetlands.

This section examines the Section 404 siting criteria and contains a discussion of how wetlands are regulated at the Federal level, followed by an explanation of how these regulations were applied in the Regional Raw Water Study Group (RRWSG) study.

3.2.1 Section 404 Wetlands Program

The United States Congress enacted the CWA in 1972 to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Section 404 of the CWA regulates the discharge of dredged and fill material into waters of the United States and establishes a permit program to ensure that such discharges comply with pertinent environmental requirements (USEPA, 1989).

The Section 404 program is administered at the Federal level by the U.S. Army Corps of Engineers (USCOE) and the U.S. Environmental Protection Agency (USEPA). The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) have important advisory roles. The USCOE has the primary responsibility for the permit program and is authorized, after notice and opportunity for a public hearing, to issue permits for the discharge of dredged or fill material. The USEPA has important roles in several aspects of the Section 404 program including development of the environmental guidelines by which permit applications must be evaluated, review of proposed permits, prohibition of discharges with unacceptable adverse impacts, establishment of jurisdictional scope of waters of the United States, interpretation of Section 404 exemptions, and power to veto any 404 permit issued by the USCOE (USEPA, 1989).

Waters of the United States protected by the Clean Water Act include rivers, streams, estuaries, the territorial seas, and most lakes, ponds, and wetlands. Wetlands are a particularly important and sensitive segment of the Nation's waters and, therefore, merit special attention.

It is important to note that the Section 404 program does not prohibit activities in wetlands, but establishes a permit process which recognizes both developmental pressures and environmental concerns (USEPA, 1986). This balancing of developmental and environmental factors is encompassed in the Section 404 Guidelines. The practicable alternative test is further defined in statutory guidelines, administrative decisions, and litigation relating to Section 404.

3.2.2 Alternative Selection - Statutory Guidelines

According to the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) regulations, 40 CFR § 1502.14, the discussion of alternatives "is the heart of the environmental impact statement." The regulation requires a presentation of "the environmental consequences of the proposal and the alternatives in comparative form," including a rigorous exploration and objective evaluation of "all reasonable alternatives," discussion of "reasonable alternatives not within the jurisdiction of the lead agency," "the alternative of no action," and "appropriate mitigation measures not already included in the proposed action or alternatives." The CEQ has also published a memorandum discussing "Questions and Answers on NEPA Regulations," 46 Federal Register 18026 (March 23, 1981), which states:

> In determining the scope of alternatives to be considered, the emphasis is on what is "reasonable" rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant.

The USCOE's NEPA regulations generally follow the CEQ's NEPA regulations. With respect to evaluation of alternatives, the USCOE's NEPA Implementation Procedures for the Regulatory Program provide that "only reasonable alternatives need be considered in detail, as specified in 40 CFR §1502.14 (a)." These regulations state further:

> Reasonable alternatives must be those that are feasible and such feasibility must focus on the accomplishment of the underlying purpose and need (of the applicant or the public) that would be satisfied by the proposed Federal action (permit issuance).... Those alternatives that are unavailable to the applicant, whether or not they require Federal action (permits), should normally be included in the analysis of the no-Federal-action (denial) alternative.

Section 404(b)(1) Guidelines were developed by the USEPA in conjunction with the USCOE to restore and maintain the chemical, physical, and biological integrity of the waters of the United States (40 CFR, §230). The Guidelines specify that:

> "Except as provided under Section 404(b)(2) [pertaining to navigation], no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences" (40 CFR, §230.10).

Under these guidelines, an alternatives analysis must evaluate practicability as well as aquatic ecosystem impacts and other environmental consequences. The Guidelines also discuss the meaning of both "practicable" and "alternative" as follows:

> "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered" (40 CFR, §230.10).

To be practicable, an alternative must be both available and feasible (USEPA, 1986; USEPA, 1990a). Availability does not require actual ownership, but, rather a reasonable expectation that acquisition could be realized for a site or technology which satisfies the basic purpose of the proposed activity; feasibility includes cost, technology, and logistical factors.

For the RRWSG's water supply alternatives, availability was defined as the likelihood of overcoming legal, regulatory, or institutional constraints that could severely delay (i.e., to the point where demand exceeds supply) or prevent a water project from being implemented or performing satisfactorily. Major legislative, common law, and regulatory obstacles to implementation, as well as institutional issues which affect the ability of the RRWSG to obtain approvals from host jurisdictions, were the pertinent subjects considered. Technologies or sites may be deemed unavailable if institutional obstacles to project development are deemed insurmountable. Availability determinations were also based on assessments of the likelihood of state, federal, or local permit denials.

In this water supply study, feasibility was defined as the extent to which a given alternative is technologically reliable and implementable at reasonable cost. An alternative becomes less feasible as reliability and cost issues become increasingly likely to prevent a water project from being implemented or from satisfactorily operating to avoid unacceptable water supply shortages. The basic statutory requirements of the regulations also state that the practicable alternatives be evaluated in terms of their impacts to the aquatic ecosystem as well as "other significant adverse environmental consequences."

In this water supply study, environmental suitability was defined as the extent to which environmental harm can be avoided. Since environmental values are protected by a variety of regulatory and institutional constraints, suitability can be defined as the extent to which a given alternative avoids constraints that could prevent implementation or satisfactory operation. Potential environmental impacts to wetlands, groundwater, cultural resources, land use, wildlife, and threatened and endangered species, as well as potential impacts to the aquatic ecosystem, were evaluated.

3.3 EVALUATION METHODOLOGY

3.3.1 Overview of Alternatives Analysis

As determined in Section 2.7, a projected 39.8-mgd treated water deficit will occur by the Year 2040 affecting the jurisdictions of the Lower Peninsula. To satisfy this deficit, various water supply alternatives throughout the region were identified and evaluated according to the procedures outlined in the Section 404 permit guidelines. Practicable alternative components were then assembled to form project alternatives that could meet the regional needs. For the purposes of the practicable alternatives analysis, a methodology based on the Section 404(b)(1) Guidelines was employed which requires that an alternative technology or site must be capable of satisfying the basic purpose of the proposed project, taking into consideration availability and technological, logistical, and economic feasibility.

The Section 404(b)(1) Guidelines support a procedure as defined in the regulations that *"no discharge of dredged or fill material may be permitted if there is a practicable alternative to the project that would have less impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences"* (40 CFR, §230.10). Under this procedure the following steps are necessary to select the preferred alternative(s):

- Eliminate alternatives that are not available.
- Eliminate alternatives that are not feasible.
- Eliminate alternatives that have more adverse impact on the aquatic ecosystem.
- Eliminate alternatives with other significant adverse environmental consequences.

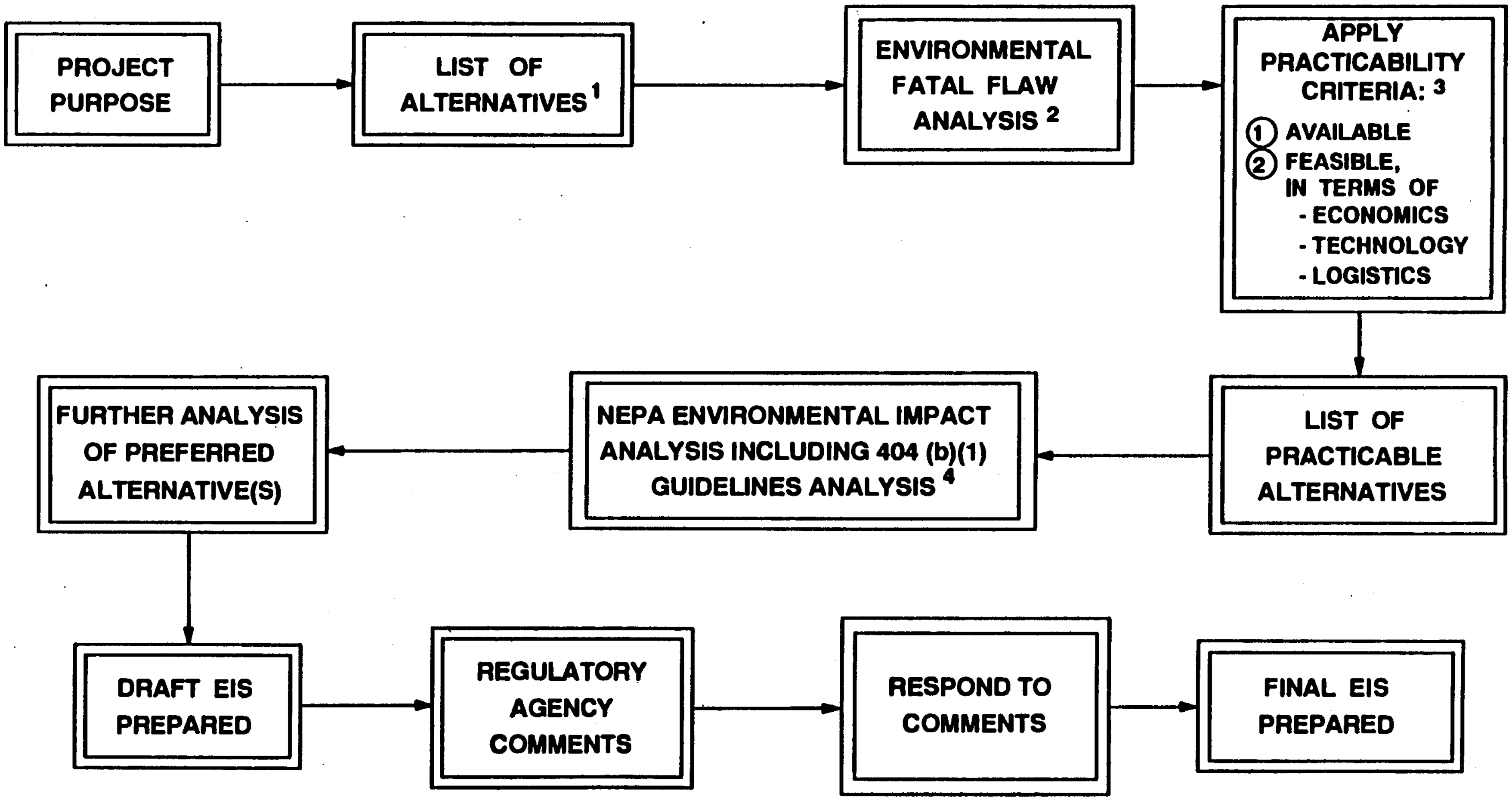
In the RRWSG project, there are a large number of potential alternatives. As a result, the evaluation procedure has been optimized by applying evaluation factors in a slightly different manner (see Figure 3-1). The complete alternatives analysis methodology is presented in ***Methodology for Identifying, Screening, and Evaluating Alternatives*** (Report C) (Malcolm Pirnie, 1993). Report C is incorporated herein by reference and is an appendix to this document.

In this procedure, alternatives with unacceptable adverse effects on the aquatic ecosystem, or other obvious significant adverse environmental consequences, were first screened, in an environmental fatal flaw analysis. Practicability criteria were then applied to develop a list of remaining alternatives that are available, and feasible, in terms of cost and technological reliability. Practicable alternatives were then evaluated according to environmental impact criteria to identify the least damaging, practicable alternative(s). Environmental impact categories were developed based on NEPA public interest factors and impact categories for aquatic ecosystems identified in the CWA Section 404(b)(1) Guidelines.

3.3.2 Practicability Criteria

Four practicability criteria were used in the evaluation. These criteria are availability, cost, technological reliability, and logistics. Availability considered the legal, regulatory, and institutional obstacles that a particular alternative faced. Cost considered the overall, life-cycle cost of an alternative relative to other practicable alternatives and the affordability of projected customer water rate increases. Technological reliability considered the unavoidable failure potential, public health concerns, effectiveness of available treatment technologies, and stage of technological development associated with each alternative. The impact of logistics on project implementation was considered under the availability, cost, and technological reliability criteria. Each of these criteria are discussed in more detail in the following sections.

FIGURE 3-1



NOTES:
1. FIRST DEFINED IN USÇOE's DECEMBER 17, 1990 SCOPING SUMMARY PREPARED FOLLOWING CLOSE OF COMMENT PERIOD ON USCOE's AUGUST 1, 1990 PUBLIC NOTICE.
2. STEP ELIMINATES, IN PART, ALTERNATIVES WITH UNACCEPTABLE ENVIRONMENTAL IMPACTS.
3. STEP ELIMINATES ALTERNATIVES WHICH ARE NOT PRACTICABLE AS DEFINED IN THE SECTION 404 GUIDELINES.
4. STEP IDENTIFIES PRACTICABLE ALTERNATIVES WHICH HAVE LEAST OVERALL ENVIRONMENTAL IMPACT.

MALCOLM PIRNIE

FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
METHODOLOGY FOR IDENTIFYING, SCREENING, AND EVALUATING ALTERNATIVES

Availability

Legal, regulatory, and institutional issues can severely delay (i.e., to a point where demand exceeds supply) or even prevent a water development project from being implemented. Necessary land and water rights must be acquired, and in some cases defended in litigation; permits from federal, state, and local agencies obtained; and approvals from other localities obtained in cases of a project located outside the boundaries of the project's owner. An alternative may be considered unavailable if legal, regulatory, or institutional obstacles are insurmountable (e.g., the USCOE, USEPA, Virginia Department of Environmental Quality (VDEQ), Virginia Department of Health (VDH), or another state, federal, or local agency determines that an alternative is not permittable). Any determination of unavailability is based on documentation of severe delays, uncertainties associated with potential permit denials, or other insurmountable legal or institutional constraints.

Cost

Alternatives may be deemed economically infeasible if they are too costly to implement. For example, an alternative that involves costly raw water treatment may impose an unacceptable financial burden on the system's customers (USEPA, 1990b). In addition, water purveyors have a responsibility to provide a reasonable cost water supply to their customers, if such a supply is available.

For this study, total life-cycle costs (i.e., capital and operating costs of storage, transmission, and treatment) have been estimated for many of the alternatives. Major costs identified are those associated with construction, land acquisition, power, and/or mitigation.

The affordability of estimated water rates resulting from alternatives has also been examined in light of current state and federal affordability criteria for utility fees. As part of Virginia's Revolving Loan Fund, the Virginia State Water Control Board (SWCB) developed guidelines for determining reasonable wastewater treatment costs for households. These affordability criteria were developed as a percentage of median household income (MHI) and are published in the ***Virginia Revolving Loan Fund - Program Design Manual*** (SWCB, 1991). "More affluent areas" are defined by the SWCB as having a MHI greater than $29,000 per year, which would include the estimated Year 1990 Lower Peninsula MHI of $31,050 per year. The SWCB's corresponding upper limit for affordability is set at 1.5 percent of MHI for wastewater treatment bills in more affluent areas.

The USEPA is now developing guidelines for determining reasonable combined sewer overflow (CSO) control costs for households. Residential Indicators are calculated as percentages of MHI and are compared to financial impact ranges that reflect the USEPA's previous experience with water pollution control programs. These ranges are defined as follows (H. Farmer, USEPA, personal communication, 1996):

Financial Impact	Residential Indicator (Cost per Household as % MHI)
Low	Less than 1.0 Percent of MHI
Mid-Range	1.0 - 2.0 Percent of MHI
High	Greater than 2.0 Percent of MHI

The USEPA estimates that residents in only 4 to 6 percent of communities in the United States incur wastewater treatment costs which exceed a level representing 2 percent of MHI. Costs above the 2 percent MHI level are usually considered very difficult to afford (H. Farmer, USEPA, personal communication, 1996).

The USEPA has not progressed as far in establishing affordability criteria for drinking water costs as for wastewater treatment costs. As of November 1996, the agency did not have any official affordability scale for drinking water. The USEPA has instead elected not to pursue the establishment of an affordability criterion for drinking water. However, the agency will provide data support to individual state agencies, and allow States to develop their own criteria (P. Shanaghan, USEPA, personal communication, 1996).

For some time the USEPA had been reviewing the variance and exemption process and requirements under the Safe Drinking Water Act (SDWA), and considering how affordability should be determined. One approach the USEPA considered involved selecting affordability criteria which correspond to percentages of MHI in the community served by the water system. Prior to September 1991, the USEPA was considering the following specific affordability ranges:

- Affordable: < 1.4 Percent of MHI
- More Detailed Analysis Required: 1.4 to 2 Percent of MHI
- Unaffordable: > 2 Percent of MHI

The 2 percent of MHI affordability cutoff was developed on at least two bases. First, only a small percentage of communities incur water costs greater than this level. Second, costs for other utilities (e.g., wastewater, electricity, natural gas, telephone) may be in the 2 percent of MHI range. The percentage of MHI approach has been considered since households are often more sensitive to rate increases than other water demand sectors (A. W. Marks, USEPA, personal communication, 1993).

The USEPA also considered a new "market-based" approach for determining affordability under the SDWA. Under this potential approach, system improvements would not be considered affordable if a community cannot obtain the necessary financing (A. W. Marks, USEPA, personal communication, 1993).

For this study, average Year 1992 Lower Peninsula household water costs were estimated at $170 per year, or 0.55 percent of the estimated Year 1990 Lower Peninsula MHI of $31,050 per year. This estimate is based on a typical Lower Peninsula household using 73,000 gallons of water per year. Based, in part, on state and federal affordability criteria for utility fees that have been developed, or are being developed, an affordability cutoff of 1.5 percent of Lower Peninsula MHI was adopted for this study. In the RRWSG's judgement, this cost feasibility cutoff is conservatively high since it equates to nearly a tripling of consumer drinking water costs.

The rate impacts of several alternatives were projected and compared to the RRWSG's adopted affordability criterion. For example, for an alternative with a present worth life cycle cost estimate of $10.1 million per mgd of treated water safe yield, the projected rate impact calculation considered the annual costs of capital debt service, treatment, distribution, and utility administration. These costs were apportioned to the projected sales of water from the new source. These sales were proportional to the projected deficit. The projected average rate over the 40-year period from the Year 2000 to 2040 for this alternative is $10.30 per thousand gallons in Year 1992 dollars. For an average Lower Peninsula household, this represents approximately 2.4 percent of the estimated Year 1990 Lower Peninsula MHI. Thus, according to the RRWSG's adopted affordability criterion, this alternative would be infeasible due to excessive cost.

Based on the results of this analysis and rate analyses for alternatives with present worth life cycle cost estimates of between $5 million and $10 million per mgd, alternatives with present worth life cycle cost estimates which are greater than approximately $8 million per mgd of treated water safe yield will be considered infeasible due to excessive cost. Such components would result in household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula MHI.

Technological Reliability

Alternatives may be deemed technically infeasible if they are judged vulnerable to mechanical or electrical failures, pipe failures, downtime, or other system disruptions that cannot be eliminated or adequately reduced through redundancy in the design. Storage, or the capacity to deliver partial flows during disruptions, could improve reliability. Serious public health concerns (i.e., documented water quality problems) associated with use of certain water supply sources, as expressed by VDH staff or other qualified experts, may also render an alternative infeasible with respect to technological reliability. In addition, the effectiveness of USEPA-determined Best Available Technology in the treatment of water may be evaluated in determining if an alternative is technologically reliable.

The practicability analysis also examines the reliability of certain technologies. For example, aquifer storage and recovery (ASR) is a relatively new water management technology which is still in the experimental stage in the Virginia Coastal Plain Province. There are major areas of technical uncertainty concerning implementation of ASR in the Lower Peninsula that could reduce its reliability. For example, ASR may be technically infeasible if hydraulic or water/soil chemistry problems preclude development of a suitable aquifer storage zone.

Logistics

Alternatives may be undesirable because of logistical factors. For example, from a logistical standpoint, it may be infeasible to implement several small alternatives rather than a single alternative which can supply all, or most, of the Lower Peninsula's additional water needs. However, logistical factors are taken into consideration under the availability, cost, and technological reliability criteria described above, and no separate logistical evaluation of alternatives was conducted.

3.3.3 Safe Yield Criterion

Definition

Safe yield estimates were developed for each of the alternative water supply projects under consideration. Although safe yield is not one of the practicability criteria, it is a very important measure of project viability. A low safe yield benefit may render the unit costs unacceptably high for an otherwise acceptable alternative.

Safe yield is the theoretical maximum rate (usually expressed in gallons per day) at which a water supply system could provide water continuously through the drought of record without causing the total depletion of the source of supply (e.g., usable reservoir storage). This theory assumes that during a drought identical to the worst drought of record, continuous operation of the water system at the "safe yield" rate would cause the supply source to approach but never to cross the margin of total depletion, at any time during the entire period of the drought. In Virginia, safe yield calculations for rivers and reservoirs typically are based on streamflow records dating back to the 1930-31 drought. Safe yield determinations also take into consideration the available raw water storage capacity and the system operating rules.

Safe yield is an accepted planning device; but it is not designed and should not be mis-used to represent the amount of water that actually would be available to consumers during a severe drought. At best, a safe yield calculation is only an estimate and is not subject to empirical verification. In practice, waterworks managers impose emergency demand reduction (conservation) measures such as mandatory water use restrictions and rationing, where necessary to force the demands on their systems below the safe yield level, well in advance of the point of total depletion. This is necessary to reduce the risk of failure of the public water supply system, which otherwise could result from such factors as miscalculation of various components of the safe yield estimate, less than optimal performance of the system under the stresses caused by a severe drought, and occurrence of a drought that is longer or more severe than the drought of record used to estimate the safe yield of the system.

Section 3.20.A.2 of the Virginia Department of Health (VDH) Waterworks Regulations (effective June 23, 1993) defines safe yield for surface water sources as follows:

"The safe yield of the source shall be determined as follows:

a. Simple intake (free flowing stream) - The safe yield is defined as the minimum withdrawal rate available during a day and recurring every thirty years (30 year - 1 day low flow). To generate the report for this, data is to be used to illustrate the worst drought of record in Virginia since 1930. If actual gauge records are not available for this, gauges are to be correlated from similar watersheds and numbers are to be synthesized.

b. Complex intake (impoundments in conjunction with streams) - The safe yield is defined as the minimum withdrawal rate available to withstand the worst drought of record in Virginia since 1930. If actual gauge records are not available, correlation is to be made with a similar watershed and numbers synthesized in order to develop the report."

The VDH regulations (§ 3.20.A.1) also state that:

> *"The quantity of water at the source shall: .... Be adequate to compensate for all losses, including evaporation, seepage, flow-by requirements, etc."*

Estimating the safe yield of groundwater sources is more difficult than for surface sources, because there is no standard method for analyzing groundwater sources. Groundwater yields are a function of pump capacity, head, and the hydrologic characteristics of the aquifer.

The safe yield of a water system is not an absolute value calculated on the basis of exact data. Rather, the determination of a system's safe yield is based on the level of risk associated with the probability of occurrence of a selected critical drought period during an extended future period. Thus, the safe yield is based on the level of acceptable risk and management's conclusions as to the reliability and resiliency of the system to respond during critical dry periods.

Methods of Analysis

Numerous variables must be considered in a safe yield analysis. The principal input data and operating rules used for estimating the safe yield of new reservoir alternatives are outlined below. To the extent possible, the assumptions were applied identically to the various alternatives to provide the maximum level of comparability in the analysis.

Safe Yield Model

Raw water safe yield benefits were estimated using the Newport News Waterworks Raw Water System Safe Yield Model (SYMODEL). (As discussed below under "Other Raw Water Losses", treated water safe yield benefits were estimated by assuming that transmission, seepage, and treatment losses not accounted for in the safe yield model represent 10 percent of simulated raw water safe yield.) This is a FORTRAN computer model which was developed by Camp, Dresser & McKee (CDM) to simulate the existing Waterworks system (CDM, 1989). Using this model, it was possible to incorporate the potential benefits of interconnecting new water sources with the existing Lower Peninsula water supply systems.

For purposes of this analysis, the Waterworks model was run on a monthly time step basis for a 58-year simulation period (Water Years 1930 and 1987). The RRWSG has complied with VDH regulations by including the early 1930's drought in the safe yield analysis. It was assumed that the entire raw water storage system was full at the beginning of the simulation period. Other model input assumptions applicable to the existing Newport News system were consistent with those outlined by CDM in the ***Newport News Raw Water System Safe Yield Model - Documentation and Users Manual*** (CDM, 1989), with the following exceptions:

- The net evaporation rate from reservoirs was set at 8.9 inches per year, which is the 10 percent exceedance net evaporation rate. This rate is conservative because it is less than one-half of the highest reported rate.
- The Newport News Waterworks reservoir drainage area was reduced from 78.7 to 75.2 square miles, to avoid double-counting precipitation onto the reservoir surfaces as surface runoff.
- Minimum acceptable reservoir storage was defined as 33.3 percent of total storage. This minimum storage level was adopted to simulate the Waterworks' operating practices and to afford water quality and aquatic habitat protection. The CDM model had used 11.8 percent of total storage, which is that percentage of total storage from which water cannot be pumped using existing pumping stations. Under the CDM assumption, no available (pumpable) water would remain in the reservoirs at the end of the simulation period. Using the 33.3 percent minimum storage figure, 76 percent of available water can be used [(100% - 33.3%)/(100% - 11.8%) = 76%] and 24 percent of available water is held in reserve [(33.3% - 11.8%)/(100% - 11.8%) = 24%].

Reservoir Inflows from River Withdrawals

The amount of water pumped from a new Pamunkey or Mattaponi River pumping station into a new reservoir was calculated for each month of the simulation period by: (1) subtracting the appropriate monthly minimum instream flowby (MIF) requirement from each daily streamflow; (2)

simulating daily withdrawals based on remaining available river flow, pump station capacity, and pumping increments; (3) summing the daily withdrawals; and (4) dividing the total monthly withdrawal by the number of days in the month. To accommodate these new simulated river withdrawals within the existing safe yield model, they were combined with estimated reservoir drainage area runoff to form a single record of combined inflows to the reservoir.

Pamunkey and Mattaponi River flows were simulated using gaged York River Basin streamflow records adjusted to the estimated drainage areas at proposed intake points. Detailed characteristics of Pamunkey and Mattaponi River streamflow at proposed intake points are presented in Tables 3-A and 3-B, respectively.

For several alternatives, multiple river withdrawal capacities were evaluated to identify withdrawal capacities which would optimize safe yield benefits. For example, the Black Creek Reservoir with Pumpover from Pamunkey River alternative would rely on a river withdrawal capacity of 120 mgd. The King William Reservoir with Pumpover from Mattaponi River alternative would rely on a river withdrawal capacity of 75 mgd. Those maximum withdrawal rates represent 15.5 and 15.2 percent, respectively, of the estimated mean historical flow rates (774 and 494 mgd, respectively) of the two Rivers at the proposed intake points. Those maximum river withdrawal rates, as percentages of mean historical flows, are both smaller than Newport News Waterworks' Chickahominy River withdrawal capacity (41 mgd, or approximately 20 percent of the estimated mean historical flow at the intake point).

It was assumed that new river pump stations would be capable of pumping at rates which could be varied in 10 mgd increments.

River withdrawals were simulated in accordance with assumed MIF policies which the SWCB has reviewed and deemed suitable for these preliminary analyses (J. P. Hassell, SWCB, personal communication, 1991 and VDEQ 1994). The assumed Pamunkey and Mattaponi River MIF policies are further described below.

River Minimum Instream Flowby (MIF)

The derivation of the assumed Pamunkey River MIF is presented in Table 3-C using a system of modified 80 percent monthly exceedance flows. The 80 percent monthly exceedance flow is that monthly flow rate which has the probability of being exceeded 80 percent of the time during the period of record. The Pamunkey River MIF has been modified to: (1) set a minimum flow rate of 140 mgd, which must be maintained when available, (2) provide an additional 25 mgd for irrigation during the months of April through September, and (3) provide an additional 40 mgd for possible future Hanover County withdrawals.

The assumed Pamunkey River MIF is consistent with that recently proposed by Hanover County for the Crump Creek Reservoir project. That MIF would preserve the general shape of the Pamunkey River's natural seasonal hydrograph and would minimize withdrawals during very dry periods when additional streamflow reductions could cause salinity intrusions farther upstream than would occur without the withdrawals.

Based on gaged Pamunkey River Basin streamflow records for Water Years 1930 through 1987, it is estimated that the assumed Pamunkey River MIF would allow some withdrawals to be made 62.4 percent of the time.

TABLE 3–A

STREAMFLOW CHARACTERISTICS OF PAMUNKEY RIVER AT NORTHBURY

EXCEEDANCE PROBABILITY (percent)	DAILY STREAMFLOW (mgd)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	90.0	90.0	137.7	219.5	135.4	62.7	13.1	3.7	3.7	1.9	18.7	37.5
95	169.0	275.3	358.1	319.7	205.0	116.2	66.5	40.5	24.4	29.8	84.4	131.5
90	240.1	355.6	435.9	363.7	234.0	131.5	82.5	60.4	43.6	53.5	114.0	168.3
85	332.7	423.7	489.5	406.9	264.6	146.2	92.5	75.0	55.8	65.8	128.5	212.6
80	390.8	494.9	544.5	456.6	296.7	166.0	103.1	82.6	61.9	80.3	148.4	259.3
75	437.5	562.1	604.2	507.1	328.1	182.0	112.5	91.0	71.1	95.6	176.7	291.4
70	474.2	608.8	660.0	555.2	355.6	202.5	124.7	103.2	83.4	110.1	205.7	328.1
65	523.9	669.2	704.4	601.9	383.9	219.5	135.4	114.0	96.4	124.7	231.7	355.6
60	562.9	725.8	761.0	650.1	408.7	241.8	153.7	126.2	108.7	138.4	259.3	389.3
55	614.9	780.1	810.7	699.0	446.2	262.3	172.1	140.7	121.6	153.0	283.1	431.2
50	671.5	818.3	879.5	742.6	483.4	284.5	189.7	161.2	140.0	170.6	306.7	476.2
45	738.8	873.6	958.0	803.0	523.1	314.3	206.5	181.8	156.8	193.5	328.9	523.9
40	787.7	948.3	1,040.1	871.9	573.6	341.9	231.7	206.5	176.2	218.0	373.2	570.5
35	881.1	1,040.1	1,147.2	948.3	648.5	374.9	258.5	245.5	200.6	249.3	432.1	638.6
30	971.3	1,177.8	1,271.1	1,063.1	722.0	416.8	288.8	283.1	228.7	283.1	508.6	717.4
25	1,116.6	1,338.4	1,453.1	1,231.3	818.3	464.2	335.0	336.5	259.3	339.6	588.7	810.7
20	1,353.7	1,590.8	1,728.4	1,453.1	940.7	558.3	402.3	419.1	311.2	418.1	676.8	963.6
15	1,674.9	1,988.5	2,126.1	1,850.8	1,094.8	666.1	523.0	544.5	367.1	539.2	818.3	1,246.6
10	2,268.4	2,500.9	2,814.5	2,455.0	1,468.4	871.9	725.5	833.6	539.2	873.6	1,170.1	1,717.2
5	3,472.2	3,449.5	3,824.0	3,816.3	2,279.1	1,379.8	1,223.7	1,667.3	1,162.5	2,080.9	2,099.7	2,755.8
0	17,997.2	14,072.3	11,089.6	32,432.4	9,167.3	19,119.9	9,865.9	30,056.5	17,622.2	11,930.8	10,401.2	12,083.8

Notes: Exceedance flows were calculated based on gaged Pamunkey River Basin streamflow records for Water Years 1930 through 1987 adjusted to the 1,279 square mile contributing drainage area at Northbury.

Mean historical streamflow at Northbury was estimated at 774 mgd based on a 53–year gaged streamflow record for the Pamunkey River near Hanover (Water Years 1942 through 1994) which was adjusted to the 1,279 square mile contributing drainage area at Northbury.

TABLE 3-B

STREAMFLOW CHARACTERISTICS OF MATTAPONI RIVER AT SCOTLAND LANDING

EXCEEDANCE PROBABILITY (percent)	DAILY STREAMFLOW (mgd) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	69.9	97.8	122.4	139.7	69.9	23.9	13.1	9.9	5.2	6.9	37.8	57.5
95	115.1	241.2	280.6	230.0	118.7	53.4	29.6	19.7	13.1	16.9	60.8	100.6
90	204.6	304.0	353.3	272.0	149.1	69.0	38.6	24.6	20.9	27.9	78.5	159.8
85	288.8	366.0	390.3	301.1	177.9	83.8	46.0	31.2	26.3	37.8	95.3	196.8
80	323.8	417.8	429.3	341.8	200.5	101.5	54.2	37.8	33.7	48.1	120.0	226.4
75	347.5	447.8	466.7	378.0	226.4	120.8	62.8	46.0	42.3	60.0	144.6	249.8
70	379.6	483.9	503.7	415.0	251.4	139.7	72.3	57.5	50.9	72.3	165.5	272.8
65	414.1	518.9	542.7	462.6	281.8	156.9	81.4	70.6	64.9	86.3	190.6	305.7
60	451.9	552.2	617.9	519.3	316.8	179.1	93.3	82.6	76.4	100.3	214.1	332.4
55	491.0	583.0	665.6	575.2	360.3	198.0	106.0	95.3	93.7	113.4	235.0	361.1
50	533.7	617.9	731.3	624.4	397.3	216.9	121.6	111.8	108.5	127.3	258.0	392.7
45	587.5	656.1	799.9	671.7	443.7	237.5	135.6	128.6	125.3	141.7	279.7	434.7
40	638.0	714.9	866.8	731.3	493.8	262.1	150.3	147.0	143.0	172.1	314.7	486.5
35	702.1	792.1	928.5	813.4	562.0	291.7	167.6	179.1	165.5	207.0	352.1	529.6
30	764.1	866.8	1,002.4	903.8	633.5	327.0	196.4	206.6	189.0	236.2	387.8	586.6
25	821.7	949.1	1,101.0	1,027.1	723.1	377.2	233.3	238.3	219.0	269.5	445.3	652.4
20	895.6	1,043.5	1,195.5	1,195.5	814.7	449.5	261.3	285.9	262.9	327.8	524.2	755.1
15	1,068.2	1,166.7	1,359.9	1,355.7	969.5	536.5	309.7	365.3	396.0	454.8	671.3	895.6
10	1,327.0	1,339.3	1,532.4	1,565.3	1,150.3	658.6	401.0	522.2	916.2	632.7	871.0	1,064.0
5	1,713.2	1,676.2	1,967.9	1,939.1	1,516.0	953.1	793.3	850.4	50,784.0	1,047.6	1,121.6	1,479.0
0	6,211.8	7,164.9	8,627.5	8,235.0	4,206.9	13,310.9	3,894.7	10,024.3	148,454.5	5,077.9	4,445.2	5,891.3

14x higher?

Notes: Exceedance flows were calculated based on gaged Mattaponi River streamflow records for Water Years 1942 through 1987 adjusted to the 781 square mile contributing drainage area at Scotland Landing.

Mean historical streamflow at Scotland Landing was estimated at 494 mgd based on a 51-year gaged streamflow record for the Mattaponi River near Beulahville (Water Years 1942-1987 and 1990-1994) which was adjusted to the 781 square mile drainage area at Scotland Landing.

TABLE 3-C

PAMUNKEY RIVER AT NORTHBURY
MODIFIED 80 PERCENT MONTHLY EXCEEDANCE MIF

Month	80% Monthly Exceedance Flow (mgd)	Minimum Threshold (1) (mgd)	Hanover County Allowance (2) (mgd)	Irrigation Demand Allowance (3) (mgd)	Modified 80% Monthly Exceedance MIF		
					MIF (mgd) (4)	% of Mean Annual Flow (5)	% Exceedance (6)
Jan	390.8	140	40	0	430.8	55.7	75.7
Feb	494.9	140	40	0	534.9	69.1	77.0
Mar	544.5	140	40	0	584.5	75.5	76.6
Apr	456.6	140	40	25	521.6	67.4	73.5
May	296.7	140	40	25	361.7	46.7	68.9
Jun	166.0	140	40	25	231.0	29.8	62.4
Jul	103.1	140	40	25	205.0	26.5	45.4
Aug	82.6	140	40	25	205.0	26.5	40.3
Sep	61.9	140	40	25	205.0	26.5	34.2
Oct	80.3	140	40	0	180.0	23.3	47.9
Nov	148.4	140	40	0	188.4	24.3	73.1
Dec	259.3	140	40	0	299.3	38.7	74.0
Annual Averages	257.1	140.0	40.0	12.5	328.9	42.5	62.4

(1) Minimum threshold equals lowest median monthly streamflow value (September).

(2) Allowance based on optimum diversion rate for yield of the proposed Crump Creek Reservoir Project (Black & Veatch, 1989).

(3) Allowance based on USGS estimate of the installed capacity of irrigation equipment along the Pamunkey River (Black & Veatch, 1989).

(4) The actual MIF value is the sum of the 80% monthly exceedance flow and the Hanover County and irrigation demand allowances. The 140 mgd minimum threshold is used in this sum, in place of the 80% monthly exceedance flow, if it is greater than that exceedance flow.

(5) Mean historical streamflow at Northbury was estimated at 774 mgd based on a 53-year gaged streamflow record for the Pamunkey River near Hanover (Water Years 1942 through 1994) which was adjusted to the 1,279 square mile drainage area at Northbury.

(6) The percent exceedance values were interpolated from the exceedance probability values presented in Table 3-A.

The minimum flowby threshold of 140 mgd is equal to the estimated median monthly streamflow at Northbury during September.[1] That threshold is based on an MIF determination method, developed in the warm water region of the East Coast, called the New England method. That method sets a base flow equal to the lowest median monthly streamflow value. The purpose of establishing the minimum threshold is to avoid overstressing aquatic biota during the adverse environmental conditions (e.g., higher temperatures and lower dissolved oxygen levels) that often occur in the lowest flow month.

The irrigation allowance is based on USGS hydrologists' estimates that installed capacity of irrigation equipment along the Pamunkey River is approximately 25 mgd (Black & Veatch, 1989).

It is possible that future expansion of irrigation withdrawal capacity could occur; however, the RRWSG considers the combined 65 mgd allowance for irrigation and public water supply to be adequate to account for possible future consumptive use in the Pamunkey River Basin. The RRWSG's total Year 2030 consumptive use projection for the Pamunkey River Basin (exclusive of potential use by RRWSG jurisdictions) is 51.1 mgd, or approximately 20 percent less than the 65 mgd of allowances added to the MIF. The information used to arrive at the Year 2030 consumptive use projection is presented in Section 5.2.2.

The derivation of the assumed Mattaponi River MIF for the RRWSG's preferred KWR-II project configuration is presented in Table 3-D. That policy is comparable to the one assumed for the Pamunkey River. The Mattaponi River MIF uses a system of 80 percent monthly exceedance flows, modified by: (1) setting a minimum flow rate threshold of 108.5 mgd (lowest median monthly streamflow value (September) at Scotland Landing), and (2) reserving an average of an additional 5.5 mgd for the SWCB's projected Year 2030 consumptive uses in the Mattaponi River Basin (exclusive of potential use by RRWSG jurisdictions). The information used to arrive at the Year 2030 consumptive use projection is presented in Section 5.2.3.

Based on gaged Mattaponi River Basin streamflow records for Water Years 1942 through 1987, it is estimated that the assumed Mattaponi River MIF would allow some withdrawals to occur 69.6 percent of the time.

As previously discussed, the assumed Mattaponi River MIF was made comparable to that assumed for the Pamunkey River instead of the original 40/20 Tennant Mattaponi River MIF for the originally proposed KWR-I project configuration. This change in the assumed Mattaponi River MIF was made to provide a more balanced comparison of potential safe yield benefits associated with use of either the Pamunkey or Mattaponi River as pumpover sources for new reservoirs. The Modified 80 Percent Monthly Exceedance Flows MIF would better preserve the shape of the Mattaponi River's natural seasonal hydrograph and establish monthly MIF levels which are higher for each month of the year. However, in simulating the effects of Mattaponi River withdrawals (made in accordance with the 40/20 Tennant MIF), VIMS found that the small incremental salinity changes that would result from the proposed withdrawals, either individually or in combination with other existing and projected consumptive Mattaponi River Basin uses, appear to be overshadowed by naturally

Base

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1 140 mgd is the median monthly rate, not the 80 percent exceedance daily rate shown in Table 3-A.

TABLE 3–D

MATTAPONI RIVER AT SCOTLAND LANDING
MODIFIED 80 PERCENT MONTHLY EXCEEDANCE MIF

Month	80% Monthly Exceedance Flow (mgd)	Minimum Threshold (1) (mgd)	Consumptive Use Allowance (2) (mgd)	Modified 80% Monthly Exceedance Flow MIF		
				MIF (mgd) (3)	% of Mean Annual Flow (4)	% Exceedance (5)
Jan	323.8	108.5	5.1	**328.9**	66.6	78.9
Feb	417.8	108.5	5.1	**422.9**	85.6	79.1
Mar	429.3	108.5	5.1	**434.4**	87.9	79.3
Apr	341.8	108.5	5.1	**346.9**	70.2	79.3
May	200.5	108.5	5.3	**205.8**	41.7	79.0
Jun	101.5	108.5	6.6	**115.1**	23.3	76.5
Jul	54.2	108.5	7.0	**115.5**	23.4	52.0
Aug	37.8	108.5	5.7	**114.2**	23.1	49.3
Sep	33.7	108.5	5.3	**113.8**	23.0	48.4
Oct	48.1	108.5	5.1	**113.6**	23.0	54.9
Nov	120.0	108.5	5.1	**125.1**	25.3	79.0
Dec	226.4	108.5	5.1	**231.5**	46.9	78.9
Annual Averages	**194.6**	**108.5**	**5.5**	**222.3**	**45.0**	**69.6**

(1) Minimum threshold equals lowest median monthly streamflow value (September).

(2) Allowance based on projected Year 2030 consumptive use of 5.5 mgd in the Mattaponi River Basin (SWCB, 1988). Seasonal variation in allowance based on estimated seasonal variation in irrigation demand component of consumptive use.

(3) The actual MIF value is the sum of the 80% monthly exceedance flow and the consumptive use allowance. The 108.5 mgd minimum threshold is used in this sum, in place of the 80% monthly exceedance flow, if it is greater than that exceedance flow.

(4) Mean historical streamflow at Scotland Landing was estimated at 494 mgd based on a 51–year gaged streamflow record for the Mattaponi River near Beulahville (Water Years 1942–1987 and 1990–1994) which was adjusted to the 781 square mile drainage area at Scotland Landing.

(5) The percent exceedance values were interpolated from the exceedance probability values presented in Table 3–B.

occurring variability and are not expected to measurably impact existing tidal freshwater wetland communities. These findings are documented in Report J, ***Tidal Wetlands on the Mattaponi River: Potential Responses of the Vegetative Community to Increased Salinity as a Result of Freshwater Withdrawal*** (Hershner et al., 1991) which is incorporated herein by reference and is an appendix to this document. Consequently, the 40/20 Tennant MIF may be adequate to prevent adverse changes in the Mattaponi River salinity regime.[2]

Although the modified 80 percent monthly exceedence flows MIF was additionally used to assess the KWR-III project configuration safe yield, the 40/20 Tennant MIF was applied to the storage-limited KWR-IV project configuration. The KWR-IV dam location is approximately 1.1 miles upstream of the RRWSG's preferred KWR-II project configuration dam site. This change in dam sites results in a reduction in total and available storage of 9.0 and 6.6 billion gallons, respectively. To provide a sufficient safe yield benefit for the currently proposed KWR-IV project configuration and minimize reservoir drawdown, the originally proposed 40/20Tennant MIF, which allows for more frequent withdrawals, was retained. The 40/20 Tennant MIF requires that minimum monthly flowby, when available, equal 40 percent of the mean annual flow at the intake during December through May, and 20 percent of the mean annual flow during June through November. The 40/20 Tennant MIF would also preclude withdrawals during periods when additional streamflow reductions could cause salinity to intrude farther upstream than would occur under natural flow conditions. This MIF was also modified by an additional 6 mgd allowance for projected consumptive use resulting from other municipal, irrigation, and industrial withdrawals in the Mattaponi River basin. This allowance is conservative in that it should not underestimate future consumptive use in the Mattaponi River basin. Total Year 2030 consumptive use for the Mattaponi River basin (exclusive of potential use by RRWSG jurisdictions) is projected at 5.5 mgd.

Reservoir Inflows from Reservoir Drainage Area Runoff

Monthly reservoir inflows from natural runoff in the proposed reservoir watersheds were simulated using available local gaged streamflow records. Where possible, those flow records were adjusted to "average contributing reservoir drainage area during the critical drought period," defined as the watershed land surface area when a reservoir is drawn down to approximately 50 percent of available capacity. Total drainage area and contributing drainage area estimates are presented below for three reservoir alternatives.

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2 In comments on the DEIS, the VDEQ stated with respect to potential MIF policies for the Pamunkey River and Mattaponi River that: *"The two rivers at the intake locations are tidal rivers. Consequently habitat, depth, submerged area and current velocity are largely maintained by the tide, regardless of withdrawals. The most significant impact that could occur is altering the salinity regime."* (J. P. Hassell, VDEQ, personal communication, 1994).

Reservoir Site	Total Drainage Area (square miles)	Contributing Drainage Area (square miles)
Ware Creek Reservoir	17.4	16.0
Black Creek Reservoir	5.47	4.45
King William Reservoir I	13.17	10.63
King William Reservoir II	11.45	9.03
King William Reservoir III	10.33	8.27
King William Reservoir IV	8.92	7.26

Reservoir Dimensions

For the King William and Black Creek Reservoir alternatives, dimensional data were developed in 1994 and 1996 by Air Survey Corporation (ASC). Those dimensional computations were based on digital files containing detailed topographic maps (with 2-foot contour intervals) generated from ASC's aerial photography. Elevation, surface area, and volume data for the four King William Reservoir configurations are presented in Tables 3-E1, 3-E2, 3-E3, and 3-E4. Data for the Black Creek Reservoir are presented in Table 3-F.

For the Ware Creek Reservoir, surface area and storage capacities were calculated at various elevations based on planimetry of 1" = 200' scale topographic maps prepared for James City County. Elevation, surface area, and volume data used for evaluation of the Ware Creek Reservoir are presented in Table 3-G.

Subsequent to publication of the DEIS, the James City Service Authority (JCSA) notified the RRWSG that the volume of the Ware Creek Reservoir had been recomputed by Gannett Fleming, Inc. based on more recent and more accurate mapping than had been previously available (J. C. Dawson, JCSA, personal communication, 1994). The new reservoir surface area and total volume estimates for Ware Creek Reservoir are 1,250 acres and 6.49 billion gallons, respectively, for a normal pool elevation of 35 feet msl (corresponding estimates used by RRWSG were 1,238 acres and 6.87 billion gallons). The 0.38 billion gallon reduction in storage capacity represents a 5.5 percent decrease in volume. Assuming that the safe yield benefit of the Ware Creek Reservoir with Pumpover from Pamunkey River alternative (Alternative 11) is directly proportional to available volume of the Ware Creek Reservoir, then the total treated water safe yield benefit would decrease by approximately 1.4 mgd (5.5 percent), from 26.2 to 24.8 mgd.

Reservoir Dead Storage

Raw water supply reservoirs are typically designed and constructed with some amount of dead storage. This is the amount of storage which is not available for water supply use due to various physical constraints of the water supply intake or pumping system. For example, it often is not feasible to locate a water supply intake at the lowest point within the reservoir. Moreover, minimum

TABLE 3-E1

KING WILLIAM RESERVOIR ELEVATION-AREA-CAPACITY DATA (KWR-I CONFIGURATION)

Elev. (ft, msl)	Surface Area (ac)	Volume (BG)	Volume (ac-ft)
90*	2,284	21.21	65,101
85	2,017	18.06	55,409
80	1,749	14.90	45,716
75	1,539	12.29	37,714
70	1,330	9.68	29,712
65	1,150	7.81	23,975
60	970	5.94	18,238
58**	908	5.42	16,618
50	660	3.30	10,137
8	0	0	0

Source: Air Survey Corporation, July 22, 1994.

* Normal pool elevation.

** Minimum pool elevation (25 percent dead storage volume).

TABLE 3-E2

KING WILLIAM RESERVOIR ELEVATION-AREA-CAPACITY DATA
(KWR-II CONFIGURATION)

Elev. (ft, msl)	Surface Area (ac)	Volume (BG)	Volume (ac-ft)
96*	2,222	21.21	65,084
90	1,864	16.99	52,133
85	1,637	14.30	43,893
80	1,409	11.62	35,652
75	1,232	9.42	28,901
70	1,054	7.22	22,150
64**	872	5.40	16,556
60	750	4.18	12,827
50	488	2.13	6,521
14	0	0	0

Source: Air Survey Corporation, July 22, 1994

* Normal pool elevation.

** Minimum pool elevation (25 percent dead storage volume).

TABLE 3-E3

KING WILLIAM RESERVOIR ELEVATION-AREA-CAPACITY DATA (KWR-III CONFIGURATION)

Elev. (ft, msl)	Surface Area (ac)	Volume (BG)	Volume (ac-ft)
96*	1,894	16.57	50,848
90	1,562	12.96	39,770
85	1,356	10.74	32,943
80	1,149	8.51	26,115
75	991	6.71	20,576
70	832	4.90	15,037
67**	751	4.19	12,855
60	563	2.53	7,764
50	339	1.02	3,130
23	0	0	0

Source: Air Survey Corporation (ASC), July 22, 1994 calculations for KWR II, modified by planimetering contour areas between KWR II and KWR III dam sites on 1"=200' scale ASC topographic maps.

* Normal pool elevation.

** Minimum pool elevation (25 percent dead storage volume).

TABLE 3-E4

KING WILLIAM RESERVOIR ELEVATION-AREA-CAPACITY DATA (KWR-IV CONFIGURATION)

Elev. (ft, msl)	Surface Area (ac)	Volume (BG)	Volume (ac-ft)
96*	1,526	12.22	37,506
90	1,252	9.53	29,229
85	1,080	7.78	23,874
80	909	6.04	18,520
75	777	4.77	14,649
70	645	3.51	10,778
67**	579	2.99	9,177
60	426	1.77	5,441
50	240	0.70	2,153
28	0	0	0

Source: Air Survey Corporation, December 23, 1996.

* Normal pool elevation.

** Minimum pool elevation (25 percent dead storage volume).

TABLE 3-G

WARE CREEK RESERVOIR ELEVATION-AREA-CAPACITY DATA

Elev. (ft, msl)	Surface Area (ac)	Volume (BG)	Volume (ac-ft)
35*	1,238**	6.87**	21,069**
30	971	4.85	14,881
25	798	3.55	10,891
20	625	2.25	6,900
16.5***	516	1.71	5,260
10	312	0.72	2,215
0	96	0.06	173
-3.6	0	0	0

Source: Planimetry of 1"=200' scale topographic maps prepared for James City County

* Normal pool elevation.

** Subsequent to publication of the Draft EIS, the JCSA notified the RRWSG that the volume of the Ware Creek Reservoir had been recomputed by Gannett Fleming based on more recent and more accurate mapping than had been previously available. The new reservoir surface area and total volume estimates are 1,250 acres and 6.49 billion gallons, respectively, for a normal pool elevation of 35 feet msl. The 0.38 billion gallon (6.87 - 6.49 billion gallons) reduction in storage capacity represents a 5.5 percent decrease in volume. The RRWSG has not recomputed Ware Creek Reservoir safe yield estimates using the new reservoir dimensions provided by the JCSA.

*** Minimum pool elevation (25 percent dead storage volume).

TABLE 3-F

BLACK CREEK RESERVOIR ELEVATION-AREA-CAPACITY DATA

Elev. (ft, msl)	Surface Area (ac)	Volume (BG)	Volume (ac-ft)
100*	910	6.41	19,674
95	779	5.17	15,870
90	648	3.93	12,066
85	535	2.87	8,818
80	422	1.82	5,571
76**	351	1.57	4,817
75	333	1.51	4,628
70	245	1.20	3,686
60	149	0.58	1,788
23***	0	0	0

Source: Air Survey Corporation, December 8, 1994.

* Normal pool elevation.

** Minimum pool elevation (25 percent dead storage volume).

*** Lowest elevation within Eastern Branch Black Creek impoundment area. Within the Southern Branch Black Creek impoundment area, the lowest elevation is 37 feet msl.

pump submergence requirements often limit pumping when reservoir levels are low. Dead storage also serves as a conservation measure. The aquatic resources of a reservoir are severely stressed when water levels drop substantially. If the reservoir is not completely drained, however, viable populations of fish and other aquatic life usually can be maintained.

In addition, water quality deteriorates as water levels drop in most water supply reservoirs, with levels of nutrients and metals increasing and dissolved oxygen decreasing. These changes in water quality can cause problems at the water treatment plant, in addition to their impacts on fish and other aquatic life. The high nutrient and low dissolved oxygen levels in such an environment can cause severe taste and odor problems in conventionally treated water, often resulting in water that is unpalatable.

The VDH has permitting authority over new water supply facilities, including reservoirs. For new reservoir alternatives, available water supply storage was set at 75 percent of the total reservoir volume (i.e., 25 percent dead storage). The VDH has recommended the 25 percent reservoir dead storage value to provide some degree of water quality protection and a safety factor in safe yield determinations.

A 25 percent minimum storage buffer provides protection of water quality because trihalomethane (THM) precursors can occur at higher concentrations in depleted reservoirs. For example, as the City of Newport News Waterworks' Diascund Creek Reservoir was drawn down to levels between 20 and 25 percent of total capacity during an 8-month period in 1983 and 1984, hyper-eutrophic conditions (i.e., mean total phosphorus concentration of at least 0.09 mg/l) developed. Hyper-eutrophic conditions often stimulate massive growth of algae and rooted aquatic plants. Large amounts of dissolved organic matter are then released into the water column by these plants during their growth cycles and at senescence and death. Dissolved organic materials become sources of precursor molecules for THMs and other by-products of chlorination.

The 25 percent dead storage allowance also provides a safety factor to protect the system against the occurrence of more severe droughts than those of record. During the 50-year planning horizon for the RRWSG's reservoir proposals, there is a risk that a more severe drought will occur than the drought of record.

There are precedents for use of a 25 percent minimum dead storage allowance. For example, the SWCB assumed a 25 percent dead storage value in its 1988 safe yield analysis of James City County's proposed Ware Creek Reservoir (C. H. Martin, SWCB, personal communication, 1988). The 25 percent minimum storage buffer affords increased aquatic habitat and water quality protection, and better simulates operating practices by water purveyors in the region. Other benefits of reservoir dead storage include preserving recreational interests, providing emergency storage for severe future droughts, and allowing for storage losses due to sedimentation.

Monthly Demand Factors

Reservoir withdrawals for water supply were modeled in conjunction with monthly demand distribution factors that represent the ratio of monthly demand to annual average demand. These factors ranged from 0.92 (March) to 1.11 (July), based on Newport News Waterworks water treatment plant pumpage reports for 1970 through 1987.

Reservoir Seepage Losses

Allowances for reservoir seepage losses also were factored into the safe yield analysis. Those losses may occur through lateral seepage and/or seepage through or under a dam. For the King William, Black Creek, and Ware Creek Reservoir alternatives, preliminary seepage loss estimates were 2 mgd, 2 mgd, and 0.34 mgd, respectively. The large difference in seepage loss estimates is largely due to the fact that Ware Creek Reservoir would be much shallower than the other reservoirs. Maximum water depths in the reservoirs would be 82 feet (King William), 77 feet (Black Creek), and 38.6 feet (Ware Creek). Ware Creek Reservoir would therefore have a much smaller elevation differential between its water surface and the banks of adjacent stream valleys where groundwater discharge of the lateral seepage was assumed to occur.

Reservoir Releases

Minimum reservoir releases, which are made to preserve downstream aquatic habitat and water quality, also were factored into the safe yield analysis. A 3 mgd minimum release was originally proposed for the King William Reservoir (KWR-I configuration) that did not vary seasonally. That represents approximately one-third of the estimated average flow of 9.3 mgd in Cohoke Creek at the originally proposed KWR-I dam location. Water levels in Cohoke Creek downstream of the dam and in the Cohoke Millpond should be maintained by this controlled downstream release. The minimum release was considered independent of reservoir spillage and seepage losses, to simplify the safe yield modeling procedure. These additional reservoir losses would effectively increase the flow below the dam to an average rate higher than the minimum release.

The Black Creek Reservoir minimum release allowance of 1.2 mgd represents 32 percent of the estimated average flow of 3.8 mgd at the proposed dam locations. The Ware Creek Reservoir allowance of 0.4 mgd represents 4 percent of the estimated average flow of 11.1 mgd at the proposed dam location. The low minimum release allowance for the Ware Creek Reservoir is based on the smallest release allowed by the SWCB in its 401 Certification for James City County's Ware Creek Reservoir project (SWCB, 1988).

In April 1995, Malcolm Pirnie discovered during analysis of detailed output files from the Newport News Waterworks Raw Water System Safe Yield Model that the model does not always treat specified reservoir releases as minimum values, as previously thought. According to CDM: *"The assumption made in the Newport News Safe Yield Model is that the reservoirs are used for water supply and are not used to augment stream flows during low flow periods by releasing water from storage. For the purposes of computing the safe yield, the release from the reservoir equals the inflow to the reservoir when inflows are less than the minimum flowby specified for the reservoir. Hence, the inflow minus flowby reported by the program cannot be less than zero."* (C. Moore, CDM, personal communication, 1995). The effect of this model assumption is to overestimate safe yield for reservoirs which would be required to always release at least a specified minimum amount. For the King William Reservoir alternative it has been determined that the reduction in raw water safe yield would be approximately 2 mgd if the assumed reservoir release were always made.[3] Although not determined for the Black Creek and Ware Creek Reservoir alternatives, the corresponding

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[3] The King William Reservoir release specified in the safe yield model as 8 mgd was composed of the following components: (1) 3 mgd minimum release, (2) 2 mgd seepage loss, and (3) 3 mgd raw water withdrawal from the reservoir by King William County.

reductions in raw water safe yield for those reservoirs would likely be less than 2 mgd due to the smaller releases (i.e., minimum release + seepage loss) specified for those reservoirs in the model simulations.

The RRWSG has identified an alternative to offset the possible reduction in safe yield described above for the RRWSG's preferred King William Reservoir project (KWR-II). A permit condition could establish a "normal minimum release" that would be temporarily reduced during drought conditions since areas below a proposed dam site would, in the absence of the dam, experience greatly reduced streamflow conditions during drought. This type of release policy was incorporated into James City County's Section 401 Certification for Ware Creek Reservoir (SWCB, 1988).[4] As depicted in Figure 3-1A, an alternative release schedule, which varies by month, was derived for the RRWSG's preferred KWR-II project configuration that more closely mimics the natural Cohoke Creek streamflow hydrograph. The 3 mgd average annual release schedule would be maintained during normal higher reservoir pool conditions, and a 1 mgd average annual release schedule would be used during critical drawdowns. The 1 mgd average release schedule would be triggered when available King William Reservoir storage declines to less than 80 percent. This storage trigger equates to a reservoir pool elevation of 91.5 feet msl for KWR-II. Based on the safe yield modeling results for the KWR-II project configuration, the normal release schedule would be in place 70 percent of the time under projected Year 2040 demand conditions. This percentage would be even higher during earlier years of reservoir operation when demand levels are not as high.

The drainage area for the currently proposed KWR-IV project configuration is substantially smaller than the drainage area associated with the originally proposed KWR-I dam site location. As a result, the proposed reservoir release for the KWR-IV configuration includes a 2 mgd average annual release schedule during normal higher reservoir pool conditions, and a 1 mgd average annual release schedule during specified drawdown conditions. The normal 2 mgd average annual release equates to approximately one-third of the estimated average streamflow rate of 6.2 mgd at dam site KWR-IV. The 1 mgd average release schedule would be triggered when available King William Reservoir storage declines to less than 80 percent. This storage trigger equates to a reservoir pool elevation of approximately 92 feet msl for the KWR-IV configuration.

Net Evaporation Rates

The annual net evaporation rate from reservoirs was set at 8.9 inches to simulate 10 percent exceedance net evaporation conditions, based on historic meteorological records for southeastern Virginia. This net evaporation rate is equaled or exceeded in only 10 percent of the years of record. In addition, the 8.9 inches/year net evaporation rate approximately coincides with the average net evaporation rate during the Years 1931 through 1933, which is the worst drought of record (see Figure 3-1B).

To help develop an appropriate net evaporation rate, daily pan evaporation data were obtained for a monitoring station near Holland, Virginia, approximately 40 miles south of Williamsburg. The data were compiled by the Tidewater Research Center of the Virginia Polytechnic Institute and State University for the period October 1895 through October 1985. Average daily pan evaporation rates

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[4] A three-tiered policy was outlined in the special conditions of James City County's Section 401 Certification for Ware Creek Reservoir. The minimum releases specified by the SWCB range from 0.4 to 1.6 mgd, dependent on runoff conditions, reservoir storage levels, and water demand reduction measures in effect.

KING WILLIAM RESERVOIR
ALTERNATIVE RELEASE SCHEDULE FOR KWR II CONFIGURATION

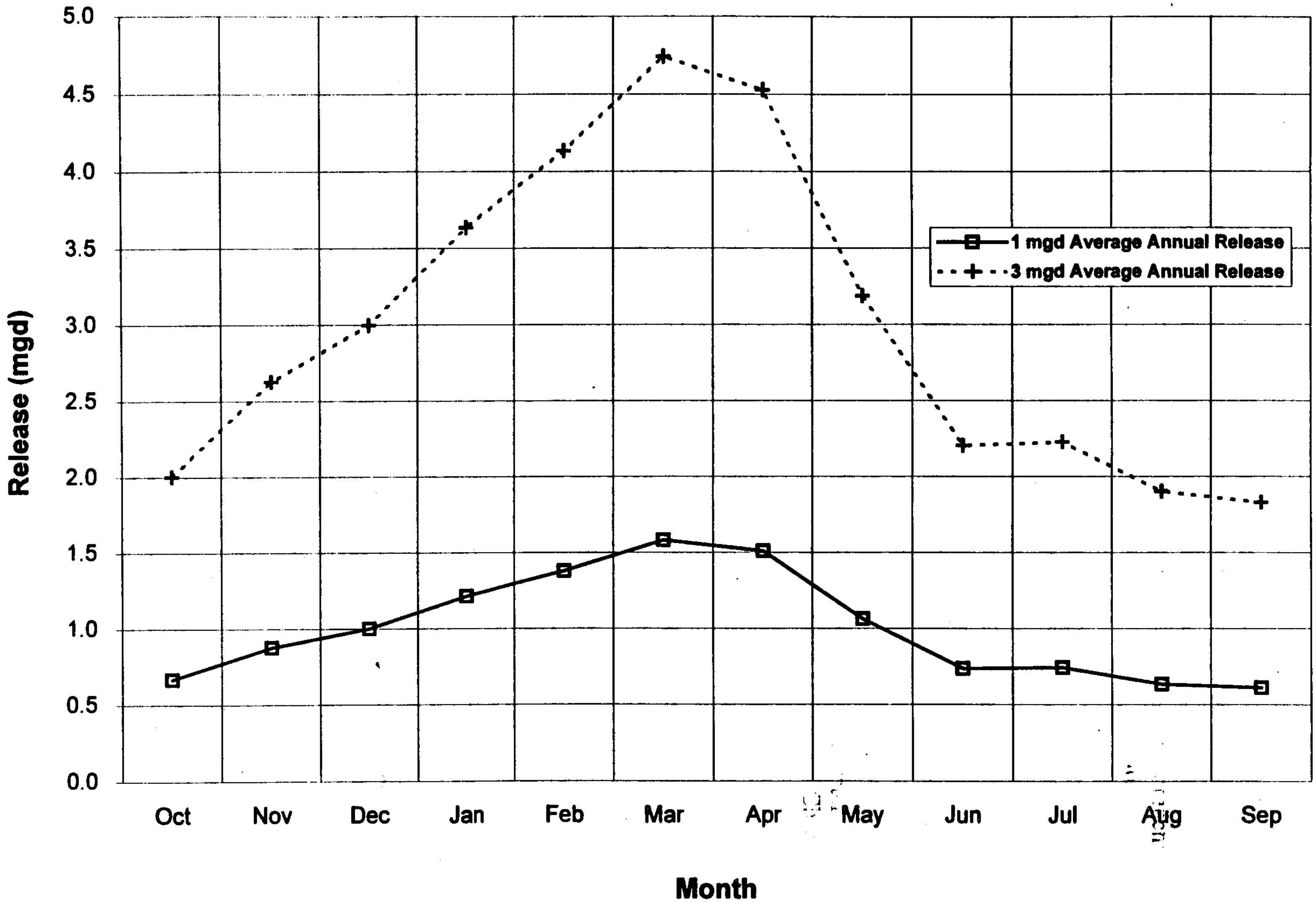


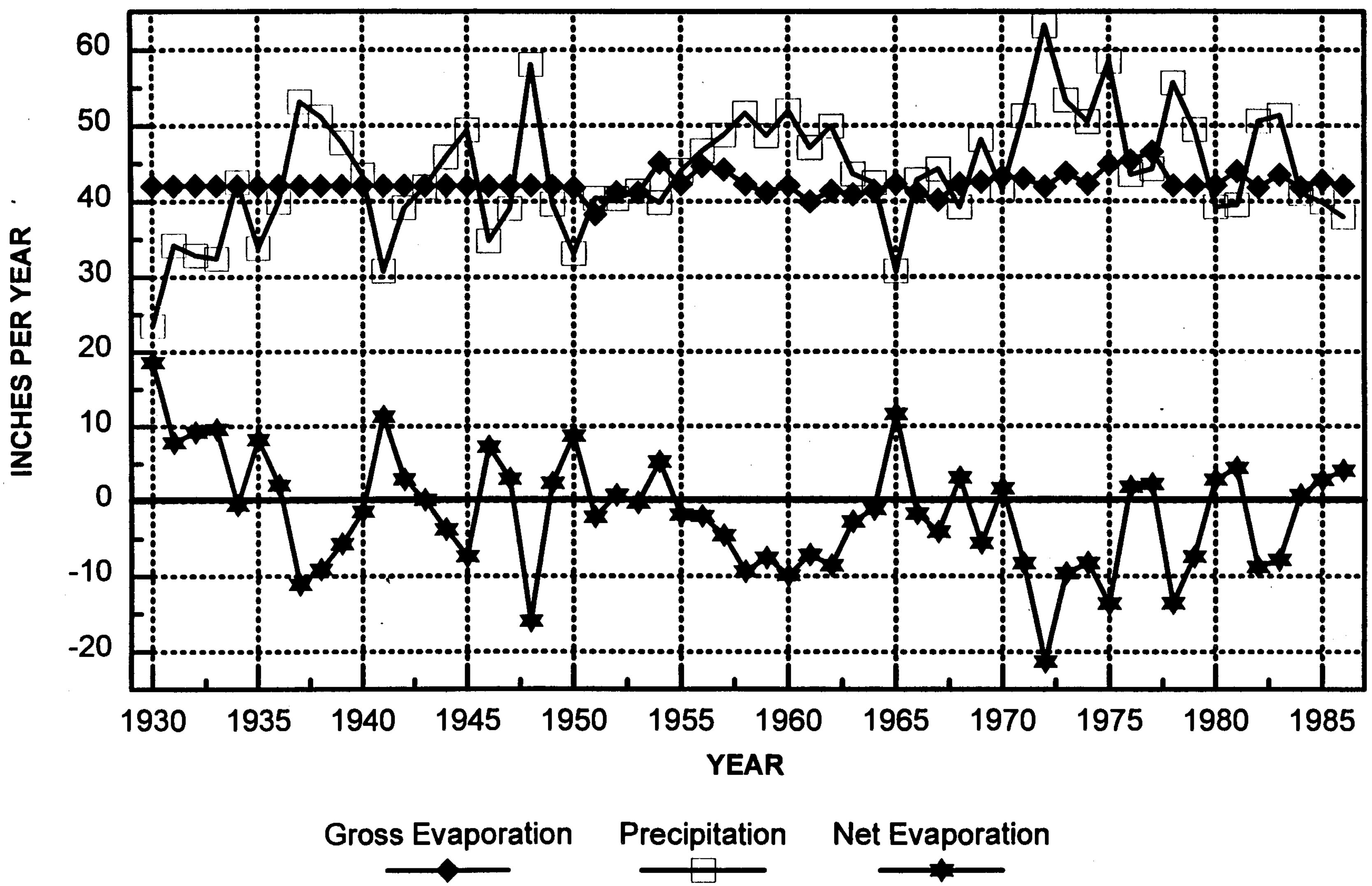
Figure 3-1A

'/9/97

Figure 3-1B

METEOROLOGICAL CONDITIONS FOR RESERVOIRS IN LOWER PENINSULA REGION

(Based on daily pan evaporation and precipitation records for 1930 to 1986)



for each month were used to estimate gross evaporation for each month of the record. Where no data were available for a given month, average historical evaporation rates for the corresponding month were used.

The pan evaporation data were then multiplied by a pan coefficient value of 0.77, to estimate gross evaporation from reservoir surfaces. That value is the mean annual Class A pan coefficient for the Lower Peninsula area, based on the National Oceanic and Atmospheric Administration's (NOAA) *Climatic Atlas of the United States* (NOAA, 1983).

Daily precipitation data were compiled for monitoring stations at Langley Air Force Base (AFB) (January 1930 through February 1986) and Williamsburg (August 1948 through December 1986). Total precipitation for each month was determined for each station. Those two precipitation records were then averaged to provide a more realistic spatial representation of precipitation in the Lower Peninsula region.

To estimate net evaporation, the average Langley AFB/Williamsburg precipitation record was subtracted from the adjusted gross evaporation record, to develop a 57-year record (1930 through 1986) of net evaporation from reservoir surfaces. A summary of annual precipitation and estimated gross and net evaporation rates from reservoir surfaces is presented in Figure 3-1B. Those data show that annual net evaporation rates approaching or exceeding the 10 percent exceedance level occurred during at least one year in each of several major drought periods. The annual evaporation and precipitation data are ranked and presented in the form of a percent exceedance curve in Figure 3-1C.

The monthly variation in net evaporation was incorporated into the analysis by using average monthly net evaporation rates for seven years in which calculated annual net evaporation from reservoirs ranged between 7.3 and 11.3 inches. The Newport News Waterworks Raw Water System Safe Yield Model only accepts 12 monthly net evaporation rates. The model does not accept monthly net evaporation rates which vary for each year of the simulation period.

Other Raw Water Losses

Other raw water losses incorporated into the safe yield analysis, but not within the model itself, included those associated with raw water transmission main losses, seepage from existing Lower Peninsula reservoirs, and losses occurring in the treatment process. These combined losses were estimated at 10 percent of raw water safe yield benefits computed by the model. The remaining net safe yield was considered to be the total treated water safe yield benefit of an alternative.

Host Jurisdiction Water Supply Allowances

Each of the new reservoir alternatives considered in this report would be located in an area outside the core Lower Peninsula study area boundaries. The King William Reservoir project would involve a new reservoir in King William County and new pipeline and pumping facilities in King William and New Kent Counties. The Black Creek and Ware Creek Reservoir projects would both involve new reservoirs located entirely or partially within New Kent County and new pipeline and pumping facilities in New Kent County.

To develop a project outside the core study area, local consent and zoning (special use permit) approvals would be required from the outside "host" jurisdictions. (A more detailed discussion of local consent and zoning requirements under Virginia law is provided in Section 3.4.13). Provision for the water supply needs of the host jurisdiction is likely to be required as a condition of local

NET EVAPORATION CONDITIONS FOR RESERVOIRS IN LOWER PENINSULA REGION

(Based on daily pan evaporation and precipitation records for 1930 to 1986)

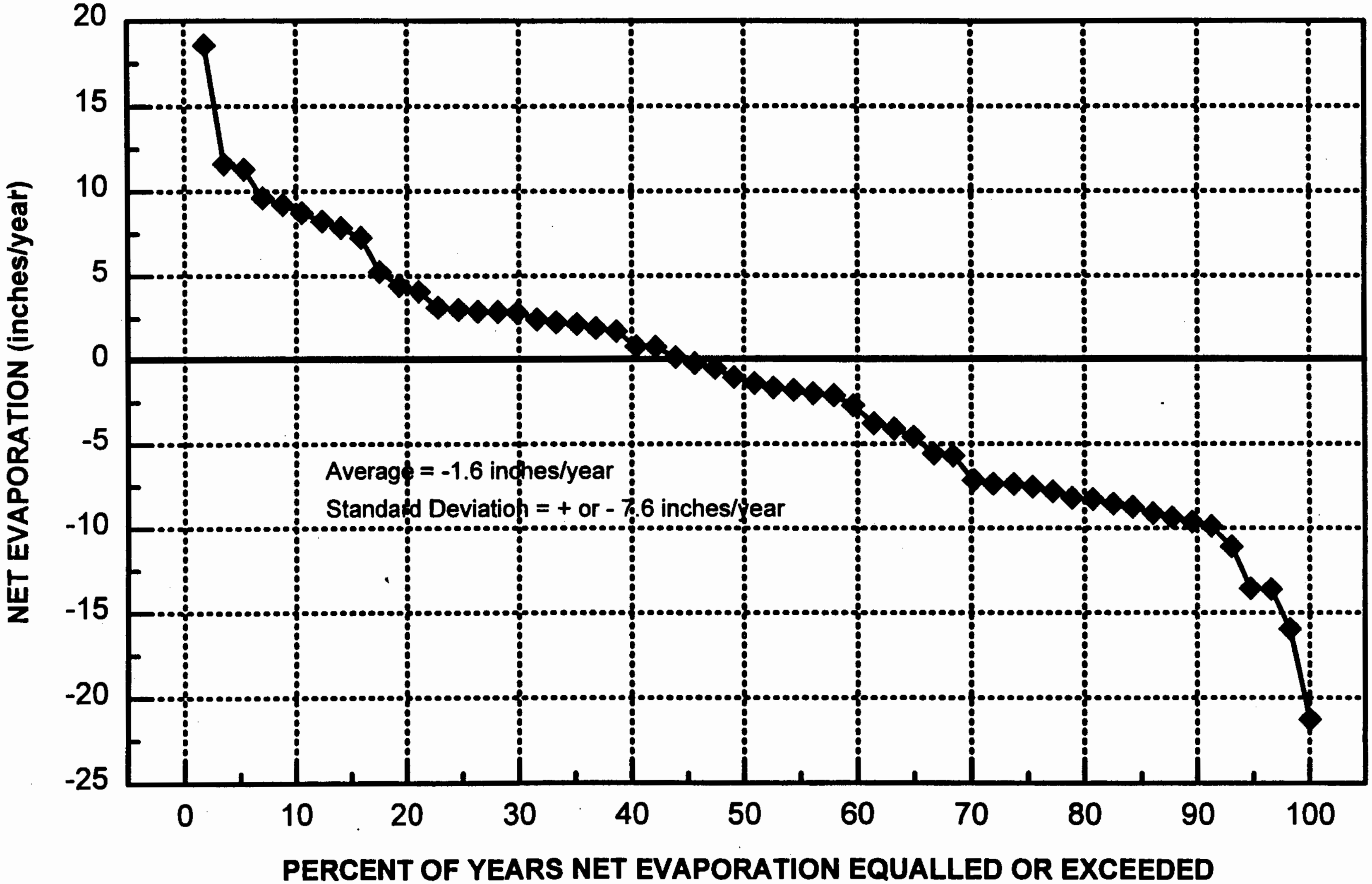


Figure 3-1C

consent approval for any water supply alternative. The future water supply needs of the potential host jurisdictions therefore must be incorporated into the safe yield analysis, as a factor reducing the amount of the project safe yield that would be available for use by the members of the RRWSG.

The King William Reservoir drainage area lies entirely within King William County. Under the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), King William County has the option to reserve and withdraw up to 3 mgd from the King William Reservoir. In addition, the City of Newport News and New Kent County have executed a Project Development Agreement which guarantees New Kent County up to 1 mgd of raw water safe yield from the King William Reservoir project. Altogether, a 4 mgd host jurisdiction raw water safe yield allowance was subtracted from the total safe yield for alternatives which include the King William Reservoir, to calculate net RRWSG safe yield benefits.

The Black Creek Reservoir drainage area lies entirely within New Kent County, so the County would likely require an option to purchase a portion of the Black Creek Reservoir capacity as a condition of its local consent approval for the project. In discussions between New Kent County and RRWSG representatives between 1992 and 1994, the County indicated a clear preference for treated water (rather than raw water) should it be host to a new reservoir project. A 3 mgd host jurisdiction treated water allowance was assumed as was done for the DEIS. However, the full extent of New Kent County's projected Year 2040 deficit of 9 mgd would not be served by the project (see Section 3.14.3). The County's unwillingness to discuss the project at the present time, or to develop an agreement resolving host jurisdiction needs, has prevented the RRWSG from defining an updated host jurisdiction allowance. Therefore, a 3 mgd treated water allowance was subtracted from the total safe yield of alternatives which include the proposed Black Creek Reservoir, to calculate net RRWSG safe yield benefits. If New Kent County requires a larger allowance, the safe yield benefit to the RRWSG would be less.

The proposed Ware Creek Reservoir impoundment and drainage areas lie in both James City and New Kent Counties. Under a December 1983 Agreement between those two Counties, New Kent County has the option to purchase an ownership interest of up to 30 percent of the capacity of James City County's Ware Creek Reservoir project (James City County and New Kent County, 1983). The RRWSG has interpreted that agreement as allowing New Kent County to acquire up to 30 percent of the safe yield of the Ware Creek Reservoir as it was proposed by James City County, as a stand-alone system (i.e., without interconnection to any other water system and without any pumpovers to augment the reservoir yield). Based on the RRWSG's safe yield analysis, that equals approximately 2.2 mgd of the raw water safe yield of the Ware Creek Reservoir, or about 2 mgd of its treated water safe yield. New Kent County could require an additional allowance because a new water pipeline would pass through the County. As previously discussed, the City of Newport News and New Kent County have executed a Project Development Agreement for the King William Reservoir project which guarantees the County up to 1 mgd of raw water safe yield from that project, in consideration of its agreement to allow the RRWSG to build necessary pipeline facilities within the County. For the Ware Creek Reservoir safe yield analysis, it was assumed that New Kent County would agree to a similar allocation with respect to the pipeline facilities required for the proposed Ware Creek Reservoir project. Altogether, a 3 mgd host jurisdiction treated water safe yield allowance for New Kent County was subtracted from the total safe yield for alternatives which include the Ware Creek Reservoir with a river pumpover, to calculate net RRWSG safe yield benefits.

3.4 ALTERNATIVES CONSIDERED

This section contains brief descriptions, safe yield estimates, and results of practicability analyses for 31 original alternatives plus 4 additional alternatives. Taken individually, each alternative has the potential to achieve all or part of the goal of providing dependable, long-term public water supply for the Lower Peninsula. The alternatives analysis demonstrated that many alternatives were either:

- Environmentally fatally flawed.
- Unavailable based on permitting, host approval, or legal constraints.
- Infeasible based on cost or technological reliability.

It was not necessary to evaluate all alternatives with respect to all practicability criteria because an alternative can be screened out based on any one of the criteria. The complete practicability analysis is presented in Report D, Volume I, ***Alternatives Assessment*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document.

The general locations of the alternatives are depicted in Plate 1 (see map pocket at rear of report). Alternative descriptions are presented in Table 3-1.

3.4.1 Lake Genito

Description

This alternative would require construction of a dam and reservoir on the Appomattox River, and an intake and pump station at Lake Chesdin in the vicinity of the existing Brasfield Dam. The constructed Lake Genito would store 113.7 billion gallons and cover an area of 10,500 acres at a normal pool elevation of 250 feet msl. The reservoir would extend 33 miles upstream on the Appomattox River.

Controlled releases from Lake Genito to Lake Chesdin would allow the Lower Peninsula to withdraw water from Lake Chesdin for transmission to Diascund Creek Reservoir. This would require the construction of a 43-mile, 48-inch, 40-mgd capacity pipeline terminating at the headwaters of Diascund Creek. A 40-mgd pump station near the Diascund Creek dam, a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir, and a new intake structure and pump station at Lake Chesdin would also be required.

Safe Yield

Safe yield calculations were performed as part of the ***Lake Genito Project Hydrologic Evaluation*** (Black & Veatch, 1988). A computer-based hydrologic model was used to assess the affect of alternative operating scenarios, minimum in-stream flow (MIF) conditions, and drawdown constraints on safe yield of the Lake Genito-Lake Chesdin system.

The calculated safe yield of the total reservoir system, Lake Genito plus Lake Chesdin, ranged from 122 to 271 mgd depending on the operating scenario and MIF requirement (Black & Veatch, 1988). Given this range of yield, the proposed reservoir system has the potential to satisfy the water

TABLE 3-1

ALTERNATIVE COMPONENTS CONSIDERED	
1. Lake Genito	New 78-foot high dam across the Appomattox River near Genito, Virginia on Amelia/Powhatan County boundary; 113.7-billion gallon lake draining 715 square miles, covering 10,500 acres at pool elevation of 270 feet, and extending 33 miles upstream. Controlled releases from Lake Genito allow pumping from new 40 mgd* intake structure on Lake Chesdin to headwaters of Diascund Creek Reservoir through new 43-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
2. Lake Chesdin	Water pumped from new 40 mgd intake structure on Lake Chesdin to headwaters of Diascund Creek Reservoir through new 43-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
3. Lake Anna	Water pumped from new 40 mgd intake structure on Lake Anna (in Louisa County) to headwaters of Diascund Creek Reservoir through new 66-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
4. Lake Gaston	Water pumped from new 40 mgd intake structure on Lake Gaston (in Brunswick County) to headwaters of Diascund Creek Reservoir through new 86-mile, 54-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
5. Rappahannock River (above Fredericksburg)	Water pumped from new 75 mgd intake structure on Rappahannock River (in Spotsylvania County, above Embry Dam) to headwaters of Diascund Creek Reservoir through new 89-mile, 66-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
6. James River (above Richmond) without New Off-Stream Storage	Water pumped from new 40 mgd intake structure on James River (in Chesterfield County, above Bosher's Dam) to headwaters of Diascund Creek Reservoir through new 50-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
7. City of Richmond Surplus Raw Water	Water pumped from new 40 mgd intake structure at the Richmond Water Treatment Plant to the headwaters of Diascund Creek Reservoir through new 34-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
8. City of Richmond Surplus Treated Water	Treated water (25 mgd average, 37 mgd maximum) pumped from Richmond Water Treatment Plant to Waterworks' northern distribution zone in James City County, through new 64-mile transmission main (42-inch pipeline in urban Richmond area; dual 30-inch pipelines with booster pump station for remainder of route).
9. James River (between Richmond and Hopewell)	Water pumped from new 40 mgd pump station on James River in Henrico County (near Hatcher Island) to headwaters of Diascund Creek Reservoir through new 25-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
10. Ware Creek Reservoir	New 50-foot high dam across Ware Creek on New Kent/James City County boundary; 6.87-billion gallon lake draining 17.4 square miles and covering 1,238 acres at pool elevation of 35 feet. Water pumped from new 20 mgd intake structure to Waterworks raw water mains through new 3.6-mile, 30-inch pipeline. New 1.5-mile, 30-inch pipeline from Waterworks raw water mains to Ware Creek Reservoir also required.
11. Ware Creek Reservoir & Pamunkey, Mattaponi, and/or Chickahominy River Pumpovers	Similar to No. 10, with 40 mgd pump station and 3.6-mile, 42-inch pipeline from Ware Creek Reservoir to Waterworks raw water mains; plus water pumped from Pamunkey River to Diascund Creek Reservoir (120 mgd pump station, 11.4 miles of 66-inch pipeline and 6.2 miles of 54-inch pipeline), Mattaponi River to Diascund Creek Reservoir (45 mgd pump station, 16.8-mile, 48-inch pipeline), and/or Chickahominy River to Little Creek and Ware Creek Reservoirs (expansion of pump station to 61 or 81 mgd; improvement of all or part of pipeline from Chickahominy River to Little Creek Reservoir; and new 1.5-mile, 42-inch pipeline to Ware Creek Reservoir from existing raw water pipeline). Pamunkey and Mattaponi options also require new 40 mgd pump station and 4.9-mile, 42-inch pipeline from Diascund Creek Reservoir to Ware Creek Reservoir.
12. Ware Creek Reservoir & James River Pumpover (above Richmond)	Similar to No. 10, with 40 mgd pump station and 3.6-mile, 42-inch pipeline from Ware Creek Reservoir to Waterworks raw water mains; plus water pumped from new 75 mgd pump station on James River in Chesterfield County (above Bosher's Dam) to Diascund Creek Reservoir through new 50-mile, 60-inch pipeline. New 40 mgd pump station and 4.9-mile, 42-inch pipeline from Diascund Creek Reservoir to Ware Creek Reservoir also required.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
13. Black Creek Reservoir & Pamunkey River Pumpover	Two new dams across southern and eastern branches of Black Creek in New Kent County; 6.4-billion gallon interconnected lake draining 5.5 square miles and covering 910 acres at pool elevation of 100 feet; supplemented with water pumped from new 120 mgd pump station on Pamunkey River in New Kent County (at Northbury) through new 5-mile, 66-inch pipeline. Water pumped from new 40 mgd reservoir intake structure to headwaters of Diascund Creek Reservoir through new 6.8-mile, 42-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
14. Black Creek Reservoir & James River Pumpover (above Richmond)	Similar to No. 13, but supplemented with water pumped from new 75 mgd pump station on James River in Chesterfield County (above Bosher's Dam) through new 43-mile, 60-inch pipeline.
15. King William Reservoir & Mattaponi River Pumpover	**KWR-I Configuration (RRWSG's Originally Proposed Project):** New 92-foot dam across Cohoke Creek in King William County; 21.21 billion gallon lake draining 13.17 square miles and covering 2,284 acres at 90 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Water delivered to Diascund Creek Reservoir through new 10.0-mile, 42- and 60-inch gravity flow pipeline (40 mgd capacity). Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir. **KWR-II Configuration (RRWSG's Preferred Project):** New 92-foot dam across Cohoke Creek in King William County; 21.21 billion gallon lake draining 11.45 square miles and covering 2,222 acres at 96 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Includes a 50 mgd King William Reservoir pump station and new 10.4-mile, 42- and 48-inch pipeline to deliver water to Diascund Creek Reservoir. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
15. King William Reservoir & Mattaponi River Pumpover (Continued)	The USCOE directed consideration of the following additional upstream dam configurations for this alternative: **KWR-III Configuration:** New 83-foot dam across Cohoke Creek in King William County; 16.57 billion gallon lake draining 10.33 square miles and covering 1,909 acres at 96 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Includes a 50 mgd King William Reservoir pump station and new 11.2-mile, 42- and 48-inch pipeline to deliver water to Diascund Creek Reservoir. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir. **KWR-IV Configuration (RRWSG's Currently Proposed Project):** New 78-foot dam across Cohoke Creek in King William County; 12.22 billion gallon lake draining 8.92 square miles and covering 1,526 acres at 96 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Includes a 50 mgd King William Reservoir pump station and new 11.7-mile, 42- and 48-inch pipeline to deliver water to Diascund Creek Reservoir. Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.
16. King William Reservoir & Pamunkey River Pumpover	Same as No. 15, but supplemented with water pumped from Pamunkey River near Montague Landing in King William County (100 mgd pump station, 5.7-mile, 60-inch pipeline) instead of Mattaponi River.
17. Chickahominy River Pumping Capacity Increase	Increase pumping capacity of existing Waterworks Chickahominy River pump station in New Kent County from 41 mgd to 61 mgd.
18. Chickahominy River Pumping Capacity Increase and Raise Diascund and Little Creek Dams	Same as No. 17, plus modifying Waterworks' Diascund Creek and Little Creek dams to increase normal pool elevations by 2 feet.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
19. Aquifer Storage and Recovery, Constrained by Number of Wells	Withdraw water from Chickahominy River at full capacity when streamflow is high and demand is low; treat and store underground for later use. Treated water injected through new system of 12 wells into underground aquifers when raw water source capacity exceeds system demand; subsequently recovered from same wells when customer demand exceeds treated water supply. Well locations limited to Waterworks property with good access to distribution system.
20. Aquifer Storage and Recovery, Unconstrained by Number of Wells	Same as No. 19, limited only by Chickahominy River withdrawal capacity and amount of surplus streamflow available (about 19 new wells required).
21. Fresh Groundwater Development	New well fields in western James City County and/or eastern New Kent County; used to augment Diascund Creek and Little Creek Reservoirs when system reservoir storage is below 75 percent of total capacity.
22. Groundwater Desalination as the Single Long-Term Alternative	Large-scale withdrawals from about 27 new wells located throughout the Lower Peninsula and drilled into deep, brackish aquifers, treated in about four or five new desalination plants.
23. Groundwater Desalination in Newport News Waterworks Distribution Area	Small-scale withdrawals from about five new wells located adjacent to Waterworks distribution facilities and drilled into deep, brackish aquifers, treated in four new reverse osmosis desalination plants.
24. James River Desalination	Water pumped from new 70 mgd off-shore intake, subaqueous pipeline and pump station on James River (in James City County, about 3,000 feet upstream of Jamestown Ferry Landing) to new 44 mgd reverse osmosis desalination plant near Waller Mill Reservoir through new 9-mile, dual 36-inch pipeline. A 20-mile, 36-inch pipeline and outfall (26 mgd capacity) also required for concentrate disposal. An alternative James River intake site is located 14 miles farther upstream at Sturgeon Point in Charles City County.
25. Pamunkey River Desalination	Water pumped from new 65 mgd intake on Pamunkey River (east of Cohoke Marsh, near Chestnut Grove Landing in New Kent County) to new 44 mgd desalination plant near Waller Mill Reservoir through new 25-mile, 54-inch pipeline. An 8.2-mile, 30-inch pipeline and outfall (21 mgd capacity) also required for concentrate disposal.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
26. York River Desalination	Water pumped from new 85 mgd intake on York River (between Sycamore Landing and York River State Park in New Kent County) to new 44 mgd reverse osmosis desalination plant near Waller Mill Reservoir through new 13.6-mile, dual 42-inch pipeline. A 20-mile, 36-inch pipeline and outfall (41 mgd capacity) also required for concentrate disposal.
27. Cogeneration	Purchase drinking water produced through distillation process powered by excess steam from privately-owned cogeneration facility. New intake on York or James River required for raw water source and power plant cooling water; discharge structure and pipeline also required for return of cooling water and concentrate disposal. Private initiative required; capacity, specifications and viability dependent on location and design of privately-owned cogeneration plant and sale of power to a utility company.
28. Wastewater Reuse as a Source of Potable Water	Blending highly treated wastewater with potable raw water supplies, using new advanced wastewater reclamation plant adjacent to existing HRSD York River WWTP, new multi-compartment reclaimed water lagoon, and new reclaimed water pump station and pipelines to Harwood's Mill and Lee Hall reservoirs.
29. Wastewater Reuse for Non-Potable Uses	One to four systems, each located adjacent to an existing HRSD WWTP on the Lower Peninsula, each providing advanced treatment of WWTP effluent to produce non-potable water suitable for industrial cooling and industrial process use. Each system would include an advanced wastewater reclamation plant, reuse water pump station, distribution system, and storage facilities.
30. Additional Conservation Measures and Use Restrictions	Lower Peninsula demand projections assume that historic conservation rates will be maintained throughout the planning horizon. Additional aggressive water conservation activities applied to residential, commercial, and industrial demand categories will provide supplemental safe yield benefits to the Lower Peninsula. Contingency measures (i.e., use restrictions) beyond additional conservation measures, employed to produce short-term reductions in water demand during water supply emergencies provide further safe yield benefits; implemented in tiered fashion as emergency intensifies: Tier 1 - voluntary use restrictions; Tier 2 - mandatory use restrictions.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
31. No Action	Do nothing to provide additional raw water supply or curtail water use on the Lower Peninsula. To limit growth, water purveyors could place moratoriums on new hook-ups. (Consideration of this alternative is required in Environmental Impact Statements.)
32.1 Black Creek Reservoir & Mattaponi River Pumpover	Similar to No. 13, but supplemented with water pumped from Mattaponi River pump station near Scotland Landing in King William County.
32.2 Ware Creek Reservoir (Three Dam Alternative) & Pamunkey River Pumpover	Three new dams across Ware Creek, Cow Swamp, and France Swamp in New Kent and James City Counties; with normal pool elevations of 40, 50, and 50 feet msl, respectively; with a combined surface area of 955 acres, and combined storage volume of 4.95-billion gallons. Water pumped from new 120 mgd pump station on Pamunkey River in New Kent County (at Northbury). Pipelines similar to No. 11.
32.3 Side-Hill Reservoir	Impoundments in King William County located against bluffs existing along the Mattaponi and/or the Pamunkey River valleys with maximum operating water depths of 50 feet; total combined storage capacity of 20-billion gallons: supplemented with water from pump station on the Matt[illegible] Pamunkey Rivers.
32.4 Smaller King William Reservoir with Two River Pumpovers	New 90-foot high dam across Cohoke Creek in King William County; 12.1-billion gallon storage capacity covering 1,515 acres at pool elevation of 96 feet msl. Supplemented with water from Pamunkey and Mattaponi Rivers by 45 and 75-mgd pumping stations, respectively. Water pumped to Diascund Creek Reservoir through new 11.7-mile, 42-inch and 48-inch diameter raw water pipeline by 50 mgd pumping station. Also includes new 40 mgd pump station and 5[illegible], 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

* mgd = million gallons per day

Notes: Principal alternative changes and additions subsequent to publication of DEIS are as follows:

13. Reservoir dimensions were updated based on more accurate topographic mapping.

15. Reservoir dimensions were updated based on more accurate topographic mapping. To avoid potential erosional impacts to Beaverdam Creek, the pipeline discharge point on Beaverdam Creek was extended downstream, and a pump station was added.

TABLE 3-1
(Continued)

30. Additional conservation measures were included as a component of this alternative.

32.1 Added as an alternative.

32.2 Added as an alternative.

32.3 Added as an alternative.

32.4 Added as an alternative.

needs of the Lower Peninsula as well as those of the Lake Genito host or "PACC" jurisdictions (Powhatan, Amelia, Cumberland, and Chesterfield Counties) and ARWA members (Chesterfield, Dinwiddie, and Prince George Counties, and the Cities of Colonial Heights and Petersburg). In addition, Chesterfield County's 4.3 billion gallon Swift Creek Reservoir can currently supply 12 mgd based upon the rated capacity of the reservoir water treatment plant. Therefore, depending on how the Genito/Chesdin system is operated, enough surplus raw water could be available to provide a 39.8-mgd treated water safe yield benefit for the Lower Peninsula.

Practicability Analysis

The magnitude of Lake Genito's potential environmental impact is markedly greater than for other alternatives under consideration. Because of these "environmental fatal flaws," this alternative is regarded as unavailable. In addition, Lake Genito is not currently considered permittable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.2 Lake Chesdin

Description

This alternative would require construction of a 40-mgd intake structure and pumping station at Brasfield Dam (Lake Chesdin) and a 43-mile, 48-inch, 40-mgd capacity raw water pipeline to convey excess Lake Chesdin spills from Lake Chesdin to Diascund Creek Reservoir. A 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir would also be required.

The intakes, pump stations, pipeline routes, and outfalls for this alternative are identical to those previously described for the Lake Genito alternative (see Section 3.4.1).

Safe Yield

This alternative's treated water safe yield benefit was calculated at 11.9 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the Lake Chesdin alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered infeasible and impracticable at this time.

3.4.3 Lake Anna

Description

Lake Anna is an existing 99.4 billion gallon impoundment on the North Anna River which covers 13,000 acres and drains a 243 square mile area (SWCB, 1988). Virginia Power owns and operates this impoundment as a source of cooling water required by two nuclear power plant reactors.

This alternative would require the construction of an intake and a 40-mgd raw water pump station on Lake Anna, approximately 66 miles of 48-inch, 40-mgd capacity raw water pipeline, an outfall on the headwaters of Diascund Creek Reservoir, a 40-mgd pump station near the Diascund Creek Reservoir dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir. The intake and pump station would be located adjacent to the existing pump station, and the pipeline would parallel the existing Diascund raw water transmission main.

Safe Yield

A continuous withdrawal of 40 mgd was assumed, with no MIF restrictions or restrictive operating rules. Assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of Lake Anna withdrawals, this alternative would provide a treated water safe yield benefit on the order of the projected Year 2040 Lower Peninsula deficit of 39.8 mgd.

Practicability Analysis

Virginia Power is strongly opposed to the use of Lake Anna as a public water supply. In addition, there are severe legal and technical constraints which exist with respect to this alternative. As a result, this alternative is not considered available by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.4 Lake Gaston

Description

This alternative would consist of an intake and a 40-mgd raw water pump station on Lake Gaston, approximately 86 miles of 54-inch, 40-mgd capacity raw water pipeline, and an outfall at Diascund Creek Reservoir. The design capacity of the Lake Gaston pipeline system to Virginia Beach is not sufficient to accommodate this additional flow.

A new 40-mgd capacity intake structure and pump station would be required at the Diascund Creek Reservoir dam to convey water through a 5.5-mile, 42-inch, 40-mgd capacity pipeline to the Little Creek Reservoir.

Safe Yield

A continuous withdrawal of 40 mgd was assumed, with no MIF restrictions or restrictive operating rules. Assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of Lake Gaston withdrawals, this alternative would provide a treated water safe yield benefit on the order of the projected Year 2040 Lower Peninsula deficit of 39.8 mgd.

Practicability Analysis

Legal conflicts have stalled the City of Virginia Beach's progress on the Lake Gaston Pipeline Project for more than 13 years. Given the likelihood of strong project opposition arguing the potential for cumulative impacts, it is expected that equally or more challenging legal conflicts than Virginia Beach has experienced would block or severely delay any proposal by the RRWSG for additional withdrawals from Lake Gaston. This alternative is also not considered available by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.5 Rappahannock River Above Fredericksburg

Description

This alternative would consist of an intake and 75-mgd raw water pump station on the Rappahannock River above Fredericksburg, approximately 89 miles of 66-inch, 75-mgd capacity river water pipeline, an outfall on the headwaters of the Diascund Creek Reservoir, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

The treated water safe yield benefit of this alternative was calculated at 7.9 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the current pursuit of additional Rappahannock River withdrawals by Fredericksburg-area jurisdictions would greatly magnify the degree of difficulty associated with the RRWSG gaining approvals for this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.6 James River Above Richmond Without New Off-Stream Storage

Description

This alternative would involve a 40-mgd raw water intake and pumping station located on the James River, approximately 50 miles of 48-inch, 40-mgd capacity river water pipeline, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 51-year simulation periods. Treated water safe yield benefits of 7.1 and 7.9 mgd were calculated for 40- and 75-mgd James River diversion capacities, respectively.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the Richmond Regional Planning District Commission (RRPDC) has taken a strong position against Lower Peninsula withdrawals from the James River above Richmond. This position indicates that this alternative is institutionally not permittable. Furthermore, the intense competition for James River water between the City of Richmond and Henrico County could severely delay any RRWSG efforts to pursue this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.7 City of Richmond Surplus Raw Water

Description

This alternative would involve a 40-mgd raw water intake and pumping station located in the City of Richmond, approximately 34 miles of 48-inch, 40-mgd capacity raw water pipeline, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

For purposes of calculating maximum theoretical yield, it was initially assumed that a continuous withdrawal of 40 mgd was possible, with no MIF restrictions or restrictive operating rules. With these assumptions, and assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of withdrawals, this alternative would provide a safe yield benefit on the order of the projected Year 2040 Lower Peninsula deficit of 39.8 mgd. However, in light of recent consultation with the USCOE and SWCB, a treated water safe yield benefit of 7.1 mgd is instead assumed for this alternative.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the RRPDC has taken a strong position against Lower Peninsula withdrawals from the James River at Richmond. This position indicates that this alternative is institutionally not permittable. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.8 City of Richmond Surplus Treated Water

Description

This alternative would involve the transmission of treated water approximately 64 miles from the Richmond Water Treatment Plant (WTP) to the Northern Zone of the Newport News Waterworks distribution system in James City County. The transmission main from Richmond would be designed to handle average and maximum day flows of 25 and 37 mgd, respectively, in the Year 2040. A single 42-inch, or dual 30-inch diameter main would be required, and would connect to the Newport News Waterworks system at the Upper York Ground Storage Tank.

Safe Yield

The "preferred water system alternative" in the ***Regional Water Resources Plan for Planning District 15*** calls for expansion of the Richmond WTP capacity to 132 mgd. However, it is possible that for relatively low incremental costs the WTP capacity could be expanded to 150 mgd through the use of higher filtration rates. This increase in rated capacity would have to be permitted by the

VDH, which has indicated some concerns about such a proposal (RRPDC, 1992). If Richmond is successful in expanding its WTP capacity to 150 mgd, then this alternative's potential treated water safe yield benefit would increase from 12.1 to 23.9 mgd on an average day demand basis. For purposes of this analysis, it is assumed that this is the case and that this alternative offers a maximum treated water safe yield of 23.9 mgd.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, there are major uncertainties concerning the availability of surplus treated water from the City of Richmond. These uncertainties are outside the control of RRWSG member jurisdictions. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.9 James River Between Richmond and Hopewell

Description

This alternative would consist of an intake and 40-mgd raw water pump station on the James River between Richmond and Hopewell, approximately 25 miles of 48-inch, 40-mgd capacity river water pipeline, an outfall at Diascund Creek Reservoir, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

A continuous withdrawal of 40 mgd was assumed, with no MIF restrictions or restrictive operating rules. Assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of James River withdrawals, this alternative would provide treated water safe yield benefit on the order of the projected Year 2040 Lower Peninsula deficit of 39.8 mgd.

Practicability Analysis

The Virginia Department of Health (VDH) has taken a strong position against withdrawals from the James River between Richmond and Hopewell for public water supply. These comments are discussed below and indicate that this alternative is not considered permittable by the State. In addition, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.10 Ware Creek Reservoir

Description

This alternative would require the construction of a dam on Ware Creek at "Dam Site V" as documented in the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek*** (USCOE, 1987). The dam would be a 50-foot high, 1,450-foot long structure located approximately 1,000 feet downstream from the confluence of Ware Creek and France Swamp on the boundary between James City and New Kent Counties. The 1,238-acre reservoir would drain 17.4 square miles and store 6.87 billion gallons at a normal pool elevation of 35 feet msl. Ware Creek Reservoir could be supplied solely by natural inflows from drainage basin runoff. A 20-mgd raw water intake and pump station would also be required at Ware Creek Reservoir to convey raw water through a 3.6-mile, 30-inch, 20-mgd capacity pipeline to the existing Newport News Waterworks raw water mains. Approximately 1.5 miles of 30-inch pipeline would be required from the existing Newport News Waterworks' raw water mains to Ware Creek Reservoir.

Safe Yield

This alternative's treated water safe yield benefit for the Lower Peninsula was calculated at 7.1 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This safe yield is based upon operation of Ware Creek Reservoir as an interconnected component of the existing Newport News Waterworks raw water system. Without this interconnection, Malcolm Pirnie has estimated this project's treated water safe yield benefit for the Lower Peninsula at 4.7 mgd.

Practicability Analysis

The history of regulatory and judicial proceedings associated with this alternative demonstrate that Ware Creek Reservoir is not practicable as a local supply (i.e., without modification or expansion to serve a larger regional need). In December 1993 the U.S. Court of Appeals for the Fourth Circuit issued a decision upholding the USEPA's second "veto" of James City County's proposed Ware Creek Reservoir Project. James City County filed a petition for review of that decision by the U.S. Supreme Court in June 1994 in an effort to overturn the veto. In October 1994, the Supreme Court denied its petition and let stand the appellate court ruling that upheld USEPA's veto.

Given this background, this alternative (without expansion) is considered to be impracticable. This practicability determination is made with the understanding that there are also serious concerns regarding long-term reservoir water quality deterioration given the extensive nature of planned development in the watershed.

In the interests of serving more of the RRWSG's future needs and avoiding legal challenges wherever possible, only an expanded Ware Creek Reservoir alternative will be carried forward for further environmental analysis.

3.4.11 Ware Creek Reservoir With Pumpovers From Pamunkey, Mattaponi, and/or Chickahominy Rivers

Description

This alternative would involve a raw water intake and pumping station located on the Pamunkey, Mattaponi, and/or Chickahominy Rivers, a river water pipeline from the river source(s) to Diascund Creek Reservoir, Diascund Creek Reservoir withdrawal and transmission improvements which depend on the river source, a 1,450-foot long dam on Ware Creek, and Ware Creek Reservoir withdrawal and transmission improvements. Each of the three possible river pumpover sources are discussed individually (see Figure 3-9 in Section 3.5).

Pamunkey River

A 120-mgd raw water intake and pumping station would be located in the vicinity of Northbury on the southern bank of the Pamunkey River in northwestern New Kent County. Northbury is located approximately 40 river miles upstream from the mouth of the Pamunkey River. From Northbury, river withdrawals would be pumped to Diascund Creek Reservoir through 11.4 miles of 66-inch, 120-mgd capacity pipeline and 6.2 miles of 54-inch, 80-mgd capacity pipeline. A 40-mgd capacity outfall on Diascund Creek in New Kent County would also be required.

Mattaponi River

A 45-mgd raw water intake and pumping station would be located in the vicinity of Scotland Landing on the southern bank of the Mattaponi River in King William County. Scotland Landing is located 24.2 river miles upstream from the mouth of the Mattaponi River. From Scotland Landing, river withdrawals would be pumped to Diascund Creek Reservoir through 16.8 miles of 48-inch, 45-mgd capacity pipeline. The raw water pipeline outfall would be located on Beaverdam Creek in New Kent County.

Chickahominy River (81-mgd Total Withdrawal Capacity)

The City of Newport News Waterworks' existing Walkers pumping station capacity, when pumping to Little Creek and/or Ware Creek reservoirs, would be expanded to 81 mgd, approximately equal to the capacity of the existing intake works. This intake and pumping station site is located on the northern bank of the Chickahominy River in southeastern New Kent County.

For this pumpover, up to 81 mgd would be pumped approximately 7.5 miles to Little Creek Reservoir in James City County, where 41 mgd would be discharged, while 40 mgd would flow an additional 1.8 miles to Ware Creek Reservoir. Under this method of operation, no flow from the Walkers pump station would be conveyed directly to the terminal reservoirs, although the capability to do so would still exist. If Ware Creek and Little Creek reservoirs were full, all flow from the Walkers pump station would be directed to the terminal reservoirs, although at a rate less than the 81-mgd maximum rate previously mentioned.

To facilitate diversion of water to Ware Creek Reservoir, approximately 1.5 miles of pipeline would be required from the existing Newport News Waterworks raw water mains to Ware Creek Reservoir, and the replacement or paralleling of all or a portion of the existing Old Chickahominy main from Walkers pump station to the existing Little Creek outfall.

Chickahominy River (61-mgd Total Withdrawal Capacity)

An alternative to expanding the City of Newport News Waterworks' existing Chickahominy River withdrawal capacity to 81 mgd would be to increase the Walkers pumping capacity to 61 mgd, when pumping water to Little Creek and/or Ware Creek reservoirs.

For this pumpover, up to 61 mgd of raw water would be pumped from the Walkers pumping station to either Little Creek or Ware Creek reservoirs. Similar to the 81-mgd option previously described, no flow from the Walkers pumping station would be conveyed directly to the terminal reservoirs when the maximum flow of 61 mgd is being discharged to Little Creek and/or Ware Creek reservoirs.

The pumpover to Ware Creek would require 1.5 miles of pipeline from the existing Newport News Waterworks raw water mains to Ware Creek Reservoir, as described for the 81-mgd option.

Diascund Creek Reservoir Withdrawal and Transmission Improvements

For the Pamunkey and Mattaponi river pumpover scenarios, a new 40-mgd capacity intake structure and pump station would be required at the Diascund Creek Reservoir dam to convey water through a 4.9-mile, 42-inch 40-mgd capacity pipeline to Ware Creek Reservoir.

For the Pamunkey and Mattaponi river pumpover scenarios, the majority of water diverted to Ware Creek Reservoir would come from these rivers via Diascund Creek Reservoir. Other lesser amounts of water would be diverted to Ware Creek Reservoir from the Chickahominy River. In order to receive these potential water diversions, two raw water outfalls are proposed in the Ware Creek Reservoir watershed. This outfall would be used to receive water diverted from Diascund Creek Reservoir.

For the Pamunkey and Mattaponi river pumpover scenarios, a second outfall would be located on France Swamp near the southernmost point of the proposed reservoir normal pool area. This outfall would be used to receive water diverted from the Chickahominy River.

Ware Creek Reservoir

A dam on Ware Creek would be constructed at "Dam Site V" as documented in the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek*** (USCOE, 1987). This 50-foot high, 1,450-foot long dam would be located approximately 1,000 feet downstream from the confluence of Ware Creek and France Swamp on the boundary between James City and New Kent counties. The 1,238-acre reservoir would drain 17.4 square miles and store 6.87 billion gallons at a normal pool elevation of 35 feet msl.

A 40-mgd raw water intake and pump station would be required at Ware Creek Reservoir to convey raw water through a 3.6-mile, 42-inch 40-mgd capacity pipeline to the existing Newport News Waterworks raw water mains. The intake and pump station would be located on the France Swamp branch of the reservoir, on the northern tip of a small peninsula, approximately 1.1 miles east-southeast of the Route 600 crossing of Interstate 64 in James City County.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 58-year simulation periods. Individual pumpovers and some combinations of pumpovers were evaluated in conjunction with Ware Creek Reservoir. Treated water safe yield benefits for the RRWSG, as listed below, were calculated for the various pumpover scenarios considered.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of a host jurisdiction allowance for New Kent County, where river withdrawal facilities, new pipeline, and a portion of the reservoir would be located. As stated in Section 3.3.3, this host jurisdictional allowance has been assumed to be a 3 mgd treated water safe yield benefit.

Pumpover Source (River(s))	Diversion Capacity (mgd)	Treated Water Safe Yield Benefit to RRWSG (mgd)
Pamunkey	40	14.1
Pamunkey	70	17.8
Pamunkey	100	21.1
Pamunkey/Chickahominy	100 / 61	23.5
Pamunkey	120	23.2
Pamunkey/Chickahominy	120 / 61	24.1
Mattaponi	45	18.0
Mattaponi	60	18.0
Mattaponi	75	18.2
Mattaponi	100	18.2
Chickahominy	61	12.5
Chickahominy	81 *	12.2

* Assumed MIF is more restrictive than that used in the simulation of the 61 mgd maximum Chickahominy River withdrawal capacity.

The above safe yield determinations are based on operation of Ware Creek Reservoir as an interconnected component of the existing Newport News Waterworks system.

Practicability Analysis

Separate practicability assessments for the Pamunkey, Mattaponi, and Chickahominy River pumpover scenarios are summarized below.

Pamunkey Pumpover

Based on information compiled to date, there is no basis for deeming this alternative (with Pamunkey River pumpover) impracticable. Therefore, the Ware Creek Reservoir with Pumpover from Pamunkey River alternative has been retained for further environmental analysis.

Mattaponi Pumpover

A substantial reduction in project safe yield would occur as a result of using the Mattaponi River rather than the Pamunkey River as a pumpover source for Ware Creek Reservoir. The characteristically larger Pamunkey River flows support a greater withdrawal capacity, thereby enhancing the safe yield benefits. Based on safe yield modeling results presented previously, this reduction would be more than 5 mgd. Consequently, a 39.8-mgd project alternative which includes

Ware Creek Reservoir with Mattaponi River pumpover would require development of a greater number of water sources than the Pamunkey River pumpover option. Environmental impacts associated with developing more water sources would likewise be greater.

The pipeline route required for the Mattaponi River pumpover scenario would be longer than for the Pamunkey River pumpover and would require crossing an additional river basin divide and the Pamunkey River. As a result, additional stream crossings and greater land disturbance would occur. Energy requirements to pump river withdrawals would also be greater, thereby creating additional energy consumption and associated impacts from increased energy production. With these increased construction and operating costs, total project costs for the Mattaponi River pumpover scenario would be higher with no reduction in impacts.

King William County has authority under the local consent provisions of Title 15.1 of the Code of Virginia, and other statutory authorities, to review and approve or disapprove any public water supply project components that would be built by any other jurisdiction and located in King William County. A more detailed discussion of the consent and zoning requirements under Virginia law is provided in Section 3.4.13. One of the key requirements for obtaining the County's local consent is the ability of an alternative to provide the County with a future water supply. Without a reservoir in King William County, Mattaponi River withdrawals would not supply the County with a reliable water supply during low flow periods when the MIF would prohibit river withdrawals. Therefore, the County has stated its opposition to a Mattaponi River withdrawal without a local reservoir (D. S. Whitlow, King William County, personal communication, 1992, and reconfirmed in May 1995). King William County has thus given a strong indication that it would deny local consent for the construction of the Mattaponi River intake structure, pumping station, and raw water transmission line required for this Ware Creek Reservoir pumpover alternative.

The RRWSG has concluded that based on the environmental, technical, and political constraints summarized above, a Mattaponi River pumpover to Ware Creek Reservoir is impracticable. Based on this evaluation, and the following practicability analysis for the Chickahominy River pumpover, the RRWSG has also concluded that only the Pamunkey River pumpover to Ware Creek Reservoir should be retained for further environmental analysis of this alternative.

Chickahominy Pumpover

The 0.8 mgd incremental safe yield benefit from raising the maximum Chickahominy River withdrawal to 61 mgd is not considered sufficient to justify its inclusion as part of this alternative.

Given the current regulatory emphasis on streamflow protection, increasing the maximum Chickahominy River withdrawal would likely trigger more restrictive MIF requirements. Therefore, increasing the maximum Chickahominy withdrawal, to supply and substantially augment the safe yield of Ware Creek Reservoir, is not considered to be available from a regulatory standpoint.

The Governor's conditional consent and approval of Little Creek Dam suggests that the maximum Chickahominy River withdrawal cannot be increased, at least without approval of the Governor.

The Chickahominy River is already critical to the welfare of the Lower Peninsula and excessive reliance on this single river source would not be prudent. Additional reliance on the Chickahominy would not provide a backup source in the event of water quality excursions or extreme low flows that severely limit Chickahominy River withdrawals. Also, with the uncertainties of future more restrictive MIF policies, it is not prudent to increase reliance on the Chickahominy River.

Several water quality concerns represent a considerable cumulative threat to long-term water quality in the Chickahominy River. Greater reliance on Chickahominy withdrawals would magnify this threat and would not provide an alternative source in the event of contamination.

Increasing the maximum Chickahominy River withdrawal to 61 mgd would raise the maximum withdrawal to 30 percent of average streamflow at the intake. There is no precedent in Virginia for this degree of reliance on a river source by a major municipal water purveyor.

Based on concerns with respect to reliability of water quality and quantity, increasing the maximum Chickahominy River withdrawal is not considered feasible as part of a long-term alternative.

For the reasons outlined above, increasing the maximum Chickahominy River withdrawal to 61 mgd or more, in conjunction with building Ware Creek Reservoir, is not considered practicable. Likewise, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.12 Ware Creek Reservoir With Pumpover From James River Above Richmond

Description

This alternative would involve a 75-mgd raw water intake and pumping station located on the James River, approximately 50 miles of 75 mgd-capacity river water pipeline, a 40-mgd intake and pump station near the Diascund Creek dam, a 4.9-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Ware Creek Reservoir, a 1,450-foot long dam on Ware Creek, and Ware Creek Reservoir withdrawal and transmission improvements.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 51-year simulation periods. Treated water safe yield benefits of 20.3 and 27.5 mgd were calculated for 40- and 75-mgd James River diversion capacities, respectively. These safe yield determinations are based on operation of Ware Creek Reservoir as an interconnected component of the existing Newport News Waterworks system. The assumed James River MIF and pumpover scenarios were identical to those used for the James River above Richmond without New Off-Stream Storage alternative (see Section 3.6.2).

Practicability Analysis

The RRPDC has taken a strong position against Lower Peninsula withdrawals from the James River above Richmond. This position indicates that this alternative is institutionally not permittable. Furthermore, the intense competition for James River water between the City of Richmond and Henrico County could severely delay any RRWSG efforts to pursue this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.13 Black Creek Reservoir with Pumpover From Pamunkey River

Description

This alternative would consist of the following components: a 120 mgd capacity raw water intake structure and pumping station on the Pamunkey River at Northbury in New Kent County; approximately 5 miles of 120 mgd capacity and 1.2 miles of 50 mgd capacity river water pipeline between the river pumping station and the two Black Creek Reservoir impoundments; a 1,200-foot long dam on the Southern Branch of Black Creek, creating a 462-acre impoundment with 2.91 billion gallons (BG) estimated gross storage at the normal pool elevation (100 feet msl); a 1,100-foot long dam on an unnamed eastern tributary of the Southern Branch of Black Creek (referred to in this report as the Eastern Branch), creating a 448-acre impoundment with 3.50 BG estimated gross storage at the normal pool elevation (100 feet msl); an intake structure in the Southern Branch impoundment, and a 20 mgd capacity, gravity flow pipeline connecting the two Black Creek reservoirs; a 40 mgd intake structure and pump station on the Eastern Branch of Black Creek; a 6.8 mile long 40 mgd raw water pipeline between Black Creek Reservoir and the headwaters of Diascund Creek Reservoir; a 40 mgd intake structure and pump station near the Diascund Creek dam; and a 5.5 mile long 40 mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir (see Figure 3-10 in Section 3.5).

The Eastern and Southern Branches join other tributaries to form the main stem of Black Creek, which flows into the Pamunkey River approximately 3.2 and 4.1 river miles downstream of the proposed Eastern and Southern Branch dams, respectively. The Black Creek Reservoir watershed is located entirely within New Kent County. The 120 mgd raw water intake and pumping station would be located in the vicinity of Northbury on the southern bank of the Pamunkey River in northwestern New Kent County, approximately 40 river miles upstream of the mouth of the Pamunkey River at West Point and approximately 3.7 river miles upstream of the mouth of Black Creek. Average streamflow in the Pamunkey River at the intake location is estimated at 774 mgd, based on an approximate contributing drainage area of 1,279 square miles (see Section 3.3.3).

From Northbury, water would be pumped to the two Black Creek Reservoirs through 5 miles of 66-inch, 120 mgd capacity pipeline. This raw water pipeline would run cross-country from the pump station site and along Route 606 in a southeasterly direction to the Eastern Branch outfall. That outfall would be located near the southern end of the Eastern Branch dam at elevation 100 feet msl, approximately 200 feet north of Route 606. From this Eastern Branch outfall, a 48-inch, 50 mgd raw water main would continue along Route 606 for approximately 1.2 miles to the Southern Branch impoundment. (This main would also be connected to a 42-inch main running from Black Creek Reservoir to Diascund Creek, to allow direct pumping from the Pamunkey River to Diascund Creek Reservoir.) A second Southern Branch outfall from the main running to Diascund Creek would be located approximately 0.2 miles west of the intersection of State Routes 606 and 609, south of Route 606. A second Eastern Branch outfall from the main running to Diascund Creek would be located approximately 0.3 miles north of the intersection of State Routes 606 and 609. These additional outfalls would allow Pamunkey River water to be discharged into the upper arms of both reservoir branches to improve reservoir flushing and water quality.

The Southern Branch of Black Creek would be impounded by construction of a 73-foot high, 1,200-foot long dam located approximately 1.3 miles south of Tunstall Station in western New Kent County. The 462-acre reservoir would drain 3.24 square miles and store 2.91 BG at a normal pool elevation of 100 feet msl. The Eastern Branch of Black Creek would be impounded by the construction of an 87-foot high, 1,100-foot long dam located approximately 0.5 miles east of Tunstall

Station. The 448-acre reservoir would drain 2.23 square miles and store 3.50 BG at a normal pool elevation of 100 feet msl. (The heights of both dams have been reduced to reflect the higher creek bottom elevations determined through the new topographic mapping efforts discussed below.) The combined reservoir surface area would be 910 acres, and the total reservoir storage volume would be 6.41 BG. Because dam construction and spillway design concepts are preliminary, it is possible that more detailed dam evaluations could lead to different recommended normal pool elevations. The proposed impoundment site on the Southern Branch of Black Creek is similar to that evaluated in the ***Comprehensive Water System Study*** (Malcolm Pirnie, 1978) prepared for the City of Newport News Department of Public Utilities.

The reservoir dimensions presented above have been updated from those presented in the DEIS. These new dimensional data were computed in December 1994 by Air Survey Corporation (ASC), based on digital files containing 1" = 100' scale topographic maps with 2-foot contour intervals compiled by photogrammetric methods from aerial photography previously taken by ASC on March 12, 1994. These dimensional estimates are considered to be more accurate than the previous estimates, which were based on planimetry of contours shown on much less detailed 1" = 2,000' scale USGS topographic maps with 10-foot contour intervals. The new 6.41 BG estimate of total reservoir volume is 23.5 percent less than the previous estimate (8.38 BG). The principal reason for the difference in volume calculations appears to be due to the large discrepancy in elevations between the USGS and ASC topographic maps. The differences are most marked at low points in the watershed, where ASC's elevations are much higher than those estimated from the USGS maps.

The increased accuracy of the ASC mapping is due, in large part, to the improved vertical and horizontal control established by ASC in March 1994. Within and immediately adjacent to the Black Creek Reservoir watershed, ASC placed 17 new surveyed monuments to aid in preparation of the contour mapping. ASC's new monuments were placed along State Routes 249, 610, 106, 609, 606, 608, and 612, and include a monument placed directly adjacent to Black Creek at the Route 608 crossing. By comparison, the USGS maps only show six bench marks within the same region represented by ASC's new monuments. The USGS bench marks are limited to four placed along State Route 249 between Quinton and Talleysville, one along the Southern Railway at Tunstall Station, and one at the intersection of State Routes 609 and 608. None of the USGS bench marks (in the region encompassed by ASC's new monuments) are directly adjacent to Black Creek or its tributaries.

The two reservoir branches would be hydraulically connected by a 3,600-foot long directionally drilled, 20 mgd capacity, 36-inch diameter pipeline. The pipeline would be located at a depth of approximately 60 feet msl, 40 feet below the normal pool elevation, and would allow water to flow between the reservoirs by gravity.

Water would be pumped from the reservoir on the Eastern Branch of Black Creek to the headwaters of Diascund Creek Reservoir. The 40 mgd water intake and pumping station would located approximately 0.3 miles off Route 606. The pump station wetwell would be tied into the reservoir interconnection pipeline, allowing the pump station to pump from the two reservoirs independently or simultaneously. A 6.8-mile, 42-inch, 40 mgd capacity pipeline would convey water from the reservoir pumping station southeast along Route 606, cross-country to State Route 33, and then southeast cross-country to an outfall on Diascund Creek.

The 6.8-mile pipeline route described above has been modified from the 7.5-mile route proposed in the DEIS, to avoid historic sites in New Kent County, including the St. Peters Church vicinity.

The raw water pipeline outfall would be located 0.8 miles southeast of the Route 608-Route 617 intersection and approximately 1.5 miles south of Carps Corner, where it would discharge at elevation 60 feet msl into Diascund Creek in New Kent County. This pipeline outfall is located approximately 5.7 river miles upstream of the normal pool area of Diascund Creek Reservoir.

As directed by the USCOE, the possibility of extending the pipeline from Black Creek Reservoir to a discharge point on the open water portion of Diascund Creek Reservoir also was considered. This pipeline extension would require approximately 30,000 additional feet of 42-inch diameter pipe. The line would be a pumped flow pipeline; therefore, a route following the high ground above the Diascund Creek valley would be possible. The present worth of the additional costs of extending the pipeline, including additional pumping power costs over the life of the project, is estimated to be $9.0 million.

A new 40 mgd capacity intake structure and pump station would be required at the Diascund Creek Reservoir dam, to convey water through a 5.5-mile, 42-inch 40 mgd capacity pipeline to the Little Creek Reservoir. The intake and pump station would be located adjacent to the existing pump station, and the pipeline would parallel the existing Diascund raw water transmission main.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. The Black Creek Reservoir project was evaluated as an interconnected component of the existing Newport News Waterworks system. The total treated water safe yield of this alternative is 21.1 mgd. The detailed methods of analysis used for estimating the safe yield of the Black Creek Reservoir alternative are presented in Section 3.3.3.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of a host jurisdiction allowance for New Kent County, where the reservoirs and most other components of the reservoir/river pumpover project would be located. As stated in Section 3.3.3, this host jurisdiction allowance has been assumed to be a 3 mgd treated water safe yield benefit. After subtracting the host jurisdiction allowance, the balance remaining for the RRWSG is 18.1 mgd (21.1 mgd - 3 mgd).

An analysis was also conducted to determine the estimated safe yield benefit of the Black Creek Reservoir using a 40/20 Tennant Pamunkey River MIF. The total treated water safe yield benefit of 18.1 mgd was derived after deducting the 3 mgd host jurisdiction treated water allowance that New Kent County would want at a minimum. This result does not differ from the aforementioned 18.1 mgd estimate that was based on a Modified 80 Percent Monthly Exceedence Flows MIF for the Pamunkey River. The 40/20 Tennant MIF does allow more water to be withdrawn from the Pamunkey River on an average annual basis. However, the 6.4 billion gallon reservoir site is storage limited under either MIF. That is, reservoir storage, rather than Pamunkey River withdrawals, seems to be the key factor which limits project safe yield.

New Kent County's comments on the DEIS advised the USCOE that it would not support a regional reservoir at Black Creek unless "a sufficient amount of that new supply were reserved for the use of New Kent County" and "unless New Kent County's water needs were fulfilled," which it noted "would require substantially more" than the 3 mgd host jurisdiction allowance that was used in the RRWSG's previous safe yield calculations (H. G. Hart, New Kent County, personal communication, 1994). However, the County's unwillingness to discuss the project since September 1994, or to develop an agreement resolving host jurisdiction needs, has prevented the RRWSG from defining an updated host jurisdiction allowance.

Subsequent to publication of the DEIS, New Kent County's Year 2040 treated water deficit was projected to be approximately 9 mgd (see Section 5.9.3). Although New Kent County cooperated in the preparation of the RRWSG's deficit projections for the County, they have been unwilling to discuss the amount of a potential host jurisdiction allowance from the proposed Black Creek Reservoir project. However, in their April 15, 1994 comments on the DEIS, the County presented projected water demands that could exceed 9 mgd by the Year 2010 (H. G. Hart, New Kent County, personal communication, 1994).

Practicability Analysis

When the DEIS was published in February 1994, the Black Creek Reservoir alternative was deemed practicable. However, in September 1994, New Kent County stated its opposition to the project and officially adopted a resolution not to cooperate in further analyses toward the RRWSG's possible development of a reservoir in Black Creek (R. J. Emerson, New Kent County, personal communication, 1994) and reiterated this position in April 1996 (E. D. Ringley, New Kent County, personal communication, 1996).

The CEQ's NEPA regulations require an examination of all reasonable alternatives to the applicant's proposal (40 CFR §1502.14). According to "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations" (published in the March 23, 1981 Federal Register), alternatives are considered reasonable if they are practical or feasible from the technical and economic standpoint, even if they cannot be carried out by the applicant.

Although the Black Creek alternative remains a reasonable alternative for a water supply reservoir, the District Engineer has determined that it is unavailable to the applicant as a practicable alternative at this time because of official opposition to the RRWSG's construction of the project in the host community. Therefore, in accordance with 33 CFR, Appendix B, this alternative is carried forward as a "No Action" alternative, and is described and compared in similar detail to the RRWSG's preferred alternative throughout the remainder of the document.

This section has been updated to present information on practicability considerations for which circumstances have changed since publication of the DEIS. It should be noted that the RRWSG's studies of the Black Creek Reservoir alternative were terminated by New Kent County's actions. As a result, available information regarding this alternative is not as complete as for other reservoir alternatives.

Host Jurisdiction Approval

The proposed Black Creek Reservoir and its drainage area lie entirely within New Kent County. Water would be pumped from the Pamunkey River, which is New Kent County's northern border, into the Black Creek Reservoir. New Kent County is not a member of the RRWSG. Under Virginia law, the proposed Black Creek Reservoir cannot be built without New Kent County's express consent and approval. The governing body (City Council or County Board of Supervisors) of a host locality must grant land use approvals and consents for another locality's development of public water supply facilities within its borders, under numerous provisions of Virginia law. These include zoning and local consent laws.

Zoning is governed by local ordinance (***New Kent County Zoning Ordinance***, 1991). Under the New Kent County Ordinance, a conditional use permit (sometimes called a special use permit or special exception) would be required to construct the necessary components of the Black Creek Reservoir project in New Kent County. A decision to grant or deny a conditional use permit is a "legislative" decision and will not be overturned by a court unless the decision is not "fairly debatable" (see, e.g., Virginia Supreme Court, 1982, Board of Supervisors of Fairfax County v. Southland Corp., 224 Virginia 514).

The local consent statutes, whose enactment was prompted by several water project disputes in the mid-1970s, are found in Virginia Code §15.1-37 (construction of dams for providing public water supply), §15.1-37.1 (construction of dams across navigable streams), §15.1-332.1 (impoundment of waters), §15.1-456 (conformity of public utility facilities with local comprehensive plans), §15.1-875 (water supply systems), and §15.1-1250.1 (water supply impoundment systems). Under each statute, the local governing body may grant or deny its consent to the proposed activity.

Most of those statutes (all except §15.1-456, which is discussed below) provide no standard whatever for the host jurisdiction's decision; they simply require its consent. Denial of local consent under those statutes is subject to review by a three-judge special court which must "balance the equities" and "determine the necessity for and expediency of the . . . proposed action and the best interests of the parties," and which has the authority to "determine the terms and conditions of the action" (Virginia Code §§15.1-37.1:2, 15.1-37.1:3).

An adverse decision under the comprehensive planning law, §15.1-456, may be challenged in an action in the Circuit Court for the locality making the decision. In the only known case decided under that law, the Brunswick County Circuit Court issued an opinion that reversed the County's denial of a §15.1-456 approval for the City of Virginia Beach's Lake Gaston pipeline project, on the ground that it stated no reasons for denial and therefore was "arbitrary."

RRWSG representatives met with New Kent County officials beginning in June 1992, in an attempt to negotiate a Black Creek Reservoir project development agreement. On some occasions prior to late 1994, New Kent County indicated a degree of willingness to work with the RRWSG on the development of a Black Creek Reservoir project. In fact, the County stated in its April 15, 1994, comments to the USCOE on the DEIS (H. G. Hart, New Kent County, personal communication, 1994) that it was:

> *"not adverse to the construction of a regional reservoir at Black Creek, but our support for such a project would only be granted if a sufficient amount of that new supply were reserved for the use of New Kent County."*

Negotiations with New Kent County came to an abrupt halt when the Acting County Administrator sent a September 20, 1994 letter to the City of Newport News (R. J. Emerson, New Kent County, personal communication, 1994) which stated that the New Kent County Board of Supervisors adopted a motion on September 19, 1994, *"requesting Newport News to discontinue all work concerning the Black Creek Reservoir"* and directing the Acting County Administrator to transmit a letter *"informing you [that] the Board of Supervisors of New Kent County has no intent to cooperate with Newport News on the Black Creek Reservoir at this time."* The County further requested that the RRWSG *"discontinue all work on the [Black Creek] reservoir project."*

The USACOE sent a March 29, 1996 letter to New Kent County concerning potential changes in the County's position on the Black Creek Reservoir alternative (R. H. Reardon, USACOE, personal communication, 1996). In response, the County Board of Supervisors stated in an April 23, 1996 letter to the USACOE that: *"The Board of Supervisors remains committed not to cooperate with Newport News toward the possible development of a water supply reservoir on Black Creek for Newport News or the RRWSG"* and *"There are no proffers from the Regional Raw Water Study Group that would facilitate further negotiations"* (E. D. Ringley, New Kent County, personal communication, 1996). A concern for *"any proposed withdrawal from the Pamunkey River or any wastewater discharge into the Pamunkey River from any source"* was also expressed.

The County has the authority under Virginia law to deny the local consent and special use permit approvals that would be required for the RRWSG or Newport News to develop the Black Creek Reservoir project; and an effort to overturn its denials in the courts could be a long, complex, expensive, and ultimately uncertain endeavor. If the County's own long-term water needs are large, in comparison to the yield of Black Creek Reservoir, it may be unlikely that the County would allow another entity to build and own the project.

Life Cycle Project Costs

A preliminary project cost estimate has been made for the Black Creek Reservoir with pumpover from the Pamunkey River alternative (see Table 3-1A). This cost estimate has been revised to account for the reduced dam embankment sizes (due to higher creek bottom elevations determined through recent topographic mapping efforts) and the new route proposed for the pipeline from Black Creek Reservoir to Diascund Creek. The Year 1992 present value of the life cycle costs of the project, including land acquisition, construction, and operation and maintenance, is $118.3 million.

To allow comparison of this alternative's costs to those of other alternatives, the life cycle cost of water treatment and transmission to the Lower Peninsula service areas must be considered. For the 21.1 mgd combined RRWSG and New Kent County treated water safe yield benefit calculated for this alternative, the Year 1992 present value of life cycle costs for treatment and transmission is estimated at $19.8 million. The cost of providing treated water to New Kent County could increase this estimate since a smaller-scale treatment facility to serve the County's needs would not have the economy of scale associated with much larger treatment facilities serving the Lower Peninsula.

Summing these estimates yields a total project life cycle cost estimate of $138.1 million, or $6.5 million per mgd of total treated water safe yield benefit. For this cost analysis, it has been assumed that New Kent County would pay for its share of the project safe yield. The assumed 3 mgd treated water host jurisdiction allowance represents approximately 14 percent of the project's total treated water safe yield (21.1 mgd). If New Kent County pays for its pro-rata share of project safe yield, the RRWSG share of the total project life cycle cost estimate would be approximately $118.3 million, or 86 percent of the total cost ($138.1 million).

TABLE 3-1A

BLACK CREEK RESERVOIR WITH PUMPOVER FROM THE PAMUNKEY RIVER PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$5,600	5	$30,000
Pipeline Easements, River to BC Res. – Acres (1)	$2,000	43	$86,000
Reservoir and Buffer – Acres (1)	$1,500	1300	$1,950,000
Pipeline Easements, BC Res. to Dias. – Acres(2)	$1,000	34	$34,000
Soil Borrow Area – Acres(2)	$1,500	150	$230,000
Mitigation Area – Acres(2)	$1,500	350	$530,000
TOTAL LAND ACQUISITION COSTS			**$2,860,000**
CONSTRUCTION			
120 mgd Pamunkey Pump Station and Intake – LS			$13,000,000
66–Inch Transmission Main to Eastern Branch BC Res. – LF	$325	26400	$8,580,000
48–Inch Transmission Main to Southern Branch BC Res. – LF	$225	6300	$1,420,000
Reservoir Clearing up to 94' msl – Acres	$2,250	950	$2,140,000
EB Dam, Clearing – LS			$200,000
EB Dam, Excavation – LS			$1,200,000
EB Dam, Slurry Wall – LS			$1,000,000
EB Dam, Embankment – LS			$7,000,000
EB Dam, Emergency Spillway – LS			$1,000,000
EB Dam, Release Structure – LS			$400,000
EB Dam, Raising Route 609 – LS			$250,000
SB Dam, Clearing – LS			$200,000
SB Dam, Excavation – LS			$700,000
SB Dam, Slurry Wall – LS			$800,000
SB Dam, Embankment – LS			$5,000,000
SB Dam, Emergency Spillway – LS			$1,000,000
SB Dam, Release Structure – LS			$400,000
SB Dam, Raising Route 249 – LS			$1,000,000
36–Inch Dir. Drilled Reservoir Transfer Pipeline – LF	$700	3600	$2,520,000
Southern Branch Res. Transfer Pipeline Intake Structure – LS			$1,000,000
40 mgd Black Creek P.S., Intake and Transfer Pipeline Structure – LS			$6,500,000
42–Inch Trans. Main to Diascund Creek – LS	$200	35900	$7,180,000
42–Inch Outfall Branches to B.C. –	$200	2100	$420,000
40–mgd Diascund Pump Station and Intake – LS			$5,600,000
42–Inch Transmission Main to Little Creek – LF	$200	29000	$5,800,000
Mitigation, On–site Berms and Dams – LS			$1,500,000
Mitigation, Off–site Fish Hatchery Imp. – LS			$550,000
Mitigation, Off–site Dam Breaching and Imp. – LS			$550,000
SUBTOTAL			**$76,910,000**
Permitting, Preliminary Engineering & Legal (5%)			$3,850,000
Design, Construction Management & Administration (12%)			$9,230,000
Contingencies (20%)			$18,000,000
TOTAL CONSTRUCTION COSTS			**$107,990,000**

TABLE 3-1A

BLACK CREEK RESERVOIR WITH PUMPOVER FROM THE PAMUNKEY RIVER PROJECT COST ESTIMATE (Continued)

COST CATEGORY Item	Unit Cost	Quantity	Totals
OPERATION AND MAINTENANCE			
Electric Power for Pumping -LS	Pamunkey P.S.		$1,754,401
	Black Creek P.S.		$816,554
	Diascund P.S.		$668,366
Operations and Maintenance -LS	Pamunkey P.S./Pipeline		$1,668,237
	Black Creek P.S./Pipeline		$1,668,237
	Diascund P.S./Pipeline		$834,119
TOTAL OPERATION AND MAINTENANCE COSTS			**$7,410,000**
TOTAL YEAR 1992 PRESENT VALUE COST			**$118,260,000**

Notes:

All costs in Year 1992 dollars.

1) New Kent County would acquire and lease to RRWSG jurisdictions.

2) RRWSG jurisdictions would acquire.

3.4.14 Black Creek Reservoir With Pumpover From James River Above Richmond

Description

This alternative would consist of the following components: a 75 mgd raw water intake structure and pumping station, located on the James River above Richmond's Bosher Dam, in Chesterfield County; approximately 43 miles of 75 mgd capacity river water pipeline between the river pumping station and Black Creek Reservoir; a 1,200-foot long dam on the Southern Branch of Black Creek, creating a 462-acre impoundment with 2.91 BG estimated gross storage at the normal pool elevation (100 feet msl); a 1,100-foot long dam on the Eastern Branch of Black Creek, creating a 448-acre impoundment with 3.50 BG estimated gross storage at the normal pool elevation (100 feet msl); an intake structure in the Southern Branch impoundment, and a 20 mgd capacity, gravity flow pipeline connecting the two Black Creek reservoirs; a 40 mgd intake structure and pump station on the Eastern Branch of Black Creek; a 6.8 mile long 40 mgd raw water pipeline between Black Creek Reservoir and the headwaters of Diascund Creek Reservoir; a 40 mgd intake structure and pump station near the Diascund Creek dam; and a 5.5 mile long 40 mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

The 75 mgd raw water intake structure and pumping station would be located 2.7 river miles upstream of Richmond's Bosher Dam on the southern bank of the James River in Chesterfield County, approximately 121.9 river miles upstream of the mouth of the James River. Average streamflow in the James River at the intake location is estimated at 4,871 mgd, based on an approximate contributing drainage area of 6,758 square miles.

From the James River pumping station, water would be pumped to Black Creek Reservoir through 43 miles of 60-inch, 75 mgd capacity pipeline in Chesterfield, Henrico, Charles City, and New Kent Counties. The raw water pipeline would leave the pumping station site and follow an existing pipeline right-of-way (ROW) south through Chesterfield County for 6.6 miles to a point approximately 0.8 miles north of the Powhite Parkway - Route 288 interchange. At this point, the pipeline would turn and follow an existing power line ROW southeast towards Centralia for 13.7 miles. Along this portion of the route, the pipeline would cross Powhite Parkway, U.S. Route 360, State Routes 10 and 288, and Falling, Licking, Reedy, and Proctors Creeks. Southeast of Centralia, the pipeline would follow the power line ROW east for 2.8 miles across State Route 288, U.S. Route 1, and Interstate 95, to the James River just north of the Virginia Power Dutch Gap Power Station. The pipeline would cross the James River at Dutch Gap by directional drill and continue northeast for approximately 6.5 miles along a power line ROW, crossing Roundabout Creek, State Route 5, and Interstate 295, en route to another existing power line ROW east of Varina Grove. The pipeline would continue northeast from this point for approximately 13.4 miles to an outfall site at the headwaters of the Southern Branch of Black Creek. Along this portion of the route, the pipeline would cross State Routes 156 and 249, the CSX Railroad, U.S. Route 60, and Interstate 64. The outfall would be located at elevation 100 feet msl approximately 1 mile east of the intersection of State Routes 249 and 612.

The other components of this alternative are described in Section 3.4.13 including updated reservoir dimensions and pipeline routes.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for a 51-year simulation period. (The 51-year simulation period is shorter than that used for the preceding Black Creek alternative because a shorter streamflow record was available for the James River near Richmond gage than for Pamunkey River Basin gages.) The Black Creek Reservoir project was evaluated as an interconnected component of the existing Newport News Waterworks system. The total treated water safe yield of this alternative is 24.8 mgd. The detailed methods of analysis used for estimating the safe yield of the Black Creek Reservoir alternative are presented in Section 3.3.3 and in Report D, ***Alternatives Assessment: (Volume I - Practicability Analysis)*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of a host jurisdiction allowance for New Kent County, where the reservoirs and many other components of the reservoir/river pumpover project would be located. As explained in the DEIS, this host jurisdiction allowance has been assumed to be a 3 mgd treated water safe yield benefit; however, as discussed in Sections 3.3.3 and 3.4.13, the full extent of New Kent County's projected needs would not be served by the project. After subtracting the host jurisdiction allowance, the balance remaining for the RRWSG is 21.8 mgd (24.8 mgd - 3 mgd).

Practicability Analysis

Host Jurisdiction Approval

As discussed in Section 3.4.13, New Kent County is opposed to development of the Black Creek Reservoir by the RRWSG. In addition, Richmond area localities, acting through the Richmond Regional Planning District Commission (RRPDC), have taken a strong position against withdrawals by the Lower Peninsula jurisdictions from the James River above Richmond, and this project could not be developed without approvals from several of its member jurisdictions (i.e., Chesterfield, Henrico, Charles City, and New Kent Counties) under applicable zoning and local consent laws (see discussion in Section 3.4.13). Furthermore, Henrico County's plans for withdrawals of up to 55 mgd from the James River above Richmond could delay any RRWSG efforts to pursue this alternative.

Life Cycle Project Costs

A preliminary project cost estimate has been made for the Black Creek Reservoir with pumpover from the James River alternative (see Table 3-1B). This cost estimate has been revised to account for the reduced dam embankment sizes (due to higher creek bottom elevations determined through recent topographic mapping efforts) and the new route proposed for the pipeline from Black Creek Reservoir to Diascund Creek. The Year 1992 present value of the life cycle costs of the project, including land acquisition, construction, and operation and maintenance, is $197.8 million.

To allow comparison of this alternative's costs to those of other alternatives, the life cycle cost of water treatment and transmission to the Lower Peninsula service areas must be considered. For the 24.8 mgd combined RRWSG and New Kent County treated water safe yield benefit calculated for this alternative, the Year 1992 present value of life cycle costs for treatment and transmission is estimated at $23.3 million. The cost of providing treated water to New Kent County could increase

TABLE 3-1B

BLACK CREEK RESERVOIR WITH PUMPOVER FROM THE JAMES RIVER PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$20,000	5	$100,000
Pipeline Easements, Urban/Suburban – Acres (1)	$10,000	90	$900,000
Pipeline Easements, Rural – Acres	$1,000	200	$200,000
Reservoir and Buffer – Acres (2)	$1,500	1300	$1,950,000
Soil Borrow Area – Acres(3)	$1,500	150	$230,000
Mitigation Area – Acres(3)	$1,500	350	$530,000
TOTAL LAND ACQUISITION COSTS			**$3,910,000**
CONSTRUCTION			
75 mgd James Pump Station and Intake – LS			$10,000,000
60-Inch Transmission Main to James River – LF	$300	122000	$36,600,000
42-Inch Directional Drill – LF	$850	2000	$1,700,000
60-Inch Transmission Main to BC Res. – LF	$300	103000	$30,900,000
Reservoir Clearing up to 94' msl – Acres	$2,250	950	$2,140,000
EB Dam, Clearing – LS			$200,000
EB Dam, Excavation – LS			$1,200,000
EB Dam, Slurry Wall – LS			$1,000,000
EB Dam, Embankment – LS			$7,000,000
EB Dam, Emergency Spillway – LS			$1,000,000
EB Dam, Release Structure – LS			$400,000
EB Dam, Raising Route 609 – LS			$250,000
SB Dam, Clearing – LS			$200,000
SB Dam, Excavation – LS			$700,000
SB Dam, Slurry Wall – LS			$800,000
SB Dam, Embankment – LS			$5,000,000
SB Dam, Emergency Spillway – LS			$1,000,000
SB Dam, Release Structure – LS			$400,000
SB Dam, Raising Route 249 – LS			$1,000,000
36-Inch Dir. Drilled Reservoir Transfer Pipeline – LF	$700	3600	$2,520,000
Southern Branch Res. Transfer Pipeline Intake Structure – LS			$1,000,000
40 mgd Black Creek Pump Station and Intake – LS			$6,500,000
42-Inch Trans. Main to Diascund Creek – LS	$200	35900	$7,180,000
42-Inch Outfall Branches to B.C. – LS	$200	2100	$420,000
40-mgd Diascund Pump Station and Intake – LS			$5,600,000
42-Inch Transmission Main to Little Creek – LF	$200	29000	$5,800,000
Mitigation, On-site Berms and Dams – LS			$1,500,000
Mitigation, Off-site Fish Hatchery Imp. – LS			$550,000
Mitigation, Off-site Dam Breaching and Imp. – LS			$550,000
SUBTOTAL			**$133,110,000**
Permitting, Preliminary Engineering & Legal (5%)			$6,660,000
Design, Construction Management & Administration (12%)			$15,970,000
Contingencies (20%)			$31,150,000
TOTAL CONSTRUCTION COSTS			**$186,890,000**

TABLE 3–1B

BLACK CREEK RESERVOIR WITH PUMPOVER FROM THE JAMES RIVER
PROJECT COST ESTIMATE
(Continued)

COST CATEGORY Item		Unit Cost	Quantity	Totals
OPERATION AND MAINTENANCE				
Electric Power for Pumping – LS	James P.S.			$1,280,314
	Black Creek P.S.			$853,451
	Diascund P.S.			$736,085
Operations and Maintenance – LS	James P.S./Pipeline			$1,668,237
	Black Creek P.S./Pipeline			$1,668,237
	Diascund P.S./Pipeline			$834,119
TOTAL OPERATION AND MAINTENANCE COSTS				**$7,040,000**
TOTAL YEAR 1992 PRESENT VALUE COST				**$197,840,000**

Notes:

All costs in Year 1992 dollars.

1) Chesterfield County would acquire and lease to RRWSG jurisdictions.

2) New Kent County would acquire and lease to RRWSG jurisdictions.

3) RRWSG jurisdictions would acquire.

this estimate since a smaller-scale treatment facility to serve the County's needs would not have the economy of scale associated with much larger treatment facilities serving the Lower Peninsula.

Summing these estimates yields a total project life cycle cost estimate of $221.1 million, or $8.9 million per mgd of total treated water safe yield benefit. These estimated unit costs are more than 10 percent above the RRWSG's adopted cost feasibility level which equates to approximately $8 million per mgd of treated water safe yield. (Unit costs above this level for an alternative yielding approximately 30 mgd would result in projected household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula median household income.) For this reason, this alternative is considered economically infeasible and impracticable at this time.

For this cost analysis, it has been assumed that New Kent County would pay for its share of the project safe yield. The assumed 3 mgd treated water host jurisdiction allowance represents approximately 12 percent of the project's total treated water safe yield (24.8 mgd). If New Kent County pays for its pro-rata share of project safe yield, the RRWSG share of the total project life cycle cost estimate would be approximately $194.6 million, or 88 percent of the total cost ($221.1 million).

3.4.15 King William Reservoir With Pumpover From Mattaponi River

Description

This alternative would consist of the following components: a 75 mgd raw water intake structure and pumping station, located on the Mattaponi River at Scotland Landing, in King William County; approximately 1.5 miles of 54-inch, 75 mgd capacity river water pipeline between the river pumping station and King William Reservoir; a dam on Cohoke Creek; an intake structure in the Cohoke Creek impoundment; a 50 mgd pump station at the King William Reservoir dam site (for KWR-II, KWR-III, and KWR-IV configurations); a raw water pipeline between King William Reservoir and Diascund Creek Reservoir; a 40 mgd intake structure and pump station near the Diascund Creek dam; and a 5.5-mile, 40 mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir (see Figures 3-11 and 3-11A in Section 3.5).

Cohoke Creek flows into the Pamunkey River approximately 3.3 river miles downstream of the proposed dam. The Cohoke Creek watershed is located entirely in King William County. The 75 mgd raw water intake structure and pumping station would be located at Scotland Landing, on the southern bank of the Mattaponi River in King William County, 24.2 river miles upstream from the mouth of the Mattaponi River at West Point. Average streamflow in the Pamunkey River at the intake location is estimated at 494 mgd, based on an approximate contributing drainage area of 781 square miles (see Section 3.3.3).

From Scotland Landing, water would be pumped to the King William Reservoir through 1.5 miles of 54-inch, 75 mgd capacity pipeline. This raw water pipeline would run cross-country from the pump station site in a southwesterly direction, crossing State Route 30, and discharging to the reservoir in the headwaters of Cohoke Creek. The reservoir outfall would be located approximately 2 miles southeast of King William Courthouse.

Four King William Reservoir configurations were evaluated and are compared in the following table:

Dam Site	Normal Pool Elevation (feet, msl)	Normal Pool Area (acres)	Total Volume (BG)
KWR-I (Originally Proposed)	90	2,284	21.2
KWR-II (RRWSG's Preferred Site)	96	2,222	21.2
KWR-III	96	1,909	16.6
KWR-IV (Currently Proposed)	96	1,526	12.2

For the RRWSG's originally proposed KWR-I configuration, Cohoke Creek would be impounded by construction of a 92-foot high, 2,400-foot long dam located approximately 1.8 miles upstream of the existing Cohoke Millpond dam. The 2,284-acre reservoir would drain 13.17 square miles and store 21.2 BG at a normal pool elevation of 90 feet msl.

For the RRWSG's preferred KWR-II configuration, Cohoke Creek would be impounded by construction of a 92-foot high, 2,400-foot long dam located approximately 2.4 miles upstream of the existing Cohoke Millpond dam. The 2,222-acre reservoir would drain 11.45 square miles and store 21.2 BG at a normal pool elevation of 96 feet msl.

The reservoir configuration and dimensions presented above, for the RRWSG's preferred KWR-II configuration, have been updated from those presented in the DEIS for the originally proposed KWR-I configuration. The Cohoke Creek dam site has been moved approximately 2,900 feet upstream of the originally proposed KWR-I dam site. A 6-foot increase in the proposed reservoir normal pool elevation (from elevation 90 to 96 feet msl) was also incorporated to maintain the original KWR-I reservoir volume. Principal benefits of the KWR-II reservoir reconfiguration include:

- Reduction in the area of wetlands inundated. Virtually all of the wetlands in the King William Reservoir impoundment site are located below 90 feet msl. Moving the dam upstream by 2,900 feet would avoid inundation of 94 acres of wetlands. However, raising the normal pool elevation by 6 feet would inundate an additional 15 acres of wetlands above elevation 90 feet msl in the reconfigured reservoir. Therefore, the net reduction in total wetlands inundated by the reservoir would be 79 acres (574 acres for KWR-II configuration versus 653 acres for KWR-I configuration) as a result of moving the dam site upstream.
- Avoidance of potential impacts to Bald Eagles which occupy a nest along Cohoke Creek just downstream of the originally proposed KWR-I dam site.
- Reduced volume of material required for dam embankment construction and closer proximity of proposed soil borrow area to new dam site. This would result in a $7.7 million reduction in estimated Year 1992 dam embankment construction costs, from $19.7 million to $12.0 million.

Under contract with the RRWSG, Air Survey Corporation (ASC) prepared new detailed topographic maps of the reservoir area. ASC conducted its aerial photography flights on February 17, 1994. In July 1994, ASC computed the dimensions of the reservoir, both as originally proposed (KWR-I) and with the KWR-II dam location. These computations were made from ASC's digital files containing 1" = 200' scale topographic maps with 2-foot contour intervals compiled by photogrammetric methods from ASC's aerial photographs. These dimensional estimates are considered to be more accurate than the previous estimates, which were based on planimetry of contours shown on 1" = 2,000' scale USGS topographic maps with 10-foot contour intervals.

The volume of the reservoir would not be substantially changed as a result of moving the dam upstream from dam site KWR-I to KWR-II and raising the normal pool elevation by 6 feet to elevation 96 feet msl. Moving the dam upstream, while keeping the normal pool elevation as originally proposed (90 feet msl), would reduce the reservoir volume by 4.23 BG. However, by raising the normal pool elevation by 6 feet at the new dam location, the volume of the reservoir would be increased by 4.22 BG. Because the Cohoke Creek bottom elevation is higher at the RRWSG's preferred KWR-II dam site than at the originally proposed KWR-I dam site, the height of the dam would not change, despite the higher normal pool elevation.

The USCOE directed consideration of additional upstream dam configurations for this alternative (i.e., KWR-III and KWR-IV). For the KWR-III configuration, Cohoke Creek would be impounded by construction of an 83-foot high, 4,400-foot long dam located approximately 3.0 miles upstream of the existing Cohoke Millpond dam and 0.7 miles downstream of the Route 626 crossing of Cohoke Creek. The 1,909-acre reservoir would drain 10.33 square miles and store 16.6 BG at a normal pool elevation of 96 feet msl.

For the RRWSG's currently proposed KWR-IV configuration, Cohoke Creek would be impounded by construction of a 78-foot high, 1,700-foot long dam located approximately 3.5 miles upstream of the existing Cohoke Millpond dam and 0.2 miles downstream of the Route 626 crossing of Cohoke Creek. The 1,526-acre reservoir would drain 8.92 square miles and store 12.2 BG at a normal pool elevation of 96 feet msl. Because dam construction and spillway design concepts are preliminary, it is possible that further studies could lead to a different recommendation about the normal pool elevation and, consequently, change the reservoir's capacity. The currently proposed KWR-IV dam site is located approximately 1.7 miles upstream of the originally proposed KWR-I dam site and would involve a corresponding storage reduction of 9.0 BG.

As directed by the USCOE, the possibility of extending the King William Reservoir (KWR-I configuration) gravity flow pipeline to a discharge point on the open water portion of Diascund Creek Reservoir was also considered. This pipeline extension would require approximately 8,000 additional feet of 60-inch diameter pipe. To maintain the gravity flow capability of the KWR-I pipeline, the pipeline route would have to follow the course of Beaverdam Creek from the originally proposed outfall location to the reservoir. The pipeline would be laid along the western edge of the bottomland of Beaverdam Creek. The total additional present worth cost of extending the pipeline is estimated to be $4.0 million. Because this would be a substantial additional expenditure, extension of the KWR-I gravity flow pipeline all the way to the pool of Diascund Creek Reservoir was not incorporated in the alternative. However, in order to minimize potential erosional effects, the Beaverdam Creek outfall location was extended 0.5 miles farther downstream for the KWR-II, KWR-III, and KWR-IV configurations. The potential hydrologic impacts of the proposed Beaverdam Creek outfall are discussed in Section 5.2.3.

For the KWR-I configuration, 10.0-mile, 42-inch and 60-inch pipeline would convey water south from the reservoir across the Pamunkey River to elevation 35 feet msl on Beaverdam Creek in New Kent County. This pipeline would initially operate in a gravity flow mode, with a capacity of approximately 30 mgd. In the future, as demands increase, a reservoir pump station would be constructed to increase the pipeline's capacity to 40 mgd.

The reservoir pump station was not required for the originally proposed configuration (KWR-I). As originally proposed, the minimum reservoir pool elevation would have been 70 feet msl (i.e., 20-foot maximum drawdown, preserving 47 percent dead storage), and the pipeline would have discharged farther upstream on Beaverdam Creek. Under the RRWSG's preferred configuration (KWR-II), the minimum reservoir pool elevation would be 64 feet msl (i.e., 32-foot maximum drawdown, preserving 25 percent dead storage), the outfall would be at 30.5 feet msl, and the pipeline would be longer. When the reservoir is drawn down to 64 feet msl, the reduced hydraulic head would have reduced the capacity of a gravity pipeline to approximately 25 mgd.

The reduction in the amount of dead storage (from 47% to 25%) would lead to larger fluctuations in reservoir operating levels and, therefore, increase the duration of periods when recreational use of the reservoir would be limited. However, using more of the total reservoir storage would offer greater flexibility in the timing of Mattaponi River withdrawals. The original project safe yield benefit could be maintained under a more restrictive river MIF than the originally proposed 40/20 Tennant MIF, whereas project safe yield could be enhanced if the 40/20 Tennant MIF was retained.

The KWR-II, KWR-III, and KWR-IV configurations would include a 50 mgd reservoir pump station at the King William Reservoir dam site. The 50 mgd capacity pipeline would have inside diameters of 42 and 48 inches. The pipeline would leave the reservoir from a location just north of Cohoke Millpond and run south through the community of Cohoke in King William County and into New Kent County. Along this portion of the route, the pipeline would cross under the bed of the Pamunkey River in a directionally-drilled pipeline crossing. The pipeline then would run southeast crossing Routes 628, 249, and 33, to the discharge point on Beaverdam Creek, which is a major tributary of Diascund Creek Reservoir. The gravity pipeline terminus would be located approximately 0.6 miles southeast of the Interstate 64 - Route 33 interchange, 0.3 river miles upstream of where Beaverdam Creek flows under a 75-foot long bridge on Interstate 64, and 0.8 river miles upstream of the normal pool area of Diascund Creek Reservoir.

The overall 10.4-, 11.2-, and 11.7 -mile pipeline routes described above for the KWR-II, KWR-III and KWR-IV configurations have been modified from the route for KWR-I described in the DEIS. The modifications were made to account for the Cohoke Creek dam site being moved farther upstream, to minimize potential conflicts with private landowners in New Kent County, and to minimize potential erosional impacts to Beaverdam Creek.

A new 40 mgd capacity intake structure and pump station would be required at the Diascund Creek Reservoir dam, to convey water through a 5.5-mile, 42-inch 40 mgd capacity pipeline to the Little Creek Reservoir. The intake and pump station would be located adjacent to the existing pump station, and the pipeline would parallel the existing Diascund raw water transmission main.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. The King William Reservoir project was evaluated as an interconnected component of the existing Newport News Waterworks system. The new reservoir configuration and 25 percent dead storage assumption were incorporated into this analysis. In addition, the assumed Mattaponi River MIF was made comparable to that proposed for the Pamunkey River. Use of the Modified 80 Percent Monthly Exceedance Flows MIF developed for the Mattaponi River (instead of the originally proposed 40/20 Tennant MIF assumed for the KWR-I configuration) would preserve the general shape of the Mattaponi River's natural seasonal hydrograph and establish monthly MIF levels which are higher for each month of the year. The total treated water safe yield of the RRWSG's preferred KWR-II configuration is 29.0 mgd. The detailed methods of analysis used for estimating the safe yield of the King William Reservoir alternative are presented in Section 3.3.3.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of host jurisdiction allowances for King William and New Kent Counties, where the reservoir and most other components of the reservoir/river pumpover project would be located. Owing to conditions set forth in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), King William County has the option to reserve up to 3 mgd of the King William Reservoir capacity. In addition, the City of Newport News has executed a Project Development Agreement with New Kent County which guarantees the County up to 1 mgd of raw water safe yield if the King William Reservoir project is developed. The treated water safe yield remaining for the RRWSG is 25.4 mgd. This is based on a total treated water safe yield of 29.0 mgd for the RRWSG's preferred KWR-II configuration, less 3.6 mgd of treated water safe yield due to 4 mgd in host jurisdiction raw water allowances. (The 3.6 mgd treated water reduction is equivalent to a 4 mgd raw water safe yield reduction after estimated treatment and transmission losses are factored into the calculation).

Safe yield estimates for four King William Reservoir project configurations are presented below. Dimensions for each reservoir configuration are presented in Section 3.3.3. The KWR-II and KWR-III configuration safe yield estimates included the application of the Modified 80 Percent Monthly Exceedence Flows MIF. A 40/20 Tennant MIF was used for KWR-I. To provide a sufficient safe yield benefit for the storage limited KWR-IV configuration and minimize reservoir drawdown, the originally proposed 40/20 Tennant MIF was retained for KWR-IV.

Project Configuration	Dead Storage %	Treated Water Safe Yield (mgd, Total/RRWSG)	
		40/20 Tennant MIF	80% Exceedance MIF
KWR-I	25	30.7/27.1	--
KWR-II	25	--	29.0/25.4
KWR-III	25	--	25.3/21.7
KWR-IV	25	26.8/23.2	--

The location of the dam site and pipeline route for each of the above configurations is depicted in Plate 2 (see map pocket at rear of report).

A King William Reservoir scenario involving no pumpover from either the Mattaponi River or Pamunkey River was also considered. Based on 11.45 square miles of drainage area for KWR-II, the estimated average surface water inflow to the reservoir would be about 8 mgd. From this amount would be subtracted a 3 mgd normal reservoir release, reservoir seepage losses (2 mgd allowance), 3 mgd for King William County, and 1 mgd for New Kent County. The average surface water runoff rate is not sufficient to offset these allowances and, consequently, there would be no safe yield benefit for the RRWSG.

Practicability Analysis

Based on information compiled to date, there is no basis for deeming this alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

This section has been updated to present information on practicability considerations for which circumstances have changed since publication of the DEIS.

Host Jurisdiction Approval

The proposed King William Reservoir and its drainage area lie entirely within King William County. Because King William County is not currently a member of the RRWSG, the County's approval would be critical to the RRWSG's successful implementation of this project. To this end, King William County and the City of Newport News signed the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990) and subsequent Addenda Numbers 1 and 2 (King William County and City of Newport News, 1992 and 1995). The Agreement and Addenda outline the terms and conditions upon which cooperative development of the King William Reservoir project could proceed. Under this Agreement, King William County has the option to construct, own, and operate a separate King William Reservoir intake structure and pumping facility for raw water withdrawals of up to 3 mgd.

Provisions for recreational use of King William Reservoir also are included as part of the Project Development Agreement. For example, public use of the reservoir would be allowed through at least five access sites mutually agreed upon by the City of Newport News and King William County. Recreational activities such as swimming, fishing, and boating (excluding the use of internal combustion engines) would be allowed in the reservoir.

As previously mentioned, the reduction in proposed reservoir dead storage to 25 percent of total volume would lead to larger fluctuations in reservoir operating levels. An analysis of predicted reservoir operating levels over the entire 58-year safe yield simulation period, under projected Year 2040 demand conditions, showed that during 71 and 84 percent of the time, water surface elevations within the reservoir would be within 5 and 10 feet, respectively, of the 96-foot spillway elevation (for KWR-II configuration). (Prior to the Year 2040, water level drawdowns would be smaller because lower demands would be made on the reservoir.) The average water level predicted in these simulations was 91.7 feet msl, which is only 4.3 feet below the proposed spillway elevation. Under the originally proposed KWR-I configuration, a maximum reservoir drawdown of 20 feet was assumed. Under the RRWSG's preferred KWR-II configuration, reservoir drawdowns of more than 20 feet would occur about 5 percent of the time.

Under projected Year 2040 demand conditions, full recreational use could still continue during approximately 95 percent of the months in the simulation period. During the earlier years of reservoir use, before the Year 2040 demand conditions are reached, the larger drawdowns and consequent reduction of recreational opportunities would be even less frequent.

King and Queen County Claim to Mattaponi River

In King and Queen County's April 19, 1994 comments on the DEIS, the County's attorney asserted that the stretch of the Mattaponi River contiguous to King William County lies entirely within King and Queen County. King and Queen County relies, in part, on the 1702 Act of the Virginia General Assembly by which King William County was formed from a part of King and Queen County. That Act assigns territory on each "side" of the Mattaponi River to the respective Counties, but it does not appear to support King and Queen County's claim that the boundary lies on the south (King William County) bank of the Mattaponi River.

The general rule concerning boundaries along waterways holds that the boundary is the center of the channel, unless otherwise expressly stated in the legislation creating the boundary. Moreover, Virginia law provides that in determining the location of territorial boundaries specified in legislative acts, due weight should be given to their "contemporaneous [*sic*] interpretation . . . by the courts and other lawful authorities within the same and by the population at large residing therein" (Supreme Court of Virginia, 1856, Hamilton v. McNeil, 54 Virginia (3 Gratt.) 389, 395). Further, maps of the territory in question "made out or published by authority of law" may serve as "persuasive evidence" of the boundary (ibid).

The center of the navigational channel has been used as the County boundary on all maps that have been made available to the RRWSG (e.g., USGS topographic quadrangle maps, Virginia Department of Transportation General Highway Maps for King William County and King and Queen County, King William County tax maps, etc.). Moreover, there is a seemingly universal (and probably long-standing) practical interpretation of the law by the two Counties, to the effect that the boundary line follows the center of the channel of the River. That interpretation appears to be followed uniformly in the exercise of the Counties' respective police powers and taxing powers. The proposed intake structure would be south of the center of the navigational channel, and therefore it would be in King William County, not in King and Queen County.

The Mayor and staff from the City of Newport News, on behalf of the RRWSG, met with the King and Queen County Chair and Vice-Chair of the Board of Supervisors and County staff in December 1996 to discuss issues of mutual interest. The Chair and Vice-Chair agreed to discuss possible needs of the County with which Newport News might assist as a cooperative by-product of the reservoir project. In addition, Newport News agreed to specifically address any concerns, issues, or questions raised by the County. The Chairman agreed to send both to the Mayor. As of the end of 1996, a list of questions regarding the project had been received and a response was being drafted. The County has not yet responded with a reaction to the offer for cooperative assistance.

Life Cycle Project Costs

A preliminary project cost estimate has been made for the King William Reservoir with pumpover from the Mattaponi River alternative (KWR-II configuration) (see Table 3-1C). This cost estimate has been updated to reflect the new configurations of the reservoir, reservoir pump station, and pipeline to Diascund Reservoir. The Year 1992 present value of the life cycle costs of the project, including land acquisition, construction, and operation and maintenance, is $123.8 million.

RCR=118,260,000

TABLE 3–1C

KING WILLIAM RESERVOIR
WITH PUMPOVER FROM THE MATTAPONI RIVER
KWR II CONFIGURATION
PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$5,600	25	$140,000
Pipeline Easements, River to KW Res. – Acres (1)	$2,000	8	$16,000
Reservoir and Buffer – Acres (2)	$1,500	4025	$6,040,000
Pipeline Easements, KW Res. to Dias. – Acres(3)	$1,000	60	$60,000
Soil Borrow Area – Acres(3)	$1,500	125	$190,000
Mitigation Area – Acres(3)	$1,500	500	$750,000
TOTAL LAND ACQUISITION COSTS			$7,200,000
CONSTRUCTION			
75 mgd Mattaponi Pump Station and Intake – LS			$10,000,000
54–Inch Transmission Main to KW Res. – LF	$250	8000	$2,000,000
48–Inch Transmission Main to Pamunkey River – LF	$225	17000	$3,830,000
42–Inch Dir. Drill Pamunkey River Crossing – LF	$850	4500	$3,830,000
48–Inch Transmission Main – LF	$225	23000	$5,180,000
42–Inch Transmission Main – LF	$200	10500	$2,100,000
Dam, Clearing – LS			$400,000
Dam, Excavation – LS			$1,900,000
Dam, Slurry Wall – LS			$1,900,000
Dam, Embankment – LS			$12,000,000
Dam, Emergency Spillway – LS			$2,300,000
Dam, Withdrawal & Release Structure – LS			$800,000
50–mgd King William Pump Station – LS			$5,500,000
Reservoir Clearing up to 90' msl – Acres	$2,250	2000	$4,500,000
40–mgd Diascund Pump Station and Intake – LS			$5,600,000
42–Inch Transmission Main to Little Creek – LF	$200	29000	$5,800,000
King William County Landfill Relocation – LS (4)			$3,000,000
County Route 626 Replacement – LF	$250	8000	$2,000,000
Mitigation – LS			$5,000,000
SUBTOTAL			$77,640,000
Permitting, Preliminary Engineering & Legal (5%)			$3,880,000
Design, Construction Management & Administration (12%)			$9,320,000
Contingencies (20%)			$18,170,000
TOTAL CONSTRUCTION COSTS			$109,010,000

TABLE 3–1C

KING WILLIAM RESERVOIR
WITH PUMPOVER FROM THE MATTAPONI RIVER
KWR II CONFIGURATION
PROJECT COST ESTIMATE
(Continued)

COST CATEGORY Item	Unit Cost	Quantity	Totals
OPERATION AND MAINTENANCE			
Electric Power for Pumping –LS	Matt. P.S.		$2,334,502
	Booster P.S.		$784,822
	Diascund P.S.		$711,423
Operations and Maintenance –LS	Matt. P.S./Pipeline		$1,668,237
	Booster P.S./Pipeline		$1,251,178
	Diascund P.S./Pipeline		$834,119
TOTAL OPERATION AND MAINTENANCE COSTS			**$7,580,000**
TOTAL YEAR 1992 PRESENT VALUE COST			**$123,790,000**

Notes:

All costs in Year 1992 dollars.

1) Assumes King William County and RRWSG would jointly own.

2) Assumes King William County would acquire and lease to RRWSG jurisdictions.

3) Assumes RRWSG jurisdictions would acquire.

4) Landfill relocation may not be required as part of this project.

To allow comparison of this alternative's costs to those of other alternatives, the life cycle cost of water treatment and transmission to the Lower Peninsula service areas must be considered. For the 29.0 mgd combined RRWSG, King William County, and New Kent County treated water safe yield benefit calculated for this alternative, the Year 1992 present value of life cycle costs for treatment and transmission is estimated at $27.4 million.

Summing these estimates yields a total project life cycle cost estimate of $151.2 million, or $5.2 million per mgd of total treated water safe yield benefit. For this cost analysis, it has been assumed that King William County and New Kent County would pay for their shares of the project safe yield. According to Section III(c) of the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990):

> *"Investment in Structural Improvements: COUNTY [King William County] shall reimburse CITY [City of Newport News] an amount equal to 9.1 percent of the total of all principal and interest payments made or payable by CITY over the financing period for those structural improvements which are necessary to the provision of water to COUNTY (i.e., the impoundment, river pumping station, connecting pipeline, and associated rights-of way and land ownership)."*

Based on the itemized costs presented in Table 3-1C, the total Year 1992 present value of construction and land acquisition costs which fall within the agreement provision outlined above would be approximately $55.3 million. Assuming that King William County would pay for 9.1 percent of this amount, the RRWSG's share of the total project cost would be reduced by approximately $5.0 million. The 1 mgd raw water allowance for New Kent County represents approximately 3 percent of the project's total raw water safe yield (29.0 mgd). If New Kent County pays for project costs (excluding treatment and transmission costs since a raw water allowance has been assumed for the County) based on its pro-rata share of project safe yield, the RRWSG share of the total project life cycle cost estimate would be reduced by approximately $3.7 million. If both Counties pay for their pro-rata shares of project safe yield as outlined above, the RRWSG share of the total project life cycle cost estimate would be approximately $142.5 million, or 94 percent of the total cost ($151.2 million).

3.4.16 King William Reservoir With Pumpover From Pamunkey River

Description

This alternative would consist of the following components: a 100 mgd raw water intake structure and pumping station, located on the Pamunkey River near Montague Landing, in King William County; approximately 5.7 miles of 60-inch, 100 mgd capacity river water pipeline between the river pumping station and King William Reservoir; a 2,400-foot long dam on Cohoke Creek at the KWR II dam site, creating a 2,222-acre impoundment with 21.2 BG estimated gross storage at the normal pool elevation (96 feet msl); an intake structure in the Cohoke Creek impoundment; a 10.4 mile long raw water pipeline, having inside diameters of 42 and 48 inches, between King William Reservoir and Diascund Creek Reservoir; a 50 mgd pump station at the King William Reservoir dam; a 40 mgd intake structure and pump station near the Diascund Creek dam; and a 5.5-mile, 40 mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

The 100 mgd raw water intake and pumping station would be located in the vicinity of Montague Landing on the northern bank of the Pamunkey River in King William County. Montague Landing is located approximately 38 river miles upstream from the mouth of the Pamunkey River.

Average streamflow at Northbury, 2 river miles upstream of Montague Landing, is estimated at 774 mgd based on an approximate contributing drainage area of 1,279 square miles.

From Montague Landing, water would be pumped to King William Reservoir through 5.7 miles of 60-inch, 100 mgd capacity pipeline. This raw water pipeline would run cross country from the pump station site in a northeasterly direction for approximately 2.7 miles, crossing State Route 632 near Mt. Olive Church. The pipeline would then continue cross country northeast for another 3 miles, crossing State Route 633, and discharging at elevation 90 feet msl at the headwaters of Cohoke Creek. This outfall would be located approximately 0.2 miles southeast of Jerusalem Church.

The other components of this alternative are described in Section 3.4.15 including the updated reservoir configuration, changes in the pipeline to Diascund Creek Reservoir, and the 50 mgd King William Reservoir pump station.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. The King William Reservoir project was evaluated as an interconnected component of the existing Newport News Waterworks system. The new reservoir configuration and 25 percent dead storage assumption were incorporated into this analysis. The total treated water safe yield of this alternative is 33.2 mgd. The detailed methods of analysis used for estimating the safe yield of the King William Reservoir alternative are presented in Section 3.3.3.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of host jurisdiction allowances for King William and New Kent Counties, where the reservoir and most other components of the reservoir/river pumpover project would be located. Although no host agreements are in place for this alternative, the same host jurisdiction allowances described in Section 3.4.15 (for Mattaponi River pumpover scenario) are assumed for this Pamunkey River pumpover scenario. It has thus been assumed that King William County and New Kent County would receive raw water safe yield allowances of 3 mgd and 1 mgd, respectively. The treated water safe yield remaining for the RRWSG is 29.6 mgd. This is based on a total treated water safe yield of 33.2 mgd, less 3.6 mgd of treated water safe yield due to 4 mgd in host jurisdiction raw water allowances. (The 3.6 mgd treated water reduction is equivalent to a 4 mgd raw water safe yield reduction after estimated treatment and transmission losses are factored into the calculation.)

Practicability Analysis

Based on the environmental, technical, and institutional constraints discussed below, a Pamunkey River pumpover to King William Reservoir alternative appears to be less practicable than a Mattaponi River pumpover alternative.

Environmental Constraints

The pipeline route from the Pamunkey River to King William Reservoir would be nearly four times as long as that from the Mattaponi River (5.7 versus 1.5 miles, respectively) and would require a larger diameter pipeline. As a result, additional stream crossings and greater temporary land disturbance would occur. Energy requirements also would be greater, causing additional impacts from increased energy generation. With increased construction and operating costs, the total Year 1992 present value of project costs for the Pamunkey River pumpover scenario would be approximately $12.7 million higher than for the Mattaponi River pumpover.

The environmental impacts of a Pamunkey River pumpover could be larger than those of the proposed Mattaponi River withdrawals, for several reasons. First, existing and projected future water demands are much greater in the Pamunkey River Basin than in the Mattaponi River Basin. As presented in Sections 5.2.2 and 5.2.3, estimated Year 1990 consumptive water use in the Pamunkey River Basin is 11 times as great as that estimated for the Mattaponi River Basin (34.2 mgd versus 3.1 mgd); and projected Year 2030 consumptive uses (without a RRWSG project) in the Pamunkey River Basin are more than 9 times as great as in the Mattaponi River Basin (51.1 mgd versus 5.5 mgd).

Water Quality Reliability

The number of existing and planned wastewater discharges to the Pamunkey River raises concerns about water quality that do not exist for the Mattaponi River. There currently are several point source discharges in the Pamunkey River Basin, including four SWCB-designated "major" municipal and industrial discharges upstream of Northbury. Chesapeake Corporation operates a large Kraft pulp and paper mill in the Town of West Point which is a major industrial discharger to the lower portion of the Pamunkey River. Hanover County, King William County, and New Kent County have each recently planned or developed new sewage treatment plant (STP) discharges to the mainstem Pamunkey River or its tributaries. In contrast, there are currently no major municipal or industrial discharges in the Mattaponi River Basin. Furthermore, the SWCB has no record of any permitted point sources in the SWCB-designated stream segment which includes Scotland Landing. That segment extends more than 30 river miles upstream and 11 river miles downstream of the proposed Scotland Landing intake site.

Host Jurisdiction Approval

The proposed King William Reservoir and its drainage area lie entirely within King William County. Because King William County is not currently a member of the RRWSG, the County's approval would be critical to the RRWSG's successful implementation of this alternative. As discussed in Section 3.4.13, the governing body (City Council or County Board of Supervisors) of a host locality must grant its approval for another locality's development of public water supply facilities within its borders, under numerous provisions of Virginia law. These include zoning and local consent laws.

King William County has stated its opposition to withdrawals by the RRWSG from the Pamunkey River as the primary source for augmenting storage in the proposed King William Reservoir (D. S. Whitlow, King William County, personal communication, 1992, and reconfirmed in May 1995). That statement is consistent with its prior actions. In the mid-1980's, King William County joined with Hanover and other Counties in the Pamunkey River Water Study Committee, an organization that was formed to oppose withdrawals from the Pamunkey River by Lower Peninsula jurisdictions. King William County's subsequent agreement with the RRWSG to support the King William Reservoir was based upon the reliance on a Mattaponi River pumpover.

Life Cycle Project Costs

A preliminary project cost estimate has been made for the King William Reservoir with pumpover from the Pamunkey River alternative (see Table 3-1D). This cost estimate has been updated to reflect the new configurations of the reservoir, reservoir pump station, and pipeline to Diascund Creek Reservoir. The Year 1992 present value of the life cycle costs of the project, including land acquisition, construction, and operation and maintenance, is $136.4 million.

To allow comparison of this alternative's costs to those of other alternatives, the life cycle cost of water treatment and transmission to the Lower Peninsula service areas must be considered. For the 33.2 mgd combined RRWSG, King William County, and New Kent County treated water safe yield benefit calculated for this alternative, the Year 1992 present value of life cycle costs for treatment and transmission is estimated at $31.2 million.

Summing these estimates yields a total project life cycle cost estimate of $167.6 million, or $5.0 million per mgd of total treated water safe yield benefit. For this cost analysis, it has been assumed that King William County and New Kent County would pay for their pro-rata shares of the project safe yield. The combined 4 mgd raw water allowance for the two Counties represents approximately 11 percent of the project's total raw water safe yield (36.9 mgd). If both Counties pay for project costs (excluding treatment and transmission costs since raw water allowance have been assumed for the Counties) based on their pro-rata shares of project safe yield, the RRWSG share of the total project life cycle cost estimate would be reduced by approximately $15.0 million. Overall, the RRWSG share of the total project life cycle cost estimate would then be approximately $152.6 million, or 91 percent of the total cost ($167.6 million).

3.4.17 Chickahominy River Pumping Capacity Increase

Description

This alternative would involve increasing the pumping capacity of the existing Newport News Waterworks Chickahominy River pumping station to 61 mgd, when pumping water to Little Creek Reservoir only. Existing station rehabilitation plans and the addition of a new Little Creek Reservoir outfall will result in a maximum pumping capacity to Little Creek of 57.5 mgd. Once this rehabilitation is complete, the installation of two additional pumps would provide a maximum pumping capacity to Little Creek of 61 mgd.

Safe Yield

This alternative's treated water safe yield benefit was calculated at 0.2 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. The lack of a substantial safe yield benefit for this alternative illustrates that available raw water storage is currently the limiting factor in the safe yield of the Newport News Waterworks system. In combination with other alternatives involving new storage, the safe yield benefit would be greater (see Sections 3.4.11 and 3.4.18).

TABLE 3–1D

KING WILLIAM RESERVOIR
WITH PUMPOVER FROM THE PAMUNKEY RIVER
PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$5,600	25	$140,000
Pipeline Easements, River to KW Res. – Acres (1)	$2,000	35	$70,000
Reservoir and Buffer – Acres (2)	$1,500	4025	$6,040,000
Pipeline Easements, KW Res. to Dias. – Acres(3)	$1,000	60	$60,000
Soil Borrow Area – Acres(3)	$1,500	125	$190,000
Mitigation Area – Acres(3)	$1,500	500	$750,000
TOTAL LAND ACQUISITION COSTS			**$7,250,000**
CONSTRUCTION			
100 mgd Pamunkey Pump Station and Intake –LS			$12,000,000
60–Inch Transmission Main to KW Res. – LF	$300	30000	$9,000,000
48–Inch Transmission Main to Pamunkey River – LS	$225	17000	$3,830,000
42–Inch Dir. Drill Pamunkey River Crossing – LF	$850	4500	$3,830,000
48–Inch Transmission Main – LF	$225	23000	$5,180,000
42–Inch Transmission Main – LF	$200	10500	$2,100,000
Dam, Clearing –LS			$400,000
Dam, Excavation –LS			$1,900,000
Dam, Slurry Wall –LS			$1,900,000
Dam, Embankment –LS			$12,000,000
Dam, Emergency Spillway –LS			$2,300,000
Dam, Withdrawal & Release Structure –LS			$800,000
50–mgd King William Pump Station –LS			$5,500,000
Reservoir Clearing up to 90' msl – Acres	$2,250	2000	$4,500,000
40–mgd Diascund Pump Station and Intake –LS			$5,600,000
42–Inch Transmission Main to Little Creek – LF	$200	29000	$5,600,000
King William County Landfill Relocation – LS (4)			$3,000,000
County Route 626 Replacement – LF	$250	8000	$2,000,000
Mitigation – LS			$5,000,000
SUBTOTAL			**$86,640,000**
Permitting, Preliminary Engineering & Legal (5%)			$4,330,000
Design, Construction Management & Administration (12%)			$10,400,000
Contingencies (20%)			$20,270,000
TOTAL CONSTRUCTION COSTS			**$121,640,000**

TABLE 3-1D

KING WILLIAM RESERVOIR
WITH PUMPOVER FROM THE PAMUNKEY RIVER
PROJECT COST ESTIMATE
(Continued)

COST CATEGORY Item	Unit Cost	Quantity	Totals
OPERATION AND MAINTENANCE			
Electric Power for Pumping – LS	Pamunkey P.S.		$2,317,160
	Booster P.S.		$784,822
	Diascund P.S.		$700,161
Operations and Maintenance – LS	Pamunkey P.S./Pipeline		$1,668,237
	Booster P.S./Pipeline		$1,251,178
	Diascund P.S./Pipeline		$834,119
TOTAL OPERATION AND MAINTENANCE COSTS			**$7,560,000**
TOTAL YEAR 1992 PRESENT VALUE COST			**$136,450,000**

Notes:

All costs in Year 1992 dollars.

1) Assumes King William County and RRWSG would jointly own.

2) Assumes King William County would acquire and lease to RRWSG jurisdictions.

3) Assumes RRWSG jurisdictions would acquire.

4) Landfill relocation may not be required as part of this project.

Practicability Analysis

The 0.2 mgd incremental safe yield benefit from raising the maximum Chickahominy River withdrawal to 61 mgd is not considered sufficient to justify it as practicable.

Given the current regulatory emphasis on streamflow protection, increasing the maximum Chickahominy River withdrawal could trigger more restrictive MIF requirements. Therefore, increasing the maximum Chickahominy withdrawal is not considered to be available from a regulatory standpoint.

The Governor's conditional consent and approval of Little Creek Dam suggests that the maximum Chickahominy River withdrawal cannot be increased, at least without approval of the Governor.

The Chickahominy River is already critical to the welfare of the Lower Peninsula and excessive reliance on this single river source would not be prudent. Additional reliance on the Chickahominy would not provide a backup source in the event of water quality excursions or extreme low flows that severely limit Chickahominy River withdrawals. Also, with the uncertainties of future more restrictive MIF, it is not prudent to increase reliance on the Chickahominy River.

Several water quality concerns represent a considerable cumulative threat to long-term water quality in the Chickahominy River. Greater reliance on Chickahominy withdrawals would magnify this threat and would not provide an alternative source in the event of contamination.

Increasing the maximum Chickahominy River withdrawal to 61 mgd would raise the maximum withdrawal to 30 percent of average streamflow at the intake. There is no precedent in Virginia for this degree of reliance on a river source by a major municipal water purveyor.

Based on the preceding concerns with respect to availability and reliability of water quality and quantity, increasing the maximum Chickahominy River withdrawal to 61 mgd, or more, is currently considered unavailable, infeasible, and impracticable. In addition, this alternative is not considered practicable by federal regulatory and advisory agencies.

3.4.18 Chickahominy River Pumping Increase and Raising Diascund and Little Creek Dams

Description

This alternative would involve increasing the pumping capacity of the existing Newport News Waterworks Chickahominy River pumping station (as discussed in Section 3.4.17), and increasing reservoir storage. Normal pool elevations of Newport News Waterworks' Little Creek and Diascund Creek reservoirs would be raised by 2 feet, and the Chickahominy River pump station maximum pumping capacity, when pumping to Little Creek Reservoir only, would be increased to 61 mgd.

Raising the normal pool elevation at Little Creek would require, at a minimum, the addition of a flood/splash wall across the top of the dam, modifications to the spillway intake tower, and the addition of a supplementary emergency spillway. Raising the normal pool elevation at Diascund Creek would require, at a minimum, the modification of the existing spillway structure and pump station, the addition of a splash wall across the top of the dam and the addition of a supplementary emergency spillway.

Safe Yield

This alternative's potential treated water safe yield benefit was calculated at 5.0 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period.

Practicability Analysis

Increasing the maximum Chickahominy River withdrawal to 61 mgd, or more, is currently considered unavailable, infeasible, and impracticable. Given this practicability determination, a new analysis was performed to evaluate the benefit of raising the Diascund and Little Creek dams without increasing the maximum Chickahominy River pumping capacity. As a result, the treated water safe yield benefit for this alternative would decline from 5.0 mgd to 1.3 mgd. With a safe yield of only 1.3 mgd, the estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.19 Aquifer Storage and Recovery Constrained By Number of Wells

Description

Aquifer storage and recovery (ASR) typically involves:

- The seasonal underground storage of treated drinking water in a suitable aquifer during times when the raw water source capacity exceeds system demand.
- The subsequent recovery from the same wells to meet peak or emergency demands beyond the raw water source capacity. Generally, the only treatment required for the recovered water is chlorination.

ASR does not supply water in and of itself, but is instead a water management technique. As with other water supply alternatives, an acceptable source of raw water must first be identified.

The Chickahominy River is the largest fresh surface water source within the Lower Peninsula study area. As such, it offers greater potential to supply a Lower Peninsula ASR system than other local fresh surface water sources. Newport News Waterworks' existing Chickahominy River withdrawal above Walkers Dam was thus chosen as a potential raw water source for this evaluation.

It was assumed that raw water transmission, water treatment, and finished water distribution capacity would be available as required to obtain the maximum ASR safe yield benefit. The additional capacities and specific improvements required in transmission, treatment, and distribution facilities have not been quantified or detailed to date.

Chickahominy River withdrawals would eventually be treated and pumped into the distribution system. Any treated water in excess of system demand would be injected into the aquifer storage zone to be used when raw water supplies cannot meet all of the treated water demands.

It was assumed that ASR wells would be developed in areas adjacent to existing Newport News Waterworks pumping stations, finished water storage tanks, and water treatment plants. Twelve potential ASR well locations were identified which have good access to Newport News Waterworks' finished water distribution system and are located on property owned by Waterworks.

A realistic upper limit for single ASR well injection rates would be approximately 1½ mgd. Therefore, the 12 well system could have a total maximum injection rate of 18 mgd. Given the 6.7 mgd estimated safe yield benefit for this alternative (see below) and an assumed maximum day demand (MDD) factor of 1.45, the ASR withdrawal facilities would be sized to supply a MDD on the order of 9.7 mgd. Assuming 1 to 2 mgd average ASR well withdrawal capacities, 5 to 10 dual-purpose ASR wells (i.e, injection and recovery) would be required. The remaining 2 to 7 wells could be dedicated ASR injection wells.

Safe Yield

This alternative's treated water safe yield benefit was estimated at 6.7 mgd by performing aquifer storage depletion analysis.

Practicability Analysis

ASR technology in the Virginia Coastal Plain Province is still in the experimental stage and there is no present basis for assuming that this technology may be applied on the Lower Peninsula. In addition, there are large uncertainties about how the quality of injected potable water and the aquifer storage zone itself will be impacted by operation of an ASR system. Given these uncertainties, this alternative is not considered to be technologically reliable. The proposed ASR system would also have the potential to cause regional aquifer drawdown impacts during the long sustained withdrawal periods required for this alternative. These potential drawdown impacts create considerable uncertainty as to whether this alternative would be permittable by the State. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.20 Aquifer Storage and Recovery Unconstrained By Number of Wells

Description

General characteristics and principal criteria governing the site-specific feasibility of aquifer storage and recovery (ASR) systems are described in Section 3.4.19. This ASR alternative is distinguished from that previously considered in Section 3.4.19 in that it is not constrained by the number of ASR wells.

Safe Yield

This alternative's treated water safe yield benefit was estimated at 9.4 mgd by performing aquifer storage depletion analysis. The assumptions used in developing this safe yield estimate were identical to those used for the ASR Constrained by Number of Wells alternative (see Section 3.4.19) with the exception of the number of ASR wells.

Practicability Analysis

ASR technology in the Virginia Coastal Plain Province is still in the experimental stage and there is no present basis for assuming that this technology may be applied on the Lower Peninsula. In addition, there are large uncertainties about how the quality of injected potable water and the aquifer storage zone itself will be impacted by operation of an ASR system. Given these uncertainties, this alternative is not considered to be technologically reliable. The proposed ASR system would also have the potential to cause regional aquifer drawdown impacts during the long sustained withdrawal periods required for this alternative. These potential drawdown impacts create considerable uncertainty as to whether this alternative would be permittable by the State. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.21 Fresh Groundwater Development

Description

This alternative would involve construction of new well fields in western James City County and/or eastern New Kent County near Diascund Creek and Little Creek reservoirs. These wells would have a total production capacity of 10 mgd and would be used to augment storage in Diascund Creek and Little Creek reservoirs during periods when Newport News Waterworks system reservoir storage is below 75 percent of total capacity.

Little Creek Reservoir Site

Because of its large total storage volume (7.48 billion gallons), small drainage area (4.6 square miles), and large withdrawal capacity (55 mgd), it was determined that this 10 mgd alternative should rely on the maximum amount of groundwater that is available from the Little Creek Reservoir site. Maximizing withdrawal from the Little Creek site would also provide a more efficient means of maintaining the water levels in this reservoir when the minimum flow restrictions on the Chickahominy River would alternatively require pumpover from the Diascund Creek Reservoir.

To provide groundwater to the reservoir, the wells would discharge raw water either into existing surface drainageways of the reservoir, or directly to the reservoir, depending on the individual well location. At the Little Creek site, a maximum of four wells could be used to provide emergency raw water supply without causing unacceptable well interference effects. If water levels in the Middle Potomac Aquifer decline due to withdrawals by others, the number and location of wells required at both the Little Creek and Diascund Creek sites could change. The well sites are spaced approximately 8,000 feet apart around the perimeter of the reservoir. Approximate well locations are listed below:

Well Number	Production Rate (gpm)	Latitude	Longitude
LC-1	800	37°22'14"	76°50'34"
LC-2	800	37°22'57"	76°48'35"
LC-3	800	37°21'01"	76°50'10"
LC-4	800	37°21'53"	76°48'45"

Diascund Creek Reservoir Site

Approximately 5.4 mgd of the total 10-mgd groundwater production capacity would be provided by the Diascund Creek well field. The Diascund Creek Reservoir's relatively large drainage area (44.6 square miles) and the higher aquifer transmissivity in the area allow for greater flexibility in determining the location of wells. Four wells located adjacent to the reservoir, each producing 1,000 gpm, would provide approximately 5.76 mgd of emergency raw water supply from this site, making the total well water production approximately 10.36 mgd. A slight downward modification of the production rate of any or all of the wells from the proposed 1,000 gpm would achieve a total withdrawal rate of 10 mgd. This could be achieved by decreasing the proposed production rate in all four Diascund Creek Reservoir wells to 950 gpm. The approximate locations of these wells are indicated below.

Well Number	Production Rate (gpm)	Latitude	Longitude
DC-1	950	37°26'50"	76°54'04"
DC-2	950	37°27'02"	76°52'20"
DC-3	950	37°25'44"	76°55'03"
DC-4	950	37°25'46"	76°53'31"

Safe Yield

This alternative's treated water safe yield benefit was calculated at 4.4 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This determination was based on the assumption that the wells would not be used until Newport News Waterworks reservoir storage falls to a 75 percent drought alert level (i.e., 75 percent of total system capacity including dead storage).

Practicability Analysis

Based on information compiled to date, there is no basis for deeming this alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.22 Groundwater Desalination As The Single Long-Term Alternative

Description

This alternative would involve new large-scale groundwater withdrawals from the deep, brackish aquifers in the Lower Peninsula. Potential locations of the withdrawals would include areas located in the City of Newport News, James City County, and York County. The areas of Copeland Industrial Park, Lee Hall, Harwood's Mill, and Little Creek Reservoir were selected as well field locations based on ease of integration with existing finished water storage and distribution system facilities, availability of existing property and easements, and to minimize drawdown by distributing the required large withdrawals in areas of higher aquifer yield. Groundwater withdrawals would require use of desalination technology, particularly in the long-term, as water levels decline and higher TDS waters are withdrawn.

The amount of firm brackish groundwater withdrawal capacity necessary to produce approximately 30 mgd of average day demand treated water safe yield is estimated at 54 mgd.

Approximately 27 wells would be required to produce at least 54 mgd of firm well yield. The individual well fields would typically include 4 to 6 wells each, depending on actual local yields and available locations.

Safe Yield

Assuming that it is always possible to use the full 54 mgd of firm withdrawal capacity, this alternative would provide a treated water safe yield benefit equal to approximately 30 mgd of the projected Year 2040 Lower Peninsula deficit of 39.8 mgd.

Practicability Analysis

The Lower Peninsula is located entirely within the boundaries of the Eastern Virginia Groundwater Management Area (EVGMA). The SWCB has taken a strong position against new large-scale groundwater withdrawals in the EVGMA. Given the widespread regional aquifer drawdown impacts expected for this alternative, it is extremely doubtful that the State would permit this alternative. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.23 Groundwater Desalination in Newport News Waterworks Distribution Area

Description

This alternative would involve the development of up to 10 mgd of deep brackish groundwater supply from wells screened in the Middle Potomac and Lower Potomac aquifers. A reverse osmosis (RO) process would be utilized to reduce levels of dissolved solids, sodium, chloride, fluoride, and iron to drinking water quality. These dissolved constituents are typically elevated in the Middle Potomac and Lower Potomac aquifers beneath the eastern region of the York-James Peninsula. The wells would be installed at finished water storage and distribution locations within the City of Newport News or on existing Newport News Waterworks property.

This groundwater alternative would include four individual RO treatment facilities, with pre-engineered buildings to house treatment processes, chemical pre-treatment and post-treatment systems, additional transfer pumps, and concentrate lines for discharge of process reject. The deep wells and individual RO treatment plants would be located adjacent to, and would discharge finished water to, the following existing finished water storage facilities in the Newport News Waterworks system:

- Site 1 - Copeland Industrial Park Ground Storage Tank
- Site 2 - Upper York County Ground Storage Tank
- Site 3 - Harwood's Mill WTP Clearwell
- Site 4 - Lee Hall WTP Clearwell

Blended groundwater from the Middle Potomac and Lower Potomac aquifers would be used to supply the RO treatment facilities to take advantage of the favorable water quality of the Middle Potomac and the increased yield available from the Lower Potomac. Potential concentrate outfall locations are as follows:

- Site 1 (Copeland Park) — Hampton Roads south of the mouth of Salters Creek
- Site 2 (Upper York County) — South bank of Queens Creek
- Site 3 (Harwood's Mill) — West bank of the Poquoson River
- Site 4 (Lee Hall) — South bank of Skiffes Creek

Safe Yield

The safe yield of this alternative depends on the individual well yields, the recovery percentages realized for the various water qualities, and the maximum day demand factor expected in the system. For a blended raw water quality of 2,000 to 4,000 mg/l TDS, recoveries of up to 80 percent can be expected with currently available RO membranes. The projected maximum week demand factor for the Lower Peninsula through the Year 2040 is 1.25. Using these values, and assuming a 10-mgd firm well production capacity, the estimated treated water safe yield benefit of this alternative was preliminarily estimated at 6.4 mgd. However, more detailed studies of Newport News Waterworks' brackish groundwater desalting project have placed the treated water safe yield benefit of this alternative at 5.7 mgd (D.W. Tucker, VDH, personal communication, 1995).

Practicability Analysis

Newport News Waterworks is actively pursuing a brackish groundwater desalting project. In August 1994 the VDEQ approved a draft groundwater withdrawal permit for Newport News.

Final design of desalting facilities and pipelines began in April 1996, following completion of feasibility studies, pilot testing, and preliminary design (RRWSG, Summer 1996). Well installation and final design of the treatment facility should be completed by the end of 1996 and start-up for the desalting facility is scheduled for mid-1998. Once the facility is on-line, an estimated 5.7 mgd of desalted groundwater will become part of the finished water flow from Newport News Waterworks' Lee Hall WTP.

Large-scale groundwater withdrawals are not considered to be available. In view of the current overused and degraded condition of the major regional aquifers and the level of state regulation under the Ground Water Management Act, the RRWSG does not consider it feasible to rely on large groundwater withdrawals for permanent use on the Lower Peninsula. A groundwater modeling analysis was conducted by Malcolm Pirnie in 1993 using the USGS Coastal Plain Model to assess whether simultaneous operation of the two practicable groundwater alternatives would be permittable under state Groundwater Withdrawal Regulations (VR 680-13-07). This analysis is presented in Appendix I-21 of Report D (Volume I). The results from this analysis demonstrate that potential drawdown impacts to other existing groundwater users, and the potential for saline groundwater intrusion, could make it very difficult for large groundwater withdrawals to be permitted under the regulations. Therefore, an alternative that relies on substantial groundwater use may not be available. However, based on the progress to date on the Newport News Waterworks' brackish groundwater desalting project, there is no basis for deeming this smaller-scale groundwater desalting alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.24 James River Desalination

Description

Jamestown Intake

This alternative would involve a 70-mgd raw water intake and pumping station on the James River; 9 miles of dual 36-inch, 70-mgd capacity raw water pipelines; an RO desalting facility capable of producing 44 mgd of finished water; a 20-mile, 36-inch 26-mgd capacity concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems. Thus, to provide an average day demand (ADD) treated water safe yield approximately of 30 mgd, this alternative must actually be able to supply a maximum day demand (MDD) of 1.45 times the ADD, or approximately 44 mgd.

Sturgeon Point Intake

This alternative would involve a 60-mgd raw water intake and pumping station on the James River; 21.5 miles of dual 36-inch, 60-mgd capacity raw water pipelines; an electrodialysis reversal (EDR) desalting facility capable of producing 44 mgd of finished water; a 20-mile, 24-inch concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems, with MDD supply provided as described for the Jamestown intake option.

Compared to the Jamestown intake alternative, this project would have a less expensive and smaller intake and raw water pump station, a much longer raw water feed pipeline, smaller conventional treatment facilities, less expensive desalination process units, and a smaller diameter concentrate outfall pipeline.

Safe Yield

Jamestown Intake

With an approximate recovery rate of 60 percent and 10 percent RO module bypass, withdrawals of 70 mgd would produce 44 mgd of desalinated surface water. Assuming no MIF requirement, and assuming a Lower Peninsula MDD factor of 1.45, this alternative would provide a treated water safe yield benefit of approximately 30 mgd.

Sturgeon Point Intake

It was assumed that an MIF would not apply to the raw water withdrawal. With an approximate overall recovery rate of 75 percent, withdrawals of 60 mgd would produce at least 44 mgd of desalinated surface water. With MDD supplied as described above, this alternative would provide a treated water safe yield benefit of approximately 30 mgd.

Practicability Analysis

Utilization of the lower James River as a source of public water supply raises specific concerns pertaining to water quality and the reliability of available treatment technologies to consistently produce a safe drinking water product. Treatment of water from either a highly variable estuary source, or a brackish/tidal fresh source, to drinking water standards has not been accomplished on a permanent basis at any scale. Any process for treating water from such a source must, therefore, be considered experimental.

The proposed Jamestown intake site would be located at the lower end of the turbidity maximum zone of the lower James River estuary. This zone is caused by the interaction and mixing of salt water and freshwater in the river, and is affected by tides, streamflow, and climatic events. The turbidity maximum zone acts as a trap for nutrients, sediment, and toxics; and has widely fluctuating salinity levels which vary in response to the daily and monthly tidal cycle, seasonal changes in streamflow, and short- and long-term climatic events.

The pesticide kepone was trapped in the turbidity maximum zone of the James River following its discharge into the river in the early 1970s. Kepone is currently trapped in the bottom sediments of this portion of the river. The severity of short-term impacts to the river due to the construction of a submerged 3,300-foot intake pipeline is unknown, as are the effects on future water quality due to shipping channel maintenance dredging. However, the possible risks associated with the existing kepone contamination are serious concerns.

The widely fluctuating salinity levels in this zone of the river are also a concern due to the difficulties they would cause in controlling the treatment process, and the increased possibility of varying product water quality and disruptions to treatment processes. Salinity swings of 2 to 4 ppt could occur approximately every 6 hours at the intake due to the normal tidal cycle.

The proposed Sturgeon Point intake site would be located at the lower end of the tidal freshwater zone of the lower James River estuary. Saltwater intrudes up to and beyond Sturgeon Point in the fall of most years, when freshwater river flows are typically lowest. During these salinity intrusion events, the turbidity maximum zone of the river would extend upstream past Sturgeon Point. Salinity levels at Sturgeon Point during these events could change dramatically in response to tides, changing streamflow, and climatic events. Turbidity in the river also would be expected to increase during a salinity intrusion event. Similar to the Jamestown intake site, kepone is trapped to some degree in the bottom sediments of the river at this point. Similar concerns related to intake construction also exist for Sturgeon Point.

The treatment technologies required to safely treat water withdrawn at Sturgeon Point may at times conflict. Proper coordination of treatment operations would be critical to ensuring the production of acceptable finished water. The combination of initial conventional treatment followed by an EDR desalting process has not yet been operated at a substantial scale in the United States. This combination must, therefore, be considered experimental.

Moving the intake site upstream to Sturgeon Point and closer to Hopewell would reduce the magnitude of seasonal and daily salinity variation; however, the intake site would also be exposed to higher risks of contamination. These risks must be taken into account while planning a water project with a 50-year life (or longer) and a very large user population.

Located at and above Hopewell is a large, diverse industrial complex. These industries have released large quantities of chemical contaminants in the past. The best known case involved the discharge into the river during the early 1970s of an estimated 100,000 pounds of the pesticide kepone. The vast majority of this kepone is believed to remain in bottom sediments in the reach of the river between Hopewell and Jamestown. This kepone could be disturbed by man's activities, including dredging, or by a severe hurricane or other natural event. The City of Richmond's Combined Sewer Overflow program will accumulate and divert contaminated runoff toward the lower James River. Finally, there is the potential for catastrophic spill events. In the late-1970s, an ocean-going sulfur freighter struck and became lodged under the Benjamin Harrison Bridge downstream of Hopewell. No spill occurred, but the accident highlights the future potential for catastrophic spill events on a heavily-traveled and used river.

In recent years, the concern over potential adverse health effects as a result of many forms of microbial contamination, and from long-term exposure to very small quantities of inorganic and organic chemicals, has been increasing. These concerns are being addressed by the USEPA as new regulations are released to implement the Safe Drinking Water Act Amendments of 1986. The 1986 Amendments required maximum contaminant levels (MCLs) to be established for an initial 83 contaminants with additional MCLs to be established for defining acceptable drinking water quality in the future.

The health risk assessments for the initial 83 contaminants and final regulations for them are not expected to be completed before the end of this decade. Even then, the MCLs will be established based on the assumption that the best quality, most pristine, naturally occurring available water source will be used. The use of less than pristine raw water sources and the possibility of synergistic effects due to combinations of organic and inorganic contaminants will not be addressed at all by these MCLs. The use of raw water sources with substantial upstream point source discharges and intensive watershed development, even when in compliance with all current MCLs and other regulations, has the potential to increase human health risks.

As presented in this document, there are other sources of potable water which have not been shown to be unavailable to the RRWSG. These water sources are of better quality than the lower James River and do not present a potential pubic health risk on a year-round basis as does this alternative. Furthermore, due to raw water quality variability and treatment control concerns, and the lack of experience in treating water sources similar to the James River at Jamestown or Sturgeon Point, both variations of this desalting alternative are considered experimental. Therefore, this alternative is not considered to be technologically reliable.

In recent years the VDH has taken a strong stance against use of the James River below Hopewell as a public water supply source. This opposition was most recently stated in a July 6, 1993 letter in which the VDH outlined its specific concerns (A. R. Hammer, VDH, personal communication, 1993). Since there are other sources of potable water which have not been shown to be unavailable to the RRWSG, it does not appear that the State would approve the James River Desalination alternative.

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. This conclusion is true for both the Jamestown and Sturgeon Point intake sites.

For the reasons summarized above, the James River Desalination alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.25 Pamunkey River Desalination

Description

This alternative would involve a 65-mgd raw water intake and pumping station on the Pamunkey River; a 25-mile, 54-inch 65-mgd capacity raw water pipeline; an RO or EDR desalting facility capable of producing 44 mgd of finished water; an 8.2-mile, 30-inch 21-mgd capacity concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems. Thus, to provide an ADD treated water safe yield of approximately 30 mgd, this alternative must actually be able to supply a MDD of 1.45 times the ADD, or approximately 44 mgd.

Safe Yield

With an approximate recovery rate of 70 percent and 10 percent RO module or EDR unit bypass, withdrawals of up to 65 mgd would be required to produce 44 mgd of desalinated surface water. Assuming no MIF requirement, and assuming a Lower Peninsula MDD factor of 1.45, this alternative could theoretically provide a treated water safe yield benefit of approximately 30 mgd.

However, a major limitation upon safe yield exists since this alternative involves a river withdrawal for which compliance with an MIF would likely be required. In December 1991 the SWCB agreed that it is appropriate to assume that an MIF would be in place for any new Pamunkey River withdrawal considered as part of this study (J. P. Hassell, SWCB, personal communication, 1991). Therefore, during droughts with extended periods of low river flow at or below the MIF level(s), withdrawals could not occur.

This desalting alternative would produce finished water without any intermediate raw water storage step, and would thus rely on the Pamunkey River as a constant source of feed water. In order for this alternative to provide its theoretical 30.2-mgd safe yield benefit, continuous Pamunkey River withdrawals of up to 65 mgd must, therefore, be allowed throughout the drought of record. Since this alternative does not include new raw water storage, and since an MIF would severely limit or preclude Pamunkey River withdrawals for extended periods (i.e., 10 consecutive months), the potential safe yield benefit of this alternative is negated.

Practicability Analysis

The Pamunkey River Desalination alternative is not expected to offer a treated water safe yield benefit. For this reason, this alternative is not considered practicable by the USCOE and USEPA. Therefore, this alternative is considered infeasible and impracticable at this time.

3.4.26 York River Desalination

Description

This alternative would consist of the following components: an 85 mgd raw water intake structure and pumping station, located on the York River in James City County; 13.6 miles of dual 42-inch, 85-mgd capacity raw water pipelines between the river pumping station and a reverse osmosis (RO) desalting facility; an RO desalting facility in York County capable of producing 44 mgd of finished water; a 20-mile, 36-inch 41 mgd capacity concentrate disposal pipeline between the RO plant and the York River; and a concentrate disposal outfall in the York River near the existing outfall of the Hampton Roads Sanitation District's (HRSD) York River STP in York County. Finished water would be supplied directly to the Lower Peninsula water distribution systems, without intermediate treated water storage. To provide an average day demand (ADD) treated water safe yield of 30 mgd, therefore, this alternative must be able to supply a maximum day demand (MDD) of 1.45 times the ADD, or approximately 44 mgd.

The York River withdrawal facilities would be located mid-way between Sycamore Landing and York River State Park in James City County, approximately 23 river miles upstream from the mouth of the York River.

The dual raw water pipelines would run cross-country from the York River pump station site in a southwesterly direction for approximately 3.6 miles through Croaker towards State Route 607. After crossing Interstate 64 just northwest of the interstate's junction with State Route 607, the pipelines would continue southwest for 3 miles towards an existing Virginia Power ROW. The pipelines would then follow the ROW for approximately 7 miles to an RO plant located near Williamsburg's Waller Mill water treatment plant in York County.

The RO plant would be designed to treat maximum raw water total dissolved solids (TDS) levels of 23,500 mg/L under summer conditions. Current membrane technology can achieve a product water recovery rate of 50 to 55 percent with raw water of this quality. Substantial treatment facilities would be required to condition the feed water before it reaches the RO membrane modules. Pre-treatment would include physical screening, conventional sedimentation and filtration (with a product water recovery rate of approximately 96 percent), and chemical addition for scale control and pH adjustment.

After pre-treatment, the feed water would enter the RO modules, which would be configured in parallel, with two-pass reject staging. Post-treatment of the RO permeate would include chlorine addition for disinfection, chemical conditioning for corrosion control, and degassing to remove excess carbon dioxide.

Initial treatment backwash water would be settled and returned to the head of the pre-treatment process. Residuals would be mechanically dewatered and disposed of off-site. Dependent on what contaminants may be present in the raw water, it is possible that special treatment of residuals prior to disposal could be required.

Concentrate from the RO process would also be disposed of off-site. If treatment chemical addition is minimized, the concentrate could possibly be discharged to the Chesapeake Bay at the mouth of the York River, where the normal TDS level in the river is high, but substantially less than the expected worst-case concentrate TDS level. The concentrate would be transported in a 20-mile, 41-mgd capacity pipeline that would discharge into the York River near the existing outfall of HRSD's York River STP in York County.

Assuming a worst-case feed water quality of 23,500 mg/L TDS, a water recovery rate of 52 percent, and a TDS rejection rate of 99 percent, the 41 mgd worst-case concentrate stream would have a TDS level of approximately 46,500 mg/L. Assuming dissolved inorganics constitute nearly all of the dissolved solids, the corresponding concentrate salinity would be approximately 45 ppt. By comparison, the average fall salinity level at the mouth of the York River is 24 to 26 ppt (SWCB, 1987a; SWCB, 1987b; SWCB, 1989; SWCB, 1991). The concentrate could possibly be discharged at this point, if dilution with York River STP effluent and an offshore diffuser outfall were provided. The maximum salinity of the combined discharge would be approximately 40 ppt. Phosphate levels in the concentrate are not expected to be above standard permit limits.

Safe Yield

With an approximate product water recovery rate of 50 to 55 percent, withdrawals of up to 85 mgd would be required to produce 44 mgd of desalinated surface water. Assuming no MIF requirement, and assuming a Lower Peninsula MDD factor of 1.45, this alternative would provide a treated water safe yield benefit of approximately 30 mgd.

In order to evaluate safe yield of this alternative, it was assumed that no MIF would apply to York River withdrawals. The basis for waiving the MIF requirement would be that the proposed withdrawal is located within the York River estuary where substantial tidal influx would preclude dewatering of aquatic habitat and allow traditional forms of water recreation to continue as before. Salinity intrusion effects are likewise not a potential concern since York River withdrawals would not be fresh, but would contain high levels of salinity. In December 1991 this assumption was reviewed and deemed suitable for this preliminary analysis by the SWCB (J. P. Hassell, SWCB, personal communication, 1991).

Practicability Analysis

For the reasons outlined below, the York River Desalination alternative is considered technologically and economically infeasible and therefore impracticable at this time.

Technological Reliability

Utilization of the York River as a source of public water supply raises serious concerns pertaining to water quality and the reliability of available treatment technologies to consistently produce a safe drinking water product. Treatment of water from a highly variable estuary source to drinking water standards has not been accomplished on a permanent basis anywhere at any scale. Any process for treating water from such a source must therefore be considered experimental.

The intake site proposed for York River withdrawals would be located just below the upriver limit of saltwater in the lower York River estuary. The area of mixing at the upriver limit of saltwater is often called the "salinity transition zone" (SWCB, 1991). This area of a tidal river experiences the most dramatic changes in salinity in response to tides, changing streamflow, and climatic events. This area of increasing salinity can cause some material suspended in the lower salinity, less dense upper water layer (flowing downstream) to coagulate, flocculate, and settle into the higher salinity, more dense bottom water layer (which has a net flow upstream). These materials can then be transported back upriver where they are reintroduced into the upper water layer or settle as sediment. This dynamic process creates an area of high turbidity, greater resuspension, and increased deposition; thus another name for this area of a tidal river is "turbidity maximum zone" (SWCB, 1991). As a result of the above-described processes, the turbidity maximum zone becomes a trap for nutrients, sediment, and toxics.

The widely fluctuating salinity levels in the vicinity of the proposed York River intake are a concern due to the difficulties they would cause in controlling the treatment process and the increased probability of varying product water quality and disruptions to treatment processes. During the course of a year, salinity concentrations in the vicinity of the intake site may vary from approximately 4 to 25 ppt (Hyer et al., 1975; SWCB, 1987a; SWCB, 1987b; SWCB, 1989; SWCB, 1991). Extreme high flow or low flow conditions (outside the limits of streamflow conditions under which salinity levels have been monitored) would likely extend this range of salinity levels at the intake site. Salinity level swings would also occur about every 6 hours due to the normal tidal cycle. In fact, salinity level swings of approximately 6 ppt have been monitored within 6-hour periods at York River mile 22.2, immediately downstream of the proposed intake site (Hyer et al., 1975). During the course of 24-hour periods, even larger salinity level swings would occur. For example, a 24-hour salinity level swing of approximately 8 ppt (4 to 12 ppt) has been monitored at York River mile 22.2 (Hyer et al., 1975).

The possibility of relocating the proposed York River intake to a site with less variable water quality was considered. However, downstream of the currently proposed location is the York River State Park and the Taskinas Creek marsh area (a component of the Chesapeake Bay National Estuarine Research Reserve System). Below the park is the Camp Peary Naval Reservation, the U.S. Naval Supply Center - Cheatham Annex, and the U.S. Naval Weapons Station. These facilities extend along the south bank of the York River to Yorktown, except for areas where the Colonial National Historical Parkway separates the U.S. Naval Weapons Station from the River. Below the developed waterfront area of Yorktown, the Colonial National Historical Park and U.S. Coast Guard Reserve Training Center extend to Marlbank Creek. It is unlikely that access to the south bank of the York River could be obtained across any of these military installations or state and national park areas. The HRSD's York River STP outfall is located just downstream of Marlbank Creek. Likewise, Amoco (Yorktown facility) and Virginia Power (Yorktown facility) are major industrial dischargers to this reach of the York River. Potential downstream intake locations therefore are not considered viable.

Upstream of the proposed York River intake site are several miles of saltwater marsh, including the marshes at the mouth of Ware Creek. Upstream of these marshes and Philbates Creek is an open river bank area where a pumping station could possibly be built. However, the York River offshore of this area of River bank is shallow and would render intake construction very difficult. Above Philbates Creek, the York River begins its transition to a brackish estuary, and the turbidity maximum zone occurs. Water quality in this zone would be even more variable than that at the currently proposed withdrawal site. Upstream withdrawal sites also would be in closer proximity to the discharge from the Chesapeake Corporation's industrial wastewater treatment plant approximately 10 river miles upstream of the proposed water intake site. This plant serves an existing Kraft pulp and paper mill located in the Town of West Point. Potential upstream intake locations are therefore not considered viable.

Due to raw water quality variability and treatment control concerns, and the lack of experience in treating water from a source of this type, this York River desalting alternative is considered experimental at this time. Therefore, this alternative is not considered to be technologically reliable.

Life Cycle Project Costs

A preliminary project cost estimate has been made for the York River Desalination alternative. The Year 1992 present value of life cycle costs, including land acquisition, construction, and operation and maintenance costs is $344.7 million. A breakdown of these costs is provided in Table 3-1E.

No additional cost estimates are required to allow comparison of this alternative's cost to the cost of other alternatives, since this alternative provides a treated water supply.

The total project life cycle cost estimate is then $344.7 million, or $11.5 million per mgd of the approximately 30 mgd treated water safe yield benefit. These estimated unit costs are more than 40 percent above the RRWSG's adopted cost feasibility level which equates to approximately $8 million per mgd of treated water safe yield. (Unit costs above this level for an alternative yielding approximately 30 mgd would result in projected household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula median household income.) For this reason, this alternative is considered economically infeasible.

Surface Water Desalting Status and Trends

The use of desalting to produce potable water from brackish surface (estuary) water remains experimental, and actual construction and operating cost data is lacking. An evaluation of the feasibility of using surface water desalting methods from ocean based sources was therefore conducted and is presented below.

Although technological advances have reduced desalting costs as much as 50 percent during the last three decades, surface water desalination remains very energy intensive, and as a result, has been used as a water supply of last resort (Frederick, 1995). Most of this surface water desalting capacity is located in the Middle East and the Carribean, where freshwater sources are not available. As of September of 1994, installed surface water desalting capacity in the United States totaled 13 mgd. Approximately 3 mgd was used for potable and non-potable water production, while the remainder has been placed on standby. The 1992 International Desalting Association (IDA) Worldwide Desalting Plants Inventory listed 8 proposed seawater desalting plants in the United States with a total capacity of 67 MGD. None of the plants was considered to be a viable water

TABLE 3-1E

YORK RIVER DESALINATION PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$40,000	3	$120,000
Pipeline Easements, Urban/Suburban – Acres (1)	$10,000	100	$1,000,000
Pipeline Easements, Rural – Acres (1)	$1,000	100	$100,000
TOTAL LAND ACQUISITION COSTS			$1,220,000
CONSTRUCTION			
85 mgd York River P.S. and Intake – LS			$16,000,000
Dual 42-Inch Trans. Main to Treatment Plant – LF	$450	71800	$32,310,000
36-Inch Concentrate Disposal Main to Outfall – LF	$175	105600	$18,480,000
36-Inch Outfall and Diffuser – LS			$2,000,000
Unadjusted Total of Desal. Treatment Facilities – LS	$212,200,000		
Present Worth of Phased Desalination Treatment Facilities			$102,995,827
48-Inch Finished Water Main to Kingsmill – LF	$225	34000	$7,650,000
SUBTOTAL			$179,435,827
Permitting, Preliminary Engineering & Legal (5%)			$8,970,000
Design, Construction Management & Administration (12%)			$21,530,000
Contingencies (20%)			$41,990,000
TOTAL CONSTRUCTION COSTS			$251,930,000
OPERATION AND MAINTENANCE			
Pilot Studies / Permitting of Treatment Process			$5,000,000
Electric Power for Pumping – LS	York River P.S.		$1,834,714
Operations and Maintenance – LS	York River P.S./Pipeline		$1,668,237
	WTP/R.O. Process		$83,063,962
TOTAL OPERATION AND MAINTENANCE COSTS			$91,570,000
TOTAL YEAR 1992 PRESENT VALUE COST			$344,720,000

Notes:

All costs in Year 1992 dollars

1) Assumes RRWSG jurisdictions would acquire.

supply source by 1994 (Leitner, 1994). Projected 1996 surface water plant construction in the United States was limited to a single 0.3 mgd facility proposed by the Marina Coast Water District in California. Thus, surface water desalting technologies in the United States have not been applied to the mainstream United States potable water markets.

Feasibility investigations and limited plant construction has occurred along the California and Florida coasts (Water Desalination Report, 1995). Due to the frequency of extended drought conditions in California, surface water desalting has been used as a standby source of potable water. A 1993 California Coastal Commission list of permitted potable water surface water desalting plant locations, plant size, and water production costs are listed below.

Plant Location	Plant Size (mgd)	Water Production Costs ($/1,000 gallons)
City of Morro Bay	0.600	$5.37
City of Santa Barbara	0.750	$5.89
California Department of Parks & Recreation, San Simeon Region	0.040	Costs Not Listed
Proposed Hotel/Conference Sterling Center, Sand City	0.020	Costs Not Listed
Santa Catalina Island	0.132	$6.14
Cambria Community Service District	0.100	Costs Not Listed

Although the 1995 City of Newport News Waterworks water production cost estimates are approximately $0.70 / 1000 gallons, a comparison of discrete utility water production costs may not be justified. These costs include site specific capital costs and terms for debt service. Operation and maintenance (O&M) costs do not include debt service, and a comparison of these variable costs is more appropriate. Cost estimates for a proposed 5 mgd Marin Municipal Water District facility in California were $5.80 / 1000 gallons, which included an O&M cost estimate of $2.30 / 1000 gallons (Kartinen, 1993). This is more than five times greater than the City of Newport News Waterworks current O&M cost of approximately $0.40 / 1000 gallons.

The need for potable water supplies from surface water desalting sources in Florida are not a result of frequent and lengthy drought conditions. Florida has investigated the use of seawater desalination to meet specific geographic constraints. Development pressure along the coasts has increased in areas that support only limited supplies of fresh water. Following Hurricane Andrew, the Florida Keys Aqueduct Authority, for example, brought a 3 mgd SWRO facility back on-line as an emergency source of potable water (Benson and Moch, 1994). The Southwest Florida Management District is investigating the feasibility of a 50 mgd surface water desalting facility in Tampa Bay which will use energy from electric power plants to make potable water from seawater. The use of pilot studies for the project have been delayed, and technological investigations are continuing.

The vast majority of existing surface water desalting plants in the United States have capacities less than 1 mgd, which is not on the same order of magnitude as the RRWSG's projected needs. These plants are typically used as standby sources of potable water because of the high energy requirements associated with the technology. As a result of high energy requirements to produce potable water, desalting costs will vary regionally, and are susceptible to changing economic and regulatory conditions. The Lower Peninsula service area needs to develop new, economically stable, water supplies for continuous use, not just standby use. The use of this source of potable water was, therefore, considered economically infeasible.

Smaller-Scale Option

The RRWSG has considered the possibility of developing a smaller-scale York River Desalination alternative. A smaller-scale desalination facility could be used in conjunction with other alternatives which, by themselves, are not sufficiently large to meet the entire 39.8 mgd projected Year 2040 deficit. A 10 mgd treated water safe yield would require a York River desalination plant sized to produce a daily maximum of 14.5 mgd, with a raw water intake capacity of approximately 28 mgd. The cost of a plant of this size was estimated, using pipeline routes, plant location, and treatment processes identical to those in the full size version of this alternative (see Table 3-1F). The Year 1992 present value of life cycle costs, including land acquisition, construction, and operation and maintenance costs is $229.5 million, or approximately $23 million per mgd of the 10 mgd treated water safe yield benefit. The cost of this smaller scale York River desalination alternative would place it as the second most expensive alternative, on a unit basis. In addition, these estimated unit costs are nearly three times greater than the RRWSG's adopted cost feasibility level which equates to approximately $8 million per mgd of treated water safe yield.

The smaller-scale version of the York River Desalination alternative also would be fraught with the same water quality and technological reliability problems associated with the full size alternative. The smaller alternative would be twice as expensive as the full size alternative on a cost per mgd safe yield basis (i.e., $23 million versus $11.4 million). For these reasons, the smaller scale alternative is also considered technologically and economically infeasible and impracticable.

3.4.27 Cogeneration

Description

This alternative would produce drinking water through desalination processes powered by excess steam from a privately-owned cogeneration facility. The alternative would involve locating a cogeneration facility on the Lower Peninsula, selling electricity to a utility company, and producing desalted water from excess steam production for sale to Lower Peninsula water purveyors.

To date, the only cogeneration facility which has been proposed for the Lower Peninsula is one originally proposed by Hadson Development Corporation (Hadson). This proposal would involve construction of a 165 megawatt (MW) pulverized coal-fired cogeneration power plant and multiple effect distillation (MED) desalination facility located off U.S. Route 60 between Skiffes Creek and BASF Corporation property in southeastern James City County. James River feed water was also proposed for facility use. Subsequently, Hadson's parent company sold its 100 percent interest in this proposed cogeneration project to LG&E Energy Systems (LG&E). It is not yet known whether LG&E will pursue this project as originally planned by Hadson.

TABLE 3–1F

YORK RIVER DESALINATION
10 MGD SAFE YIELD
PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$40,000	3	$120,000
Pipeline Easements, Urban/Suburban – Acres (1)	$10,000	100	$1,000,000
Pipeline Easements, Rural – Acres (1)	$1,000	100	$100,000
TOTAL LAND ACQUISITION COSTS			$1,220,000
CONSTRUCTION			
28 mgd York River P.S. and Intake –LS			$5,000,000
36–Inch Trans. Main to Treatment Plant – LF	$175	71800	$12,570,000
24–Inch Concentrate Disposal Main to Outfall – LF	$120	105600	$12,670,000
24–Inch Outfall and Diffuser –LS			$1,400,000
Treatment Facilities			
Conventional Pretreatment – LS			$36,000,000
Pretreatment Residual Handling – LS			$11,000,000
RO Plant Structure – LS			$4,000,000
RO Piping & Mechanical – LS			$8,000,000
Standby Power – LS			$2,900,000
RO Modules – LS			$22,000,000
30–Inch Finished Water Main to Kingsmill – LF	$150	34000	$5,100,000
SUBTOTAL			$120,640,000
Permitting, Preliminary Engineering & Legal (5%)			$6,030,000
Design, Construction Management & Administration (12%)			$14,480,000
Contingencies (20%)			$28,230,000
TOTAL CONSTRUCTION COSTS			$169,380,000
OPERATION AND MAINTENANCE			
Pilot Studies / Permitting of Treatment Process			$5,000,000
Electric Power for Pumping –LS	York River P.S.		$985,993
Operations and Maintenance –LS	York River P.S./Pipeline		$1,668,237
	WTP/R.O. Process		$51,275,930
TOTAL OPERATION AND MAINTENANCE COSTS			$58,930,000
TOTAL YEAR 1992 PRESENT VALUE COST			$229,530,000

Notes:

All Costs in Year 1992 dollars.

1) Assumes RRWSG jurisdictions would acquire.

With this alternative, it is assumed that a proposed intake could be located on the James or York rivers. River water would be used to cool the power plant as well as provide for a raw water source for the distillation process. A discharge structure would also be required for return of the cooling water and concentrate disposal.

The implementation of this alternative relies largely on the viability of a private cogeneration vendor willing to construct such a facility on the Lower Peninsula and sell water produced from the excess steam. The feasibility of this type of arrangement is primarily driven by a combination of electrical energy production markets as well as water production costs.

Safe Yield

The potential water production capacity of the distillation facility is dependent on the power plant capacity. Information from the Hadson cogeneration proposal indicates that the maximum distilled water production capacity from the proposed 165 MW facility would be 20 mgd. However, in early discussions between Hadson and Newport News Waterworks, a water production rate of 5 to 10 mgd was discussed. The safe yield from cogeneration facilities is highly variable and dependent upon individual private vendor proposals. As a result, a safe yield number cannot be assigned to this alternative at this time.

Practicability Analysis

The VDH has taken a strong position against use of the lower James River as a public water supply source; and there appear to be other sources of potable water which have not been shown to be unavailable to the RRWSG. In this case, therefore, it does not appear that the State would approve this cogeneration alternative (Hadson proposal) since it would rely on lower James River withdrawals. Additionally, the RRWSG member jurisdictions have not received any formal proposals from private cogeneration vendors to sell water produced from excess steam. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.28 Wastewater Reuse as a Source of Potable Water

Description

This alternative would involve blending highly treated wastewater with potable raw water supplies as a means of increasing total raw water supplies. Increasing potable water supplies with highly treated wastewater in this way is considered "indirect reuse" of wastewater, as opposed to "direct" or "pipe to pipe" recycle. This indirect wastewater reuse alternative would consist of an advanced wastewater reclamation plant close to the existing Hampton Roads Sanitation District (HRSD) York River WWTP; a multi-compartment, reclaimed water lagoon; a reclaimed water pump station; and pipelines to Harwood's Mill and Lee Hall reservoirs.

Safe Yield

This alternative's Year 2040 treated water safe yield benefit was calculated at 6.5 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This determination was based on the assumption that steady streams of advanced WWTP effluent would be discharged to Harwood's Mill and Lee Hall reservoirs at rates of 4 mgd and 3 mgd, respectively. The Year 1992 treated water safe yield benefit would be approximately 3.7 mgd based on advanced

WWTP effluent being discharged to Harwood's Mill and Lee Hall reservoirs at rates of 1 mgd and 3 mgd, respectively.

The reported treated water safe yield benefits assume that combined losses associated with WWTP effluent transmission, seepage from the terminal reservoirs, and treatment would be on the order of 5 percent of total simulated raw water safe yield benefits.

Practicability Analysis

The VDH has taken a strong position against wastewater reuse as a source of potable water. The VDH position indicates that this alternative is not considered permittable by the State. There are also major public health concerns associated with potable reuse which bring into question the technological reliability of the alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.29 Wastewater Reuse For Non-Potable Uses

Description

This alternative would involve advanced treatment of WWTP effluent to produce non-potable water, suitable for industrial cooling and industrial process use. The utilization of WWTP effluent as a non-potable water source would allow existing potable water sources to satisfy additional potable water demands. This wastewater reuse alternative would consist of one or more reuse water systems. Each system would include an advanced wastewater reclamation plant, reuse water pump station, distribution system, and storage facilities. Each system would be located adjacent to an existing Hampton Roads Sanitation District (HRSD) WWTP on the Lower Peninsula.

Safe Yield

The current and short-term projected average daily flows at the Williamsburg, York River, and Boat Harbor WWTPs were evaluated. Allowing for low flow periods below the average, these flows represent a current reliable source of at least 20 mgd that may be made available for industrial reuse. However, the safe yield for this alternative is represented by the amount of potable public water supply water usage that is converted to this non-potable supply, thus freeing the potable water supply for use by others. By reducing the demand for traditional potable water, this alternative would make available an additional supply of potable water that could be utilized by new customers. Additionally, the safe yield reflects only that use of non-potable water that traditionally would have been supplied by the potable public supply system. The use of non-potable reuse water instead of low quality groundwater by industry would not represent any overall safe yield benefit to the potable public supply system.

In December 1991, Malcolm Pirnie conducted a telephone survey of existing large industrial water customers on the Lower Peninsula. Industrial customers surveyed use in excess of 100,000 gallons per day of potable public water for non-potable uses. Based on this survey, approximately 2.5 mgd of current potable water usage could be served by a non-potable water supply. This represents approximately 25 percent of the total 1990 heavy industrial demand for public water. Assuming this ratio will be similar for new industry, approximately 2.5 mgd of new heavy industrial demand could be served by a non-potable water supply in the Year 2040. Therefore, a long-term treated water safe yield benefit of between 0 and 5 mgd may be possible through implementation of this alternative.

Practicability Analysis

The RRWSG member jurisdictions cannot dictate whether industrial water users or other large water users develop separate distribution systems which make use of treated wastewater effluent for non-potable uses. Lower Peninsula water purveyors could build their own separate distribution systems to supply non-potable water demands with treated wastewater effluent. However, it is anticipated that the costs of doing so would be excessive in comparison to other alternatives under consideration.

While this alternative has not been shown to be impracticable, it will not be carried forward for further environmental analysis. Instead, as recommended by federal regulatory and advisory agencies, this alternative is included as part of the regional conservation plan presented in the ***Water Demand Reduction Opportunities*** report (Malcolm Pirnie 1993).

3.4.30 Additional Conservation Measures and Use Restrictions

Additional conservation measures and use restrictions were defined and discussed in Section 2.6.1. They are evaluated in this section as an alternative to new source development.

Additional Conservation Measures

As presented in Section 2.6.4, Lower Peninsula water demands are projected to increase at an annual average rate of 1.16 percent, from 55.2 mgd in the Year 1990 to 98.2 mgd in the Year 2040. These demand projections assume that the same level of conservation that has occurred on the Lower Peninsula, and has resulted in the existing usage rates, will be maintained throughout the planning horizon. However, as a result of the additional aggressive water conservation activities within the study area, the potential exists that existing usage rates can be reduced even further. Per capita and per employee water usage (applied for residential and commercial demand projections, respectively) are estimated to decline over the planning period to account for demand reductions resulting from the implementation of aggressive conservation measures.

As part of the RRWSG's conservation strategy, Reasonable Conservation Objectives (RCOs) were established for each of the RRWSG jurisdictions. RCOs were developed as reasonable, achievable goals based on documentation of the need for water and achievable per capita demand reductions through conservation. The RRWSG's conservation strategy is described in detail in Report A, ***Water Demand Reduction Opportunities*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document.

Residential Water Usage RCO

For residential water use, the RCO is developed based on the amount of daily water needed per capita for essential water uses. This objective is developed on a per capita basis and not as a percent reduction. Using a percent reduction would require those residential users who have already achieved a reduotion from the implementation of existing conservation measures to reduce their demands by the same percentage as those areas which have achieved less water demand reductions.

To determine the residential RCO, a literature review was conducted to characterize residential water usage. A national study (Brown and Caldwell, 1984) sponsored by the U.S. Department of Housing and Urban Development (HUD) was included in this review. This study characterized indoor water use and estimated the amount of water required in a conserving versus a non-conserving home. This HUD study was the only broadly accepted, scientifically based study of water usage characteristics identified in the research effort. It was, therefore, used as a basis for developing the RRWSG's residential RCO.

The HUD study methodology considered such factors as household size, age distribution, housing types, and income levels. The HUD study group characteristics were similar to and representative of the RRWSG region. Therefore, it was decided that the HUD data could be applied to the RRWSG study area.

The HUD study indicated that average indoor water usage in a non-conserving home is 77 gallons per capita per day (gpcpd). Through the use of water conserving fixtures and effective indoor water conservation techniques, the study indicated that average indoor water usage can reasonably be reduced to 60 gpcpd (Maddaus, 1987). Updated information on toilet leakage and shower time adjusted this total to 60.2 gpcpd. This indoor usage with conservation was adopted by the RRWSG. This analysis assumes that plumbing retrofits with low-flow plumbing, as mandated by the Federal Energy Policy Act, will occur in the Lower Peninsula over the next 50 years.

To develop a residential RCO, a value must be added to the indoor usage value of 60.2 gpcpd to represent outdoor usage. After a careful review of billing cycles and usage patterns, an estimated outdoor use value of 6.7 gpcpd was adopted by the RRWSG. Adding this estimated outdoor usage value to the RRWSG adopted indoor usage value of 60.2 gpcpd results in an RCO of 66.9, or 67 gpcpd. This conservation goal was used as a basis for estimating future residential water demands within the study area. Current water usage of 72.9 gpcpd will need to be decreased by an average of 8.1 percent to meet the residential RCO.

Commercial Water Usage RCO

As a result of the variability of water use within the commercial category, it was not possible to define an RCO as calculated for residential water usage. However, because water is used in a similar manner as in the residential category, similar conservation measures used to achieve reductions in the residential category can also be applied to the commercial category. Therefore, the RCO for commercial demands was also set at an 8.1 percent reduction over base year demands.

Industrial Water Usage RCO

Due to the wide variety of industrial water uses and quantity requirements, and the inability to accurately predict the impact of influencing factors on future industrial demands, a specific RCO for existing industry on the Lower Peninsula was not defined. However, it is assumed that heavy industry on the Lower Peninsula will continue to be influenced to conserve water in the future as a result of financial incentives and regulatory requirements.

Safe Yield

Applying the RCO's to the demand projections presented in Section 2 (see Table 2-17) results in the demand projections presented in Table 3-1G. These projections reflect the reduction in residential per capita usage of 8.1 percent throughout the planning period. The per capita use rates are 72.9 gpcpd for the Year 1990, declining to 67 gpcpd for the Years 2010 through 2040 as a result of anticipated expansion in additional conservation efforts. Commercial, institutional and light industrial demand projections are also expected to decrease by 8.1 percent in the planning period. The per-employee use rate is 70.4 gpepd for the Year 1990 declining to 64 gpcpd for the Years 2010 through 2040. All other assumptions used in projecting demands in Section 2 remain the same.

A comparison of demand projections with and without additional conservation measures is presented in Table 3-1H. The data in Table 3-1H indicate that additional conservation measures will reduce Year 2040 demands by approximately 5.6 mgd (5.7 percent). Therefore, the safe yield benefit of additional conservation measures is 5.6 mgd.

Further Discussion of Conservation Objectives

The Southern Environmental Law Center (SELC) provided comments on the 1994 DEIS to the USCOE (D.W. Carr, SELC, personal communication, 1994). The SELC advocated a demand side management approach employing aggressive conservation measures to postpone the need for additional water supplies. To support its view, the SELC cited examples of demand side projects being used in Denver, Seattle, and Southern California. However, there are differences in water use patterns between these Western United States areas and Southeastern Virginia which lead to differences in water demand reductions actually achievable.

Caution is required when comparing the actual demand reductions achieved in one area to those which may be achieved in another. Water savings are often defined in terms of percentages. For example, it is not unusual to see demand reductions of 25 percent or greater following the implementation of conservation plans in the Western United States. Per capita water usage in the West is generally much higher than in the East, due to the differences in climate between the two areas. In the West, outdoor water usage is a much greater percentage of total demand than it is in the East. Therefore, substantial demand reductions in the West can often be achieved by targeting outdoor usage. The potential for similar reductions in outdoor usage is not available on the Lower Peninsula. As described above, estimated outdoor usage on the Lower Peninsula is very low (about 7 gpcpd). Substantial demand reductions must therefore occur within the home or establishment.

The Reasonable Conservation Objectives (RCOs) identified above, which were used as a basis for developing demand projections for the residential and commercial demand categories, are aggressive conservation targets for the Lower Peninsula region. While the percentage reduction in demand expected from additional conservation may not be as great as those experienced in the West, they are considerable reductions for urban areas in the Virginia Coastal Plain. For example, the RRWSG's residential and commercial RCOs represent 8.1 percent reductions from base year usage rates in the Lower Peninsula.

TABLE 3-1G

CALCULATION OF PROJECTED LOWER PENINSULA TOTAL WATER DEMAND WITH ADDITIONAL CONSERVATION MEASURES (2000-2040)

(mgd)

		RESIDENTIAL			COMM./INST./LIGHT. IND.			HEAVY WATER USE INDUSTRY								FEDERAL INSTALL.	SUBTOTAL DEMAND	UAW		TOTAL DEMAND
								INDUSTRIAL EMPLOYMENT				EXIST. IND.	NEW INDUSTRY		TOTAL IND.					
								TOTAL	NEW											
YEAR	TOTAL REGION. POP.	CIVILIAN POP. SERVED	REG. AVG GPCPD	DEMAND	TOTAL COMM. EMPL.	REG. AVG. GPEPD	DEMAND		TOTAL	EXIST.	NEW	DEMAND	GPEPD	DEMAND	DEMAND	DEMAND		%	DEMAND	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
2000	459978	425646	70	29.80	174511	67	11.69	37275	4564	746	3818	10.37	640	2.44	12.81	4.82	59.12	10.00	6.57	65.69
2010	519281	485871	67	32.55	196654	64	12.59	42081	9370	1106	8264	12.02	640	5.29	17.31	5.45	67.90	10.00	7.54	75.44
2020	554077	519667	67	34.82	208717	64	13.36	44901	12190	1411	10779	12.10	640	6.90	19.00	5.48	72.65	10.00	8.07	80.73
2030	594565	559145	67	37.46	223125	64	14.28	48182	15471	1816	13655	12.18	640	8.74	20.92	5.51	78.17	10.00	8.69	86.86
2040	636308	599848	67	40.19	238170	64	15.24	51565	18854	3121	15733	12.31	640	10.07	22.38	5.52	83.33	10.00	9.26	92.59

[shaded box] PROJECTED VALUES USED IN ARRIVING AT TOTAL DEMAND

LEGEND:

A – TOTAL PROJECTED POPULATION ON LOWER PENINSULA, FROM TABLE 2-10.
B – TOTAL PROJECTED RESIDENTIAL POPULATION SERVED ON LOWER PENINSULA, FROM TABLE 2-12.
C – PROJECTED RESIDENTIAL USAGE RATE (GALLONS PER CAPITA PER DAY), WITH ADDITIONAL CONSERVATION.
D – PROJECTED DEMAND, COLUMN B*C.
E – TOTAL PROJECTED EMPLOYMENT ON LOWER PENINSULA MINUS EMPLOYMENT IN HEAVY WATER USE INDUSTRY AND MILITARY EMPLOYMENT.
F – PROJECTED COMMERCIAL/INSTITUTIONAL/LIGHT INDUSTRIAL USAGE RATE (GALLONS PER EMPLOYEE PER DAY), SAME PERCENTAGE REDUCTION DUE TO CONSERVATION AS IN RESIDENTIAL USAGE.
G – PROJECTED DEMAND, COLUMN E*F.
H – TOTAL PROJECTED EMPLOYMENT IN HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA INCREASE IN THIS EMPLOYMENT IS DIRECTLY PROPORTIONAL TO INCREASE IN TOTAL POPULATION.
I – TOTAL NEW EMPLOYEES WORKING IN HEAVY WATER USE INDUSTRIES, COLUMN H-32,711 (NUMBER OF EMPLOYEES IN YEAR 1990).
J – NEW EMPLOYEES HIRED BY EXISTING HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA DUE TO GROWTH OF THESE INDUSTRIES. SELF-PROJECTED BY EXISTING INDUSTRIES. FROM APPENDIX REPORT B, TABLE 4-11.
K – NEW EMPLOYEES HIRED BY FUTURE NEW HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA COLUMN I-J.
L – PROJECTED DEMAND, SELF-PROJECTED BY EXISTING HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA
M – PROJECTED HEAVY WATER USE INDUSTRIAL USAGE RATE (GALLONS PER EMPLOYEE PER DAY). FROM APPENDIX REPORT B, SECTION 4.
N – PROJECTED DEMAND, COLUMN M*K.
O – PROJECTED TOTAL HEAVY WATER USE INDUSTRIAL DEMAND, COLUMN L+N.
P – FEDERAL INSTALLATIONS DEMAND, FROM REPORT B. TABLE 4-23.
Q – SUBTOTAL OF PROJECTED METERED DEMANDS, COLUMN D+G+O+P.
R – PROJECTED UNACCOUNTED-FOR WATER PERCENTAGE EXPRESSED AS PERCENT OF TOTAL FINISHED WATER PUMPED INTO THE DISTRIBUTION SYSTEM.
S – PROJECTED DEMAND, COLUMN Q*(R/(100-R))
T – TOTAL PROJECTED LOWER PENINSULA DEMANDS, COLUMN Q+S.

TABLE 3-1H

COMPARISON OF YEAR 2040 DEMANDS WITH AND WITHOUT CONSERVATION

Demand Category	Regional Demands (mgd)		Savings from Normal Conservation	
	Without Conservation	With Conservation	(mgd)	(%)
Residential	43.73	40.19	3.54	8.1
Commercial, Institutional and Light Industrial	16.77	15.24	1.53	8.1
Heavy Industrial	22.38	22.38	0	0
Federal Installations	5.52	5.52	0	0
Unaccounted-for Water	9.82	9.26	0.56	5.7
Total	**98.22**	**92.59**	**5.63**	**5.7**

To examine the validity of the residential RCO, the experience of the nearby City of Virginia Beach, Virginia was reviewed. A series of droughts beginning in 1976-77 have caused severe water supply shortages in the City. Since 1981, Virginia Beach has operated under an intensive water conservation program. Virginia Beach also enacted a City Ordinance in February 1992 which imposed mandatory year round water use restrictions, pending completion of the Lake Gaston pipeline project. In 1993, after imposition of these restrictions, Virginia Beach's total per capita demand was estimated at 80 gpcpd (City of Virginia Beach, 1994). Assuming that Virginia Beach's industrial and commercial demands remained at 15 gpcpd as estimated for 1986[5], its domestic and public usage in 1993 was 65 gpcpd[6].

For the Lower Peninsula, the 1990 residential per capita demand is estimated at approximately 73 gpcpd. With the implementation of additional conservation measures, the RRWSG expects to reduce the residential per capita demand to 67 gpcpd by the Year 2010. The RRWSG's goal is to meet this target all the time instead of only during water supply emergencies, which makes this an aggressive target in light of the estimated 65 gpcpd use rate which Virginia Beach achieved in 1993 during a severe water shortage.

<u>Use Restrictions</u>

A use restrictions operating schedule has been developed for the Lower Peninsula which employs similar techniques to those applied in other areas. This schedule, which includes storage threshold levels applicable to each use restriction tier, is summarized in the following table.

Reservoir Storage Capacity (% of total)	Demand Reduction Measures
100-75	Additional Conservation Measures
75-50	Voluntary Restrictions (Tier 1)
50-0	Mandatory Restrictions (Tier 2)

Report L, ***Water Conservation Management Plan*** (City of Newport News, Department of Public Utilities, 1995) which is incorporated herein by reference and is an appendix to this document, includes a use restrictions plan which relies on a risk-based assessment of reservoir conditions which varies throughout the year. The actual plan in effect in the service area is simplified herein for use in this analysis. Water rationing is required in the water conservation management plan under extreme conditions, but is not included in this schedule. It would not be prudent management for a

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1 Prior to the 1980-81 drought, Virginia Beach's total per capita water demand was approximately 97 gpcpd (1976-77) (Malcolm Pirnie, 1991). By 1986 its total demands had been reduced to an estimated 87 gpcpd, with domestic and public water demands accounting for 72 gpcpd. The 15 gpcpd difference was attributed to industrial and commercial usage (City of Virginia Beach, 1988).

2 If reductions in industrial and commercial demands also contributed to the reductions achieved since 1986, then domestic and public usage contributed a larger portion of the 1993 total than 65 gpcpd.

water utility to plan on water rationing to meet the future water needs of its service area, due to the severe socioeconomic impact this could have on water customers. Rather, water rationing should be reserved as a safety factor for possible use during water supply emergencies.

Demand reduction objectives have been developed for the residential, commercial, heavy industrial, and federal installations water demand categories. For the residential category, the Tier 1 and Tier 2 objectives are 64 gpcpd and 62 gpcpd, respectively. These factors represent a 4.5 percent and a 7.5 percent reduction in demand in addition to an 8.1 percent reduction goal (to be achieved through additional conservation measures). The same percentage reductions are assumed for commercial, heavy industrial, and federal installations demands. The commercial objectives are also in addition to the 8.1 percent reduction included for additional conservation measures. These use restriction objectives are presented as demand reduction factors as shown below:

Demand Reduction Measures	Average Annual Usage Goals (%)	Demand Reduction Factors
Voluntary Restrictions (Tier 1)	4.5	0.955
Mandatory Restrictions (Tier 2)	7.5	0.925

Safe Yield

The treated water safe yield benefit of the use restrictions alternative was calculated using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. Safe yield determinations were based on the demand reduction factors and corresponding raw water storage threshold levels defined in the preceding description of this alternative. Assuming operation of the existing system with its current safe yield, the treated water safe yield benefit of the use restrictions alternative would be approximately 1.5 mgd.

An analysis was also conducted to determine the safe yield benefit of the use restrictions alternative as part of the King William Reservoir with Mattaponi River Pumpover alternative. Operating at a demand level equivalent to the safe yield of an expanded system with the King William Reservoir project on-line, the RRWSG's treated water safe yield benefit attributable to use restrictions would be as follows, depending on which King William Reservoir configuration is considered.

KWR-I	5.5 mgd
KWR-II	5.2 mgd
KWR-III	4.9 mgd
KWR-IV	4.9 mgd

Practicability Analysis

Based on information compiled to date, there is no basis for deeming the Additional Conservation Measures and Use Restrictions alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

Summary

Based on the analysis presented above, Additional Conservation Measures and Use Restrictions have a combined safe yield which ranges from 7.1 mgd to 11.1 mgd. Projected demands with and without the Additional Conservation Measures and Use Restrictions alternative are presented in Figure 3-1D.

The data presented in Figure 3-1D are based on the assumption that there would be a steady increase in the safe yield benefit of use restrictions beginning in the Year 2000. At that time, the use restrictions benefit would be 1.5 mgd and, after the addition of new King William Reservoir Storage, would steadily increase to a maximum benefit of approximately 5 mgd in the Year 2040 as projected demands increase. These simplifying assumptions were used for the purposes of presentation.

3.4.31 No Action

Description

The Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations, specify that the alternative of "no action" be included in the analysis of project alternatives (40 CFR § 1502.14).

The No Action alternative could be expanded to include those alternatives which would not require a federal or state permit. At least two alternatives would require no federal or state permits: Use Restrictions and No Action. However, for purposes of this EIS, the Use Restrictions alternative is evaluated separately (see Section 3.4.30).

Under the No Action alternative, the RRWSG would do nothing to provide additional raw water supply or curtail water use on the Lower Peninsula. To limit growth, water purveyors could place moratoriums on new hook-ups. New industry and other water users would, therefore, be unable to locate in the region due to a lack of treated water supply.

Safe Yield

No safe yield benefit is associated with the No Action alternative and, as a result, deficit projections presented in Section 2.7 would be anticipated throughout the planning period.

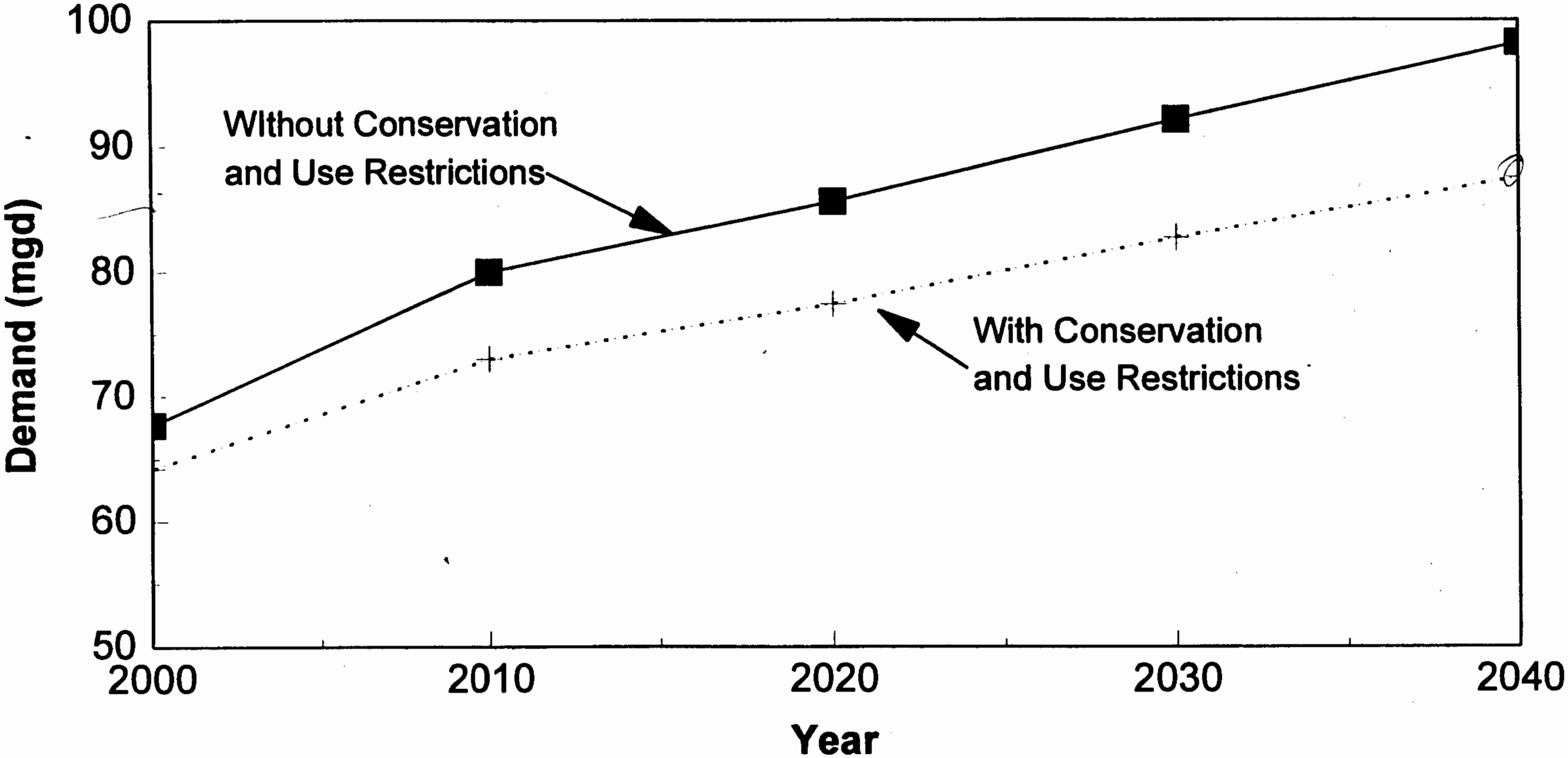
Practicability Analysis

The No Action alternative is not considered feasible or practicable since it does not contribute to a solution of the basic project purpose. Nevertheless, the No Action alternative has been retained for further environmental analysis pursuant to the CEQ NEPA regulations (40 CFR § 1502.14).

3.4.32 Additional Alternatives Considered

The RRWSG considered four additional reservoir alternatives. Two of those alternatives were identified during the course of interagency scoping, and the other two alternatives (Side-Hill Reservoir and King William Reservoir with Two River Pumpovers) were identified subsequent to publication of the DEIS. None of those alternatives was included in the original list of 31 alternatives

PROJECTED LOWER PENINSULA DEMAND WITH AND WITHOUT ADDITIONAL CONSERVATION MEASURES AND USE RESTRICTIONS



* Year 2040 demand reduction of up to 11.1 mgd possible with Additional Conservation Measures and Use Restrictions in conjunction with King William Reservoir with Mattaponi River Pumpover alternative.

Figure 3-1D

in the USCOE's *Conceptual Scoping Outline for the Lower Peninsula's Raw Water Supply Draft EIS* (W. H. Poore, Jr., USCOE - Norfolk District, personal communication, 1990). Nevertheless, efforts were made by the RRWSG to evaluate the practicability of these alternatives, and the results of its investigations are summarized below.

3.4.32.1 Black Creek Reservoir with Pumpover from Mattaponi River

Description

This project would be similar to the Black Creek Reservoir with Pumpover from Pamunkey River alternative described in Section 3.4.13, but the primary raw water source would be the Mattaponi River instead of the Pamunkey.

Safe Yield

It is anticipated that a substantial reduction in project safe yield would occur as a result of using the Mattaponi River rather than the Pamunkey River as a pumpover source for the Black Creek Reservoir due to lower average flow levels in the Mattaponi and a smaller river pumping station capacity than the 120 mgd capacity proposed on the Pamunkey.

This conclusion is supported by safe yield evaluations conducted for the Ware Creek Reservoir alternative, which would have a similar volume as Black Creek Reservoir (6.87 versus 6.41 BG). The safe yield analysis results presented in Section 3.4.11 show that a 5.1 mgd reduction in safe yield would occur if the Mattaponi (at 75 mgd withdrawal capacity) is used instead of the Pamunkey (at 120 mgd withdrawal capacity) to supply Ware Creek Reservoir. In reality, this reduction would be even larger since the Mattaponi River MIF now being considered (i.e., Modified 80 Percent Monthly Exceedance Flows) establishes higher MIF values for each month of the year than the MIF used to calculate the results presented in the DEIS (i.e., 40/20 Tennant). Consequently, it is expected that the reduction in Black Creek Reservoir project safe yield could be on the order of 5 mgd or more if the Mattaponi were used as a pumpover source instead of the Pamunkey.

Practicability Analysis

Given the reduction in project safe yield described above, development of a 39.8 mgd project alternative which includes the Black Creek Reservoir with Mattaponi River pumpover, rather than the Pamunkey River pumpover, would require development of a greater number of water sources. The environmental impacts associated with developing additional water sources likewise would be greater.

The pipeline route required for the Mattaponi River pumpover scenario would be longer than for the Pamunkey River pumpover and would require crossing an additional river basin divide and the Pamunkey River. As a result, additional stream crossings and greater temporary land disturbance would occur. Energy requirements to pump river withdrawals also would be greater, thereby creating additional energy consumption and associated impacts from increased energy production. With these increased construction and operating costs, total project costs for the Mattaponi River pumpover scenario would be higher than for the Pamunkey River pumpover, with no reduction in impacts.

The Mattaponi River intake and a portion of the pipeline route would lie within King William County. Because King William County is not a member of the RRWSG, the County's approval would be critical to the RRWSG's successful implementation of this alternative. As discussed in

Section 3.4.13, the governing body (City Council or County Board of Supervisors) of a host locality must grant its approval for another locality's development of public water supply facilities within its borders, under numerous provisions of Virginia law. These include zoning and local consent laws.

One of the key requirements for obtaining King William County's local consents and approvals is the capacity of an alternative to provide the County with a future water supply. Without a reservoir in King William County, Mattaponi River withdrawals would not supply the County with a reliable water supply during low flow periods when the MIF would prohibit river withdrawals. Therefore, the County has stated its opposition to a Mattaponi River withdrawal without a local reservoir (D. S. Whitlow, King William County, personal communication, 1992, and reconfirmed in May 1995). The County has thus given a strong indication that it would deny local consents and approvals for the construction of the Mattaponi River intake structure, pumping station, and raw water transmission line required for this Black Creek Reservoir pumpover alternative.

Based on the environmental, technical, and institutional constraints discussed above, a Mattaponi River pumpover to Black Creek Reservoir is less practicable than a Pamunkey River pumpover. Therefore, a Mattaponi River pumpover scenario for the Black Creek Reservoir was not retained for further environmental analysis.

3.4.32.2 Ware Creek Reservoir (Three Dam Alternative) with Pamunkey River Pumpover

Description

This alternative Ware Creek project was proposed in the course of the USCOE's evaluation of James City County's Section 404 permit application for Ware Creek Reservoir. One dam would be located across Ware Creek at a point 3,000 feet upstream of the Ware Creek dam site proposed by the County. A second dam would be located on Cow Swamp at a point 2,250 feet upstream of its confluence with France Swamp. A third dam would be located in the extreme headwaters of France Swamp, approximately 1,500 feet south of Interstate 64. The normal pool elevations of these three impoundments would be at 40, 50, and 50 feet msl, respectively; and the combined surface area of the three impoundments would be 955 acres for a combined storage volume of 4.95 BG (USCOE, 1987).

As a regional project for the RRWSG, the three impoundments would be interconnected with one another and with the Newport News Waterworks system, and augmented by a 120 mgd capacity Pamunkey River pumpover.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. Ware Creek Reservoir was evaluated as an interconnected component of the existing Newport News Waterworks system. The total treated water safe yield of this alternative is 20.8 mgd. The detailed methods of analysis used for estimating the safe yield of the Ware Creek Reservoir alternative are presented in Section 3.3.3.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of host jurisdiction allowance for New Kent County, where a portion of the reservoir and other components of the reservoir/river pumpover project would be located. As explained in Section 3.3.3, a combined 3 mgd host jurisdiction treated water safe yield allowance was subtracted from the total safe yield for alternatives which include Ware Creek Reservoir with river pumpover. After subtracting this host jurisdiction allowance, the balance remaining for the RRWSG is 17.8 mgd (20.8 mgd- 3 mgd (for New Kent County)).

Practicability Analysis

Without the King William Reservoir, the combined safe yield benefit of the practicable groundwater and additional conservation measures and use restriction alternatives would be 17.2 mgd. For purposes of this discussion, it is assumed that both of the groundwater development projects would be permitted, which may be uncertain (see Section 3.5). If 17.2 mgd were available from those alternatives, and if it were coupled with the RRWSG safe yield benefit of 17.8 mgd from the Ware Creek Reservoir three dam alternative, the resulting total (35.0 mgd) still would be 4.8 mgd short of the RRWSG's projected Year 2040 deficit of 39.8 mgd. Even when combined with the three practicable alternatives which do not involve new reservoir construction, the Ware Creek Reservoir three dam alternative would fail to meet projected RRWSG needs, so it is considered impracticable at this time and has not been retained for further environmental analysis.

3.4.32.3 Side-Hill Reservoir

Subsequent to publication of the DEIS, regulatory agency personnel expressed interest in the efforts of Hanover County to identify a viable side-hill reservoir project. As directed by the USCOE, the RRWSG conducted an investigation of using a side-hill reservoir or reservoirs as the off-stream storage component of a project that would yield approximately 30 mgd. The results of this side-hill reservoir investigation are described in Report M, ***Practicability Analysis of Side-Hill Reservoir Alternatives in the Lower Pamunkey River and Mattaponi River Valleys*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document.

Description

A side-hill reservoir differs from a conventional water storage reservoir because a naturally occurring stream valley is not required to form the storage pool. Rather, a side-hill reservoir is constructed on an upland site, utilizing existing terrain such as the face of a bluff adjacent to a flat plain to form one or two sides of the impoundment. The possibility of locating a reservoir in an area with very few wetlands represents the potential environmental advantage of a side-hill reservoir.

The remaining sides of such an impoundment structure are constructed of compacted earth fill dams or embankments. Water is withdrawn from a nearby river through an intake structure and pumped through a transmission main to the reservoir. Water is withdrawn or pumped from the reservoir for treatment, or conveyed through another transmission main to the next component of the raw water storage system.

For this proposal, the side-hill reservoirs would be located against bluffs existing along either the Mattaponi or the Pamunkey River valleys. Water would be withdrawn from one of the rivers and pumped to the side-hill reservoirs. Water would then be pumped from the side-hill reservoirs through a transmission main to the existing Diascund Creek Reservoir watershed.

The areas evaluated for side-hill reservoir sites were the corridors along the Mattaponi and Pamunkey River valleys. Due to costs associated with increased piping distances, and the strong potential for jurisdictional conflicts, it was determined that the potential sites should be no farther west than the western borders of King William County. Also, due to increasing salinity levels and development densities, it was determined that the RRWSG side-hill reservoir sites could be located no farther downstream than the confluence of the Mattaponi and Pamunkey Rivers at the Town of West Point.

Areas in Hanover County were not evaluated, in part, because the distance from any possible Hanover County reservoir sites to the existing Lower Peninsula reservoirs would result in excessive raw water transmission costs. Moreover, Hanover County, in cooperation with Richmond, has studied and evaluated its own side-hill reservoir project to serve the County's needs and provide more water to serve the needs of the Greater Richmond Area. Therefore, it appears unlikely that Hanover County would allow the RRWSG to develop potential sites located within the County's borders for the purpose of providing water to the Lower Peninsula.

Areas in New Kent County also were eliminated, because of the relationship between the RRWSG and New Kent County. On September 19, 1994, the New Kent County Board of Supervisors adopted a motion stating its opposition to the RRWSG's activities in New Kent County and its intention not to cooperate with Newport News on the Black Creek Reservoir project (R. J. Emerson, New Kent County, personal communication, 1994). Based on this action, and other past dealings between New Kent County and Newport News, it appears unlikely that New Kent County would allow the RRWSG to develop a side-hill reservoir, which would offer fewer recreational, economic, and aesthetic benefits to the County than the Black Creek Reservoir project, which it has already rejected. The one potential site identified in New Kent County, near Gleason Marsh, appeared to contain over 650 acres of wetlands, so it would likely have been eliminated from further consideration regardless of the County's opposition.

Several assumptions have been made with respect to the required configuration and operating rules associated with a RRWSG side-hill reservoir alternative. The most important of those assumptions are listed below.

- Total side-hill reservoir storage capacity of approximately 20 BG and available storage of approximately 15 BG.

- Reservoir dead storage equal to 25 percent of total reservoir volume. This is consistent with the dead storage assumptions used by the RRWSG to evaluate other reservoir alternatives, and with the Virginia Department of Health's historical practice of using a 25 percent volume dead storage value in studies of drinking water reservoirs for which a specific dead storage value is not defined by pumping equipment configuration.

- Maximum operating water depth of 50 feet. Topographic relief in the areas under study is more limited than farther west in Hanover County. This operating depth is based on the maximum possible height of the embankments, which is 60 feet, reserving ten feet of freeboard to protect the dams against wave action, flooding, and other operating uncertainties.

- Upstream and downstream embankment faces should have 3:1 slopes. These embankment slopes were selected as the most cost-effective configuration that should maintain structural integrity.

- Rip rap should be placed on upstream embankment face from the top of the embankment down to 5 feet below the minimum operating pool elevation. The rip rap would help protect an underlying liner on the embankment from possible damage from floating debris, boats, and other hazards.

- A slurry wall should be installed at the toe of the upstream embankment slope to control seepage losses beneath the embankment.

To avoid large wetland tracts and minimize impacts to wetland areas, potential side-hill reservoir sites were screened using USFWS National Wetland Inventory (NWI) maps and SCS Soil Survey maps. Field studies were also conducted at the sites to further verify the locations of potential wetland boundaries. Four sites within King William County were selected and configured so as to impound at least 5 billion gallons each, while minimizing impacts to potential wetland areas. The reservoirs would be interconnected, and constructed one at a time, as needed.

<u>Safe Yield</u>

This alternative's safe yield benefit was calculated using a spreadsheet-based model for a 58-year simulation period. The total treated water safe yield of this alternative is 26.5 mgd. This estimate also assumes that a 75 mgd capacity Mattaponi River pumping station would be used to supply the side-hill reservoirs.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of host jurisdiction allowances for King William and New Kent Counties, where the reservoirs and most other components of the reservoir/river pumpover project would be located. Although no host agreements are in place for this alternative, the same host jurisdiction allowances described in Section 3.4.15 for King William Reservoir with Pumpover from Mattaponi River alternative, are assumed for this alternative (i.e., 3 mgd for King William County and 1 mgd for New Kent County). The treated water safe yield remaining for the RRWSG is 22.9 mgd. This is based on a total treated water safe yield of 26.5 mgd, less 3.6 mgd of treated water safe yield due to 4 mgd in host jurisdiction raw water allowances. (The 3.6 mgd <u>treated</u> water reduction is equivalent to a 4 mgd <u>raw</u> water safe yield reduction after estimated treatment and transmission losses are factored into the calculation.)

<u>Practicability Analysis</u>

Life Cycle Project Costs

A preliminary project cost estimate for this alternative is presented in Report M. The Year 1992 present value of the life cycle costs of the project, including land acquisition, construction, and operation and maintenance, is $309.1 million.

To allow comparison of this alternative's costs to those of other alternatives, the life cycle cost of water treatment and transmission to the Lower Peninsula service areas must be considered. For the 26.5 mgd combined RRWSG, King William County, and New Kent County treated water safe yield benefit calculated for this alternative, the Year 1992 present value of life cycle costs for treatment and transmission is estimated at $24.9 million.

Summing these estimates yields a total project life cycle cost estimate of $334.0 million, or $12.6 million per mgd of total treated water safe yield benefit. These estimated unit costs are nearly 60 percent above the RRWSG's adopted cost feasibility level which equates to approximately $8 million per mgd of treated water safe yield. (Unit costs above this level for an alternative yielding approximately 30 mgd would result in projected household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula median household income.) For this reason, this alternative is considered economically infeasible at this time.

For this cost analysis, it has been assumed that King William County and New Kent County would pay for their pro-rata shares of the project safe yield. The combined 4 mgd raw water allowance for the two Counties represents approximately 14 percent of the project's total raw water safe yield (29.4 mgd). If both Counties pay for project costs (excluding treatment and transmission costs since raw water allowance have been assumed for the Counties) based on their pro-rata shares of project safe yield, the RRWSG share of the total project life cycle cost estimate would be reduced by approximately $43.3 million. Overall, the RRWSG share of the total project life cycle cost estimate would then be approximately $290.7 million, or 87 percent of the total cost ($334.0 million).

Conclusions

Side-hill reservoirs are an innovative concept to provide water supply while minimizing impacts to wetlands. In certain areas of the United States and even other areas of Virginia, side-hill reservoirs could be a part of a solution to a projected raw water supply shortage. However, as a potential alternative water supply source for the Lower Peninsula, side-hill reservoirs do not compare favorably to the RRWSG's practicable alternatives.

It is unlikely that King William County would grant approval to the RRWSG to build a side-hill reservoir project. Without the economic, recreational, and aesthetic benefits associated with a traditional reservoir, there would be little incentive for King William County to agree to such a project.

Although each of the elements of the side-hill reservoir design has been successfully implemented individually in other projects, reliability concerns exist regarding the overall construction and operation of these reservoirs.

Even though the side-hill reservoir sites were selected to minimize potential wetland impacts, development of the four sites identified could still result in large wetland losses. The four sites are mapped as containing a total of approximately 530 acres of hydric soil areas on SCS Soil Survey maps and 90 acres of wetlands on USFWS NWI maps. Therefore, it appears that potential side-hill reservoir sites in the lower portions of the Pamunkey River and Mattaponi River valleys may not afford the same opportunity to minimize wetland impacts as in other areas.

3.4.32.4 Smaller King William Reservoir with Two River Pumpovers

In Section 5.9 of the Supplement, a two river pumpover scenario was discussed as a possible means of enhancing the King William Reservoir Project (KWR-II configuration) to supply the needs of a larger region. The RRWSG has no plans at this time to develop such an enhanced King William Reservoir Project. However, at the USCOE's direction, the RRWSG has evaluated a two river pumpover scenario for a smaller King William Reservoir that would meet the projected needs of the RRWSG.

Description

This alternative would consist of the following components: a 75 mgd raw water intake structure and pumping station located on the Mattaponi River at Scotland Landing; approximately 1.5 miles of 54-inch, 75 mgd capacity river water pipeline from the Mattaponi pumping station to the King William Reservoir; a 45 mgd raw water intake structure and pumping station located on the Pamunkey River near Montague Landing; approximately 5.7 miles of 42-inch, 45 mgd capacity river water pipeline from the Pamunkey pumping station to the reservoir; a dam on Cohoke Creek located upstream of dam site KWR-IV and below the County Route 626 crossing, creating an impoundment covering approximately 1,500 acres and storing approximately 12 BG at a normal pool elevation of 96 feet msl; an intake structure in the reservoir; a 50 mgd capacity King William Reservoir pump station; an 11.7- mile long, 42-inch and 48-inch diameter raw water pipeline between the King William Reservoir pump station and Diascund Creek Reservoir; a 40 mgd intake structure and pump station near the Diascund Creek Reservoir dam; and a 5.5 mile, 42-inch diameter raw water pipeline from the Diascund Creek Reservoir to Little Creek Reservoir. More detailed descriptions of the pipeline routes and pump stations can be found in Sections 3.4.15 and 3.4.16.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. The King William Reservoir project was evaluated as an interconnected component of the existing Newport News Waterworks system. The approximate dam site configuration and a 25 percent reservoir dead storage assumption were incorporated into this analysis. The total treated water safe yield of this alternative is approximately 28.3 mgd. The detailed methods of analysis used for estimating the safe yield of the King William Reservoir alternative are presented in Section 3.3.3.

To calculate the safe yield benefits of this alternative to the RRWSG member jurisdictions, the total treated water safe yield value must be reduced by the amount of host jurisdiction allowances for King William and New Kent Counties, where the reservoir and most other components of the reservoir/river pumpover project would be located. Although no host agreements are in place for this alternative, the same host jurisdiction allowances described in Section 3.4.15 (for Mattaponi River pumpover scenario) are assumed for this dual river pumpover scenario. It has thus been assumed that King William County and New Kent County would receive raw water safe yield allowances of 3 mgd and 1 mgd, respectively. The treated water safe yield remaining for the RRWSG is approximately 24.7 mgd. This is based on a total treated water safe yield of 28.3 mgd, less 3.6 mgd of treated water safe yield due to 4 mgd in host jurisdiction raw water allowances. (The 3.6 mgd treated water reduction is equivalent to a 4 mgd raw water safe yield reduction after estimated treatment and transmission losses are factored into the calculation).

Practicability Analysis

A smaller King William Reservoir with two river pumpovers would reduce the gross acreage of wetlands affected, but would rely on an additional pumpover from the Pamunkey River. A smaller King William Reservoir would provide less storage to withstand droughts, thus requiring larger total river withdrawals to meet projected demands during periods of drought. Such withdrawals would come from both the Mattaponi and the Pamunkey. As a result, the impacts of river pumping during droughts would be both spread more widely and increased in intensity.

Further technical evaluation of a smaller King William Reservoir Project with two river pumpovers was not conducted because such a project is not considered practicable, for several institutional reasons. These reasons are as follows:

First: When the host agreement with King William County was amended at the request of the City of Newport News in 1995 and allowed for the possibility of a second river withdrawal from the Pamunkey River, the County agreed to this change reluctantly, and only with certain conditions. One of the required conditions for a second river pump station is that it must enhance the yield of the reservoir project and provide King William County with additional raw water. King William County has since stated that "... [to] reduce the size of the pool and yet require a second pump-over without any increase in the amount of water available for users is not acceptable to the County." (C.T. Redd, King William County, personal communication, 1996). Under Virginia law, each "host" jurisdiction for any portion of a public water supply project has a "veto" power over those portions of the project. Sections 15.1-37, 15.1-37.1, 15.1-456, 15.1-875, and 15.1-1250 of the Virginia Code provide the basis for this position. King William County's statement that a reduced King William Reservoir is "not acceptable" is backed by the County's legislative and regulatory authority under Virginia law.

Second: As discussed in Section 3.4.13, New Kent County has already expressed its opposition to a RRWSG-sponsored reservoir at Black Creek with a withdrawal from the Pamunkey River. Its opposition is based in part on local concerns that its water resources already are heavily committed to supplying water to the Lower Peninsula, through the City of Newport News' Diascund Reservoir and its existing withdrawal rights from the Chickahominy River. With the Chickahominy River already fully committed to the Lower Peninsula's public water supply, New Kent County must look to the Pamunkey for both future water supply and sewage discharge purposes. Given its future reliance on the Pamunkey River, "New Kent County would be very concerned about any proposed withdrawal from the Pamunkey River..." (E. D. Ringley, New Kent County personal communication, 1996). Furthermore, providing more water to New Kent County from a smaller King William Reservoir would not be possible, even with two river withdrawals. At best, such a project could only help satisfy the RRWSG's own projected needs through the Year 2040.

Third: Competition for Pamunkey River water would bring Hanover County into conflict with the RRWSG. As discussed in Section 5.9.1, Hanover County has a long history of pursuing development of Pamunkey River withdrawals to expand the County's water supply. Also, as discussed in Section 4.2.1, Hanover County is planning future wastewater discharges to the Pamunkey River upstream of potential RRWSG withdrawal locations (R. J. Klotz, Hanover County, personal communication, 1996). Hanover County is not a "host" jurisdiction and, therefore, does not have veto power over the King William Reservoir Project; however, its opposition to Pamunkey River withdrawals would probably be given considerable weight by the State and federal agencies.

Fourth: State support for the proposed King William Reservoir Project has resulted in large part from the careful planning, and unified regional support, for that project (B. N. Dunlop, Virginia Office of the Governor, personal communication, 1996). That unified support could quickly disappear if the RRWSG were to pursue a smaller King William Reservoir with a second pumpover from the Pamunkey (O. Pickett, U.S. House of Representatives, personal communication, 1996; A. A. Diamonstein, et.al., Virginia General Assembly, personal communication, 1996). Besides the power of the host jurisdictions to veto a reduced King William Reservoir project, the disputes that would likely follow any proposal to develop such a project would substantially delay its implementation. Under these circumstances, the State might not issue a Virginia Water Protection Permit (VWPP) and Clean Water Act Section 401 Certification. Without a VWPP and a Section 401 Certification, the project would not be eligible for a Section 404 Permit and could not be built. It is unlikely the State would support the allocation of water from both the Mattaponi and Pamunkey rivers to meet a need which could be met from the Mattaponi alone, when other jurisdictions are also interested in securing water supplies for their future from the Pamunkey.

For the foregoing reasons, the RRWSG believes that a smaller King William Reservoir alternative with two river pumpovers is not institutionally practicable.

Life Cycle Project Costs

A preliminary project cost estimate has been made for the Smaller King William Reservoir with Two River Pumpovers alternative (see Table 3-11). The Year 1992 present value of the life cycle costs of the project, including land acquisition, construction, and operation and maintenance, is $144.3 million.

To allow comparison of this alternative's costs to those of other alternatives, the life cycle cost of water treatment and transmission to the Lower Peninsula service areas must be considered. For the 28.3 mgd combined RRWSG, King William County, and New Kent County treated water safe yield benefit calculated for this alternative, the Year 1992 present value of life cycle costs for treatment and transmission is estimated at $26.6 million.

Summing these estimates yields a total project life cycle cost estimate of $170.9 million, or $6.0 million per mgd of total treated water safe yield benefit. For this cost analysis, it has been assumed that King William County and New Kent County would pay for their pro-rata shares of the project safe yield. The combined 4 mgd raw water allowance for the two Counties represents approximately 13 percent of the project's total raw water safe yield (31.5 mgd). If both Counties pay for project costs (excluding treatment and transmission costs since raw water allowance have been assumed for the Counties) based on their pro-rata shares of project safe yield, the RRWSG share of the total project life cycle cost estimate would be reduced by approximately $18.8 million. Overall, the RRWSG share of the total project life cycle cost estimate would then be approximately $152.1 million, or 89 percent of the total cost ($170.9 million).

TABLE 3-11

SMALLER KING WILLIAM RESERVOIR
WITH PUMPOVERS FROM THE MATTAPONI AND PAMUNKEY RIVERS
PROJECT COST ESTIMATE

COST CATEGORY Item	Unit Cost	Quantity	Totals
LAND ACQUISITION			
River Pump Station Site – Acres (1)	$5,600	50	$280,000
Pipeline Easements, River to KW Res. – Acres (1)	$2,000	38	$76,000
Reservoir and Buffer – Acres (1)	$1,500	2900	$4,350,000
Pipeline Easements, KW Res. to Dias. – Acres(2)	$1,000	60	$60,000
Soil Borrow Area – Acres(2)	$1,500	125	$190,000
Mitigation Area – Acres(2)	$1,500	500	$750,000
TOTAL LAND ACQUISITION COSTS			**$5,710,000**
CONSTRUCTION			
75 mgd Mattaponi Pump Station and Intake –LS			$10,000,000
54–Inch Transmission Main to KW Res. – LF	$250	8000	$2,000,000
45 mgd Pamunkey Pump Station and Intake –LS			$7,600,000
42–Inch Transmission Main to KW Res. –LF	$200	30000	$6,000,000
Dam, Clearing –LS			$400,000
Dam, Excavation –LS			$1,900,000
Dam, Slurry Wall –LS			$1,900,000
Dam, Embankment –LS			$12,000,000
Dam, Emergency Spillway –LS			$2,300,000
Dam, Withdrawal & Release Structure –LS			$800,000
50–mgd King William Pump Station –LS			$5,500,000
48–Inch Transmission Main to Pamunkey River – LF	$225	24000	$5,400,000
42–Inch Dir. Drill Pamunkey River Crossing – LF	$850	4500	$3,830,000
48–Inch Transmission Main – LF	$225	23000	$5,180,000
42–Inch Transmission Main – LF	$200	10500	$2,100,000
Reservoir Clearing up to 90' msl – Acres	$2,250	1600	$3,600,000
40–mgd Diascund Pump Station and Intake –LS			$5,600,000
42–Inch Transmission Main to Little Creek – LF	$200	29000	$5,800,000
King William County Landfill Relocation – LS (3)			$3,000,000
County Route 626 Replacement – LF	$250	6000	$1,500,000
Mitigation – LS			$5,000,000
SUBTOTAL			**$91,410,000**
Permitting, Preliminary Engineering & Legal (5%)			$4,570,000
Design, Construction Management & Administration (12%)			$10,970,000
Contingencies (20%)			$21,390,000
TOTAL CONSTRUCTION COSTS			**$128,340,000**

TABLE 3-1I

SMALLER KING WILLIAM RESERVOIR WITH PUMPOVERS FROM THE MATTAPONI AND PAMUNKEY RIVERS PROJECT COST ESTIMATE (Continued)

COST CATEGORY Item	Unit Cost	Quantity	Totals
OPERATION AND MAINTENANCE			
Electric Power for Pumping – LS	Mattaponi P.S.		$2,334,502
	Pamunkey P.S.		$1,369,042
	King William P.S.		$784,822
	Diascund P.S.		$711,423
Operations and Maintenance – LS	Mattaponi P.S./Pipeline		$1,668,237
	Pamunkey P.S./Pipeline		$1,251,178
	King William P.S./Pipeline		$1,251,178
	Diascund P.S./Pipeline		$834,119
TOTAL OPERATION AND MAINTENANCE COSTS			**$10,200,000**
TOTAL YEAR 1992 PRESENT VALUE COST			**$144,250,000**

Notes:

All costs in Year 1992 dollars.

1) Assumes King William County would acquire and lease to RRWSG jurisdictions.

2) Assumes RRWSG jurisdictions would acquire.

3) Landfill relocation may not be required as part of this project.

3.5 SUMMARY OF PRACTICABILITY ANALYSES

This section summarizes the results of practicability analyses conducted for the alternative components described in Section 3.4.

To be practicable in this analysis, a project alternative (which may consist of several elements or components) must satisfy the following criteria:

1. The project alternative must provide additional treated water safe yield at least equal to the projected deficit for each year through the Year 2040; that is, it must satisfy both short- and long-term demands. The long-term deficit is 39.8 mgd, which is the projected regional deficit through the Year 2040 (see Section 2.7).

2. The project alternative must have the least cumulative environmental impact possible, while satisfying Criterion No. 1.

3. The combination of project alternative components should be institutionally acceptable and cumulatively feasible while satisfying Criteria No. 1 and 2.

From the list of practicable alternative components, it has been demonstrated that to satisfy the projected Year 2040 regional water supply deficit, any project alternative must include a reservoir component. (The combined treated water safe yield benefit of the practicable alternatives which do not involve new reservoir construction is only 21.2 mgd, which is 18.6 mgd less than the 39.8 mgd projected Year 2040 deficit).

The alternative components carried forward into the environmental analysis include the Ware Creek, Black Creek, and King William reservoir and pumpover components, with groundwater (fresh or desalted) and additional conservation measures and use restrictions to make up the remaining project deficit. Alternative components are listed in Table 3-1J.

Based on the results of the environmental analysis presented in Report D, ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document, the environmental impacts of the practicable non-reservoir project components rank as follows:

Alternative Component	RRWSG Treated Safe Yield (mgd)	Degree of Environmental Impact
Additional Conservation Measures and Use Restrictions	7.1-11.1	Least
Fresh Groundwater Development	4.4	
Groundwater Desalination in Newport News Waterworks Distribution Area	5.7	Most

TABLE 3-1J

ALTERNATIVE COMPONENTS

ALTERNATIVE COMPONENT			TREATED SAFE YIELD (mgd)	
			TOTAL	RRWSG**
1.	Ware Creek Reservoir with Pumpover from Pamunkey River		26.2	23.2
2.	Black Creek Reservoir with Pumpover from Pamunkey River		21.1	18.1
3.	King William Reservoir with Pumpover from Mattaponi River	KWR-I	30.7	27.1
		KWR-II	29.0	25.4
		KWR-III	25.3	21.7
		KWR-IV	26.8	23.2
4.	Fresh Groundwater Development		4.4	4.4
5.	Groundwater Desalination in Newport News Waterworks Distribution Area		5.7	5.7
6.	Additional Conservation Measures and Use Restrictions		7.1-11.1	7.1-11.1
7.	No Action*		0.0	0.0

* Although it is not considered a feasible alternative, the No Action alternative has been carried forward for further environmental analysis pursuant to the Council on Environmental Quality's (CEQ) NEPA regulations.

** For reservoir alternatives, RRWSG treated water safe yield benefits are less than total benefits due to assumed host jurisdiction allowances for King William, New Kent, and/or James City Counties. For Black Creek Reservoir, the full extent of New Kent County's projected needs would not be served by the host jurisdiction allowance for this alternative (see Section 3.4.13).

Notes: Principal alternative changes and additions subsequent to publication of DEIS are as follows:

1. The total host jurisdiction treated water allowance was reduced from 7 mgd to 3 mgd due to including all of James City County's needs in the RRWSG's deficit projections. This alternative's overall RRWSG safe yield benefit therefore increased from 19.2 to 23.2 mgd.

TABLE 3-1J

ALTERNATIVE COMPONENTS
(Continued)

3. The originally proposed KWR-I project configuration was presented in the DEIS.

   The RRWSG's preferred KWR-II project configuration was presented in the Supplement. A 50 mgd capacity reservoir pump station was added to the KWR-II project configuration subsequent to publication of the Supplement. Additional modeling of this transmission limit resulted in a safe yield reduction of 0.1 mgd.

   The KWR-III and the currently proposed KWR-IV project configurations were added subsequent to publication of the Supplement. The total and RRWSG safe yields are greater for the KWR-IV project configuration than for KWR-III, because a less stringent MIF was used for KWR-IV.

5. More detailed studies of this alternative resulted in a 0.7 mgd reduction in safe yield.

6. Use restrictions were remodeled as a component of the King William Reservoir alternative and additional conservation measures were added to this alternative. Safe yield estimates therefore increased from 1.7 mgd to between 7.1 and 11.1 mgd, depending on which KWR configuration is considered.

These components will generally be brought on line in the order of least impact to most impact, while taking into consideration criteria 1 and 3 identified above.

Table 3-2 contains the results of life cycle cost estimates for 19 of the original 31 components. (It was not necessary to evaluate the remaining 12 alternatives with respect to cost, because those alternatives were eliminated based on other practicability criteria (i.e., availability and/or technological reliability) or were not amenable to generating cost estimates (i.e., Additional Conservation Measures and Use Restrictions and No Action alternatives). These cost estimates have been updated since February 1994, when the DEIS was published, based on changes in project configuration and/or safe yield assumptions for alternatives involving the Ware Creek, Black Creek, and King William reservoirs with river pumpovers.

Table 3-3 contains the 19 life cycle cost estimates, ranked from low to high, in terms of total cost per mgd of safe yield for each alternative component. All alternatives with unit costs that exceed the affordability criterion are considered economically infeasible and therefore impracticable. Unit costs above approximately $8 million per mgd of treated water safe yield would, for an alternative yielding approximately 30 mgd, result in projected household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula median household income.

Table 3-4 summarizes the fatal flaws which caused many alternatives to be considered impracticable.

The locations of key physical features of the practicable alternative components (and the Black Creek Reservoir alternative) are shown on Plate 2 (see map pocket at end of this document) and Figures 3-4 through 3-8. The three reservoir alternatives are depicted schematically in Figures 3-9 through 3-11A.

To identify project alternatives that will satisfy short-term as well as long-term demands, the RRWSG has developed an evaluation of the region's short-term or interim needs, defined as the net amount of additional water that will be required to meet regional demands until a reservoir realistically can be expected to become operational. It can take as much as 10 years or even more, from the present, to permit, design, construct, and fill a reservoir for use. In this analysis, it is assumed that completion of a reservoir project component would require another 10 years, or through the Year 2006. It is believed that completion of the Black Creek Reservoir alternative could take longer than either of the other reservoir alternatives because of the additional time that might be required to complete the zoning (special use permit) and local consent processes in New Kent County and the litigation processes that likely would be required to overturn the County's anticipated denials of necessary zoning and local consent approvals (see Section 3.4.13). Nevertheless, since time to completion could vary for any of the reservoir projects, the assumed 10-year implementation period was not varied by alternative.

Regional water demands are expected to equal the combined safe yields of the existing Lower Peninsula supplies before the Year 2000, with the deficit growing at a rate of approximately 0.8 mgd per year thereafter. Without additional conservation, use restrictions, groundwater or surface water supplies, the projected Year 2006 interim regional deficit is 14.8 mgd. The projected Year 2006 interim deficit of the Newport News Waterworks service area is 11.9 mgd if no action is taken, and a deficit could be experienced at any time under severe drought conditions. Newport News Waterworks is projected to experience a deficit situation earlier than other Lower Peninsula water purveyors, but surplus capacity in other systems is not readily transferable.

TABLE 3-2
SUMMARY OF ALTERNATIVE COMPONENTS LIFE CYCLE COST ESTIMATES
(Year 1992 Present Worth in $ million)

DISCOUNT RATE = 7.00%

Alternative Components *	Total Treated Safe Yield (MGD)	Raw Water Project		Treatment & Transmission		Complete Alternative	
		Cost	Cost per MGD	Cost	Cost per MGD	Total Cost	Cost per MGD
2. Lake Chesdin	11.9	107.61	9.04	11.19	0.94	118.80	9.98
5. Rappahannock River above Fredericksburg	7.9	251.34	31.82	7.43	0.94	258.77	32.76
6. James River above Richmond w/o New Off-Stream Storage	7.1	122.44	17.25	6.67	0.94	129.11	18.19
7. City of Richmond Surplus Raw Water	7.1	92.13	12.98	6.67	0.94	98.80	13.92
8. City of Richmond Surplus Treated Water	23.9					198.91	8.32
10. Ware Creek Reservoir	9.1	45.54	5.00	8.55	0.94	54.09	5.94
11. Ware Creek Reservoir with Pumpover from Pamunkey River	26.2	127.51	4.87	24.63	0.94	152.14	5.81
12. Ware Creek Reservoir with Pumpover from James River	30.5	197.00	6.46	28.67	0.94	225.67	7.40
13. Black Creek Reservoir with Pumpover from Pamunkey River	21.1	118.26	5.60	19.84	0.94	138.10	6.54
14. Black Creek Reservoir with Pumpover from James River	24.8	197.84	7.98	23.31	0.94	221.15	8.92
15. King William Reservoir with Pumpover from Mattaponi River	29.0	123.79	4.27	27.26	0.94	151.05	5.21
16. King William Reservoir with Pumpover from Pamunkey River	33.2	136.45	4.11	31.21	0.94	167.66	5.05
17. Chickahominy River Pumping Capacity Increase	0.2	0.64	3.20	0.19	0.94	0.83	4.14
18. Chick. River Pumping Cap. Incr. & Raise D.C. and L.C. Dams	5.0	16.04	3.21	4.70	0.94	20.74	4.15
21. Fresh Groundwater Development	4.4	5.74	1.30	4.14	0.94	9.88	2.24
22. Groundwater Desalination as the Single Long-Term Alt.	30.0					78.68	2.62
23. Groundwater Desalination in NN Waterworks Dist. Area	5.7					34.21	6.00
24. James River Desalination	30.0					261.63	8.72
26. York River Desalination	30.0					344.72	11.49

* Cost estimates are shown for 19 of the 31 original alternatives. It was not necessary to evaluate the remaining 12 alternatives with respect to cost, because these alternatives were eliminated based on other practicability criteria or were not amenable to generating cost estimates.

TABLE 3–3
RANKED ALTERNATIVE COMPONENTS LIFE CYCLE COST ESTIMATES
(Year 1992 Present Value Cost in $ million)

DISCOUNT RATE = 7.00%

Alternatives In Order of Cost Per MGD (Low to High)	Total Treated Safe Yield (MGD)	Total Cost per MGD of Safe Yield*	Impracticable due to Cost**
21. Fresh Groundwater Development	4.4	2.24	
22. Groundwater Desalination as the Single Long–Term Alternative	30.0	2.62	
17. Chickahominy River Pumping Capacity Increase	0.2	4.14	
18. Chick. River Pumping Cap. Incr. and Raise D.C. and L.C. Dams	5.0	4.15	
16. King William Reservoir with Pumpover from Pamunkey River	33.2	5.05	
15. King William Reservoir with Pumpover from Mattaponi River	29.0	5.21	
11. Ware Creek Reservoir with Pumpover from Pamunkey River	26.2	5.81	
10. Ware Creek Reservoir	9.1	5.94	
23. Groundwater Desalination in NN Waterworks Dist. Area	5.7	6.00	
13. Black Creek Reservoir with Pumpover from Pamunkey River	21.1	6.54	
12. Ware Creek Reservoir with Pumpover from James River	30.5	7.40	
8. City of Richmond Surplus Treated Water	23.9	8.32	X
24. James River Desalination	30.0	8.72	X
14. Black Creek Reservoir with Pumpover from James River	24.8	8.92	X
2. Lake Chesdin	11.9	9.98	X
26. York River Desalination	30.0	11.49	X
7. City of Richmond Surplus Raw Water	7.1	13.92	X
6. James River above Richmond w/o New Off–Stream Storage	7.1	18.19	X
5. Rappahannock River above Fredericksburg	7.9	32.76	X

* Cost estimates from Table 3–2.

** Unit costs above approximately $8 million per mgd of treated water safe yield would, for an alternative yielding approximately 30 mgd, result in projected household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula median household income.

TABLE 3-4
PRACTICABILITY ANALYSIS SCREENING RESULTS

ALTERNATIVE COMPONENTS			PRACTICABILITY CRITERIA FATAL FLAWS			PRACTICABLE ? (Unshaded alternatives are carried forward)
NUMBER	NAME	RRWSG TREATED SAFE YIELD (mgd)	AVAILABILITY	COST	TECHNOLOGICAL RELIABILITY	
1	LAKE GENITO	39.8	USCOE, USEPA, and USFWS Opposition due to Impacts			NO
2	LAKE CHESDIN	11.9		Exceeds RRWSG Criterion		NO
3	LAKE ANNA	39.8	Virginia Power Opposition			NO
4	LAKE GASTON	39.8	Local Consent & Legal Delays			NO
5	RAPPAHANNOCK RIVER ABOVE FREDERICKSBURG	7.9	Local Competition for Source	Exceeds RRWSG Criterion		NO
6	JAMES RIVER ABOVE RICHMOND WITHOUT NEW OFF-STREAM STORAGE	7.1	Local Consent (RRPDC Opposition) & Local Competition for Source	Exceeds RRWSG Criterion		NO
7	CITY OF RICHMOND SURPLUS RAW WATER	7.1	Local Consent (RRPDC Opposition)	Exceeds RRWSG Criterion		NO
8	CITY OF RICHMOND SURPLUS TREATED WATER	23.9	Availability Highly Uncertain and Outside RRWSG Control	Exceeds RRWSG Criterion		NO
9	JAMES RIVER BETWEEN RICHMOND AND HOPEWELL	39.8	VDH Opposition due to Public Health Concerns		Questionable Treatability	NO
10	WARE CREEK RESERVOIR	7.1	Two USEPA Vetoes		Water Quality Reliability Concerns Due to Watershed Development	NO
11	WARE CREEK RESERVOIR WITH PUMPOVER FROM PAMUNKEY RIVER	23.2				YES *
12	WARE CREEK RESERVOIR WITH PUMPOVER FROM JAMES RIVER ABOVE RICHMOND	27.5	Local Consent (RRPDC Opposition) & Local Competition for Source			NO
13	BLACK CREEK RESERVOIR WITH PUMPOVER FROM PAMUNKEY RIVER	18.1	Local Consent (New Kent County Opposition)			NO **
14	BLACK CREEK RESERVOIR WITH PUMPOVER FROM JAMES RIVER ABOVE RICHMOND	21.8	Local Consent (New Kent & RRPDC Opposition) & Local Competition for Source	Exceeds RRWSG Criterion		NO
15	KING WILLIAM RESERVOIR WITH PUMPOVER FROM MATTAPONI RIVER	25.4				YES
16	KING WILLIAM RESERVOIR WITH PUMPOVER FROM PAMUNKEY RIVER	29.8	Local Consent (King William County Opposition) & Local Competition for Source	Higher Costs and Impacts than for Mattaponi River Pumpover	More Water Quality Reliability Concerns than for Mattaponi River Pumpover	NO

* Mattaponi River and expanded Chickahominy River pumpovers to Ware Creek Reservoir are not considered practicable.

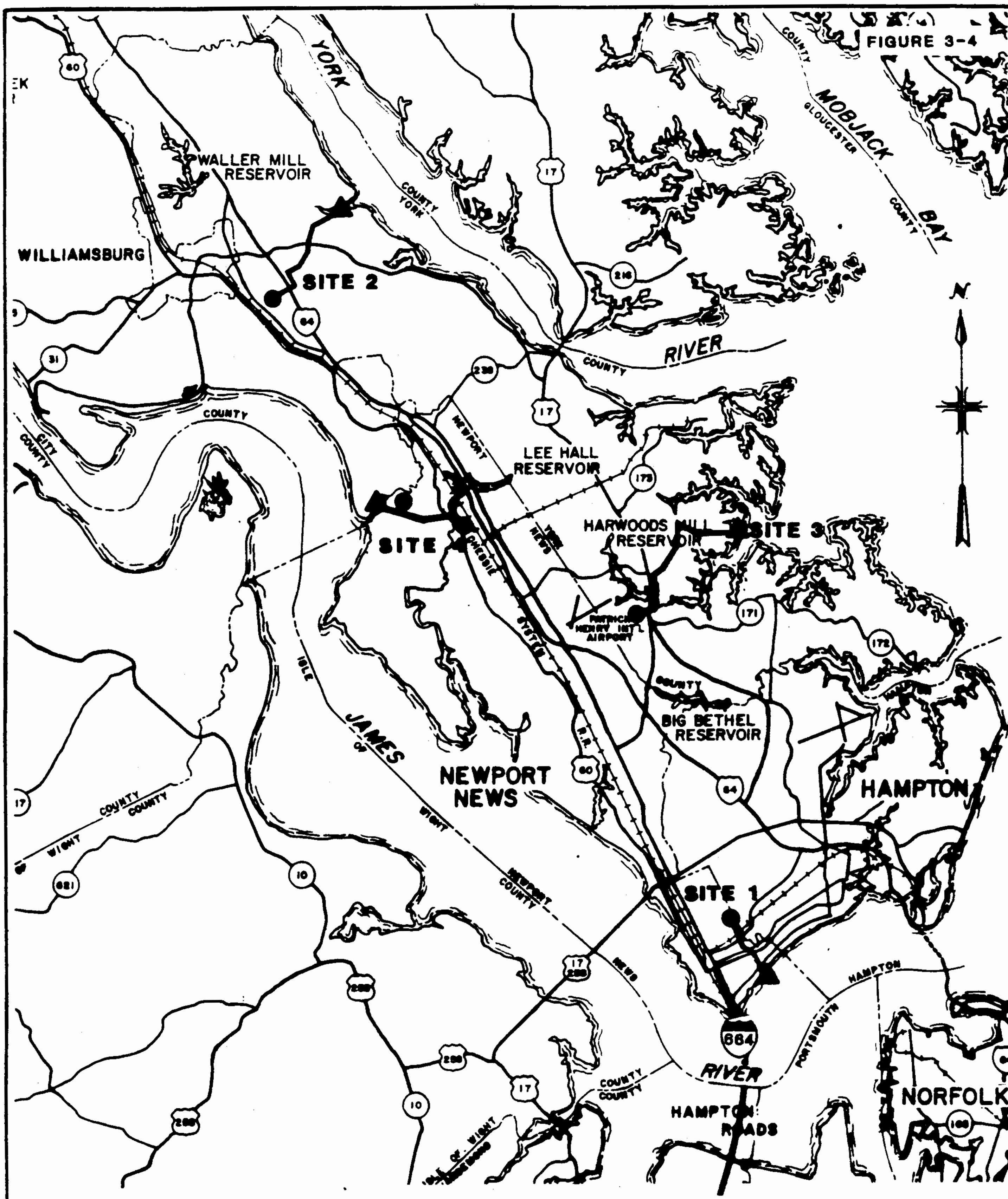
** Although not considered available or practicable by the RRWSG, this Black Creek Reservoir alternative was retained for further environmental analysis pursuant to USCOE instructions.

TABLE 3-4
PRACTICABILITY ANALYSIS SCREENING RESULTS
(Continued)

ALTERNATIVE COMPONENTS			PRACTICABILITY CRITERIA FATAL FLAWS			PRACTICABLE ? (Unshaded alternatives are carried forward)
NUMBER	NAME	RRWSG TREATED SAFE YIELD (mgd)	AVAILABILITY	COST	TECHNOLOGICAL RELIABILITY	
17	CHICKAHOMINY RIVER PUMPING CAPACITY INCREASE	0.2	Need Governor's Approval Amended & Could Trigger Higher MIF		Excessive Reliance on River Source Unprecedented in Virginia	NO
18	CHICKAHOMINY RIVER PUMPING CAPACITY INCREASE AND RAISE DIASCUND AND LITTLE CREEK DAMS	5.0	Need Governor's Approval Amended & Could Trigger Higher MIF	Exceeds RRWSG Criterion without Chickahominy Pumping Capacity Increase	Excessive Reliance on River Source Unprecedented in Virginia	NO
19	ASR CONSTRAINED BY NUMBER OF WELLS	6.7	VDEQ Permittability Unlikely Due to Potential Regional Aquifer Drawdown		Experimental Technology in Virginia & Uncertain Quality after Injected	NO
20	ASR UNCONSTRAINED BY NUMBER OF WELLS	9.4	VDEQ Permittability Unlikely Due to Potential Regional Aquifer Drawdown		Experimental Technology in Virginia & Uncertain Quality after Injected	NO
21	FRESH GROUNDWATER DEVELOPMENT	4.4				YES
22	GROUNDWATER DESALINATION AS THE SINGLE LONG-TERM ALTERNATIVE	30.0	VDEQ Permittability Unlikely Due to Potential Regional Aquifer Drawdown			NO
23	GROUNDWATER DESALINATION IN NEWPORT NEWS WATERWORKS DISTRIBUTION AREA	5.7				YES
24	JAMES RIVER DESALINATION	30.0	VDH Opposition due to Public Health Concerns	Exceeds RRWSG Criterion	Experimental Application of Technology & Uncertain Water Quality Reliability	NO
25	PAMUNKEY RIVER DESALINATION	0.0	VDEQ MIF Policy Requirement Negates Safe Yield Benefit			NO
26	YORK RIVER DESALINATION	30.0		Exceeds RRWSG Criterion	Experimental Application of Technology & Uncertain Water Quality Reliability	NO
27	COGENERATION	Unknown	VDH Opposition due to Public Health Concerns & No Proposals Exist for Water Sales			NO
28	WASTEWATER REUSE AS A SOURCE OF POTABLE WATER	3.7-6.5	VDH Opposition due to Public Health Concerns		Uncertainties with Adequacy of Treatment Technology	NO
29	WASTEWATER REUSE FOR NON-POTABLE USES	0.0-5.0	RRWSG can not Dictate whether Large Water Users Implement			YES *
30	ADDITIONAL CONSERVATION MEASURES AND USE RESTRICTIONS	7.1 - 11.1				YES
31	NO ACTION	0.0	Does not Contribute to Solution of Basic Project Purpose			NO **

* Non-Potable Reuse is already included as part of the regional conservation plan and will not be carried forward for further environmental analysis.

** Although not considered feasible, the No Action alternative will be retained for further environmental analysis pursuant to the CEQ's NEPA regulations.



LEGEND

- ● GROUNDWATER WITHDRAWAL
- ▲ CONCENTRATE DISCHARGE OUTFALL
- ▬ CONCENTRATE DISCHARGE PIPELINE

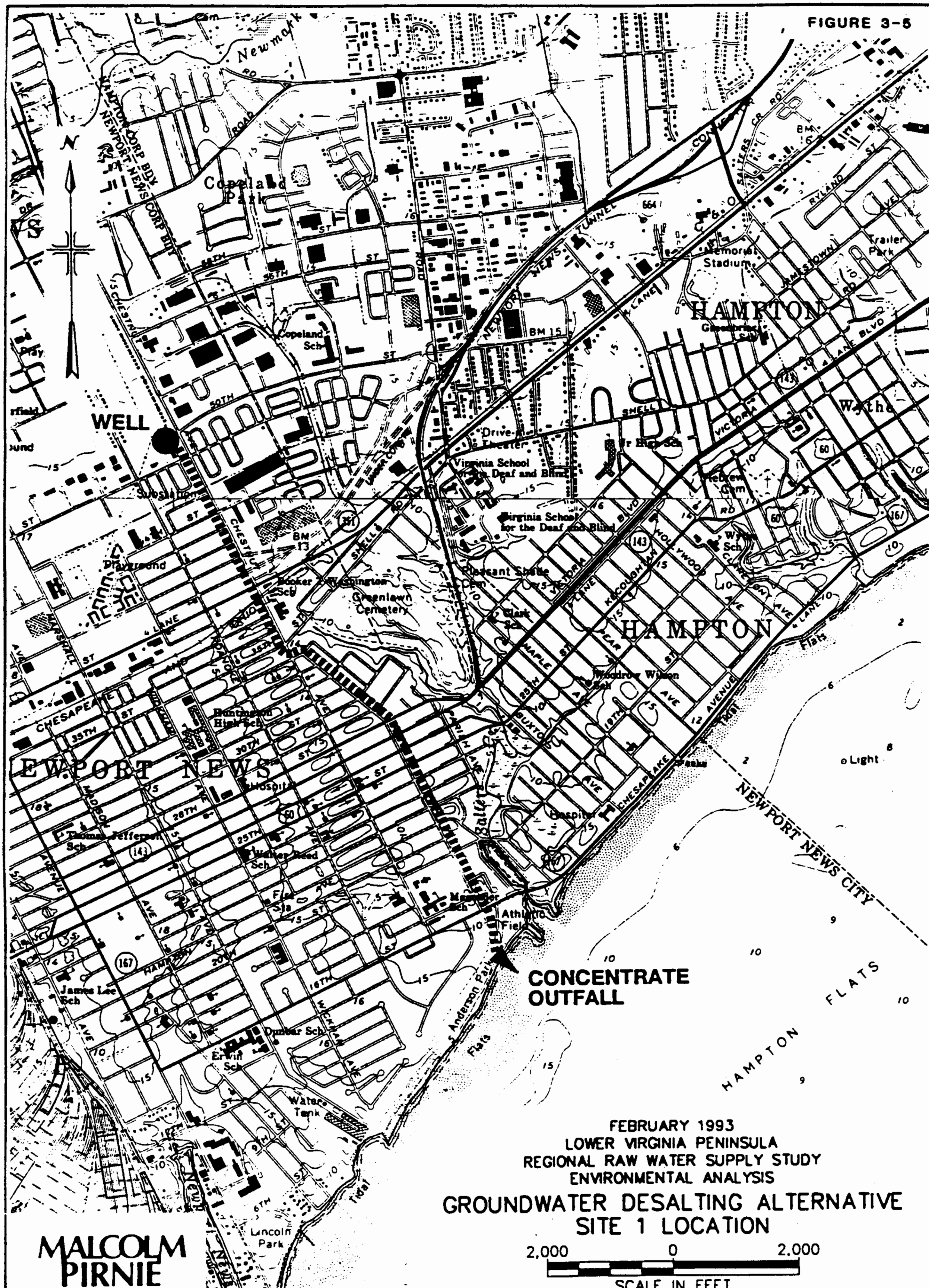
MALCOLM PIRNIE

MARCH 1993

LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
PROJECT LOCATION

5 0 5
SCALE IN MILES



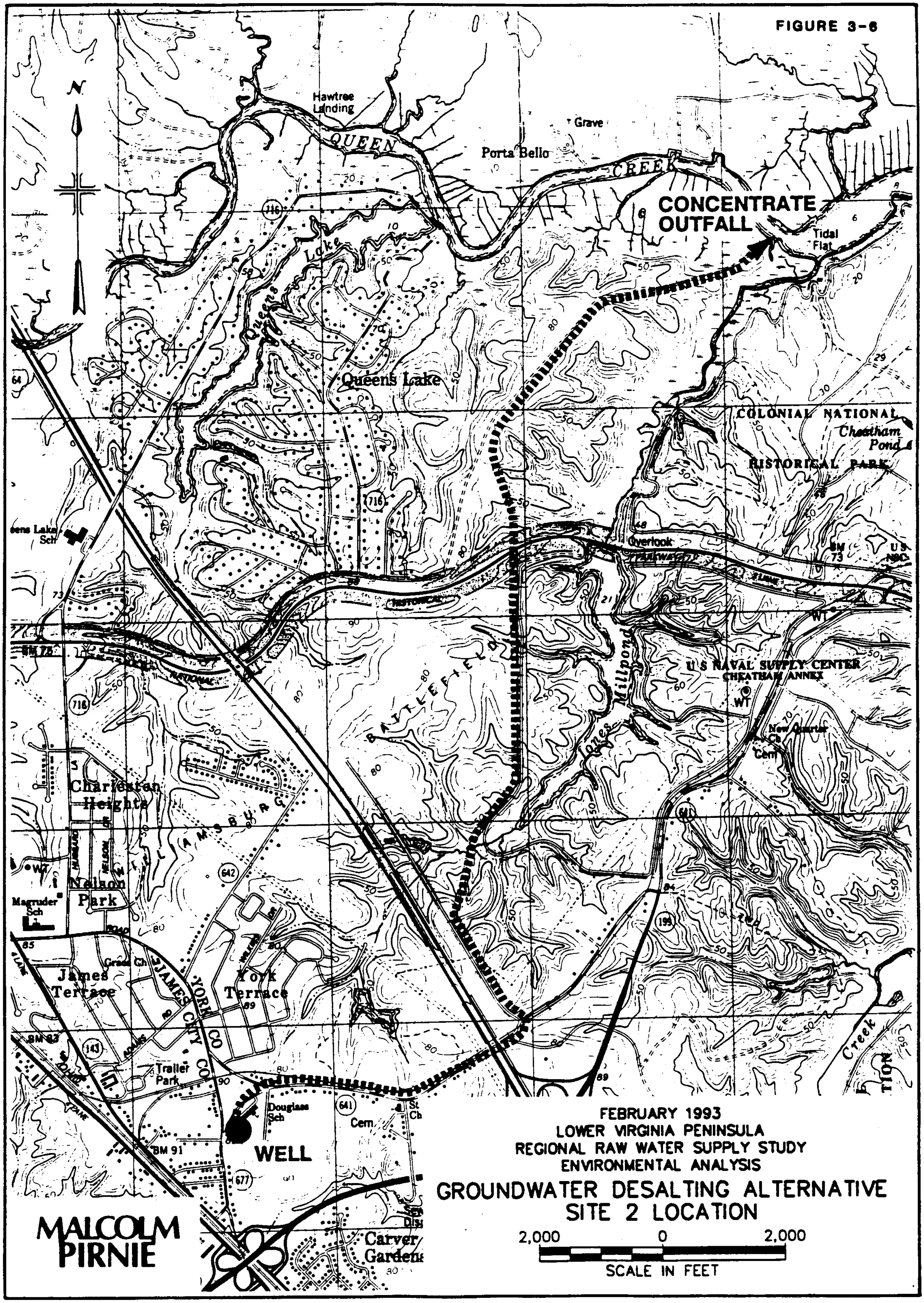
FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
SITE 1 LOCATION

2,000 0 2,000
SCALE IN FEET

MALCOLM PIRNIE

FIGURE 3-6

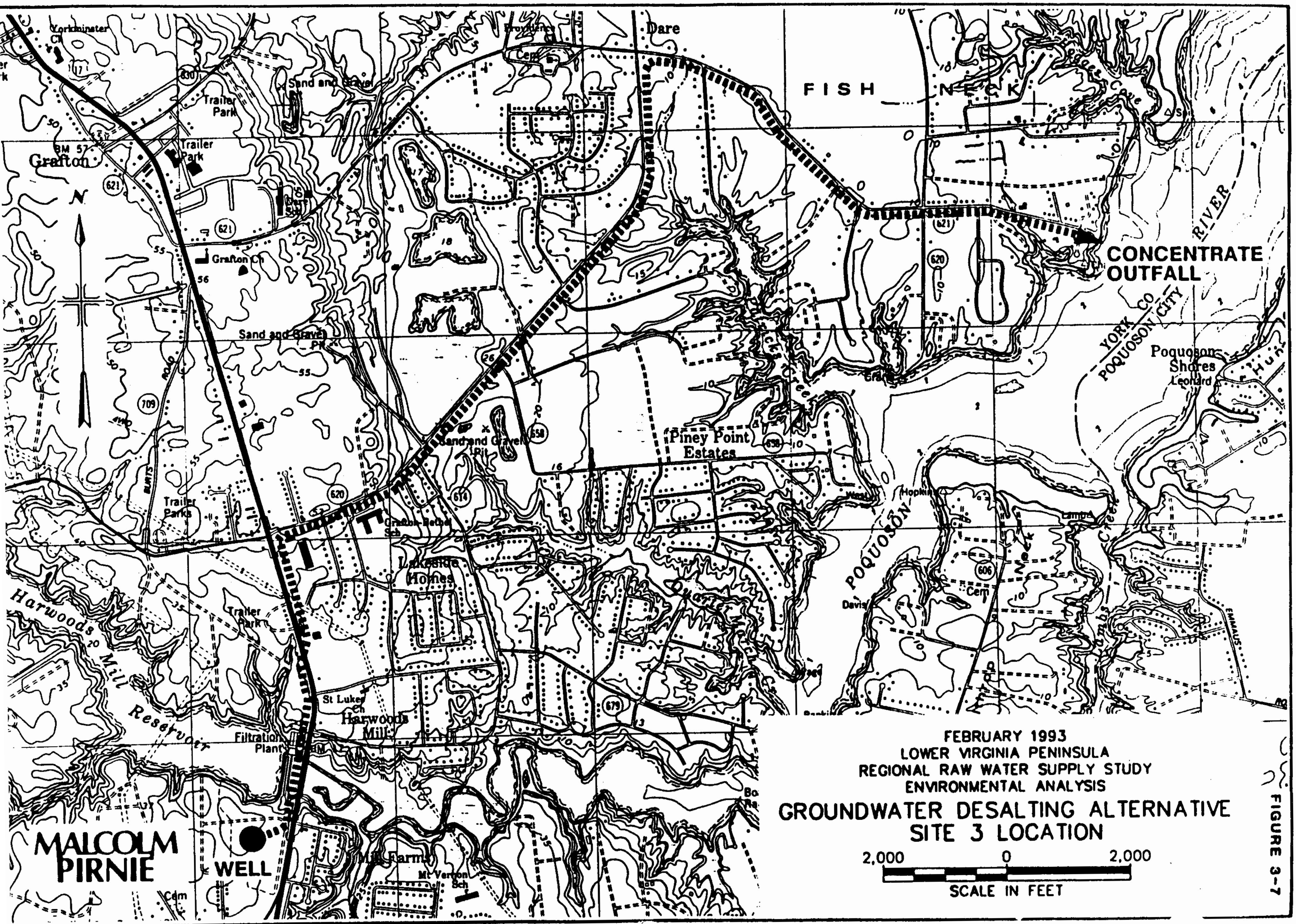


FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
SITE 2 LOCATION

2,000 0 2,000
SCALE IN FEET

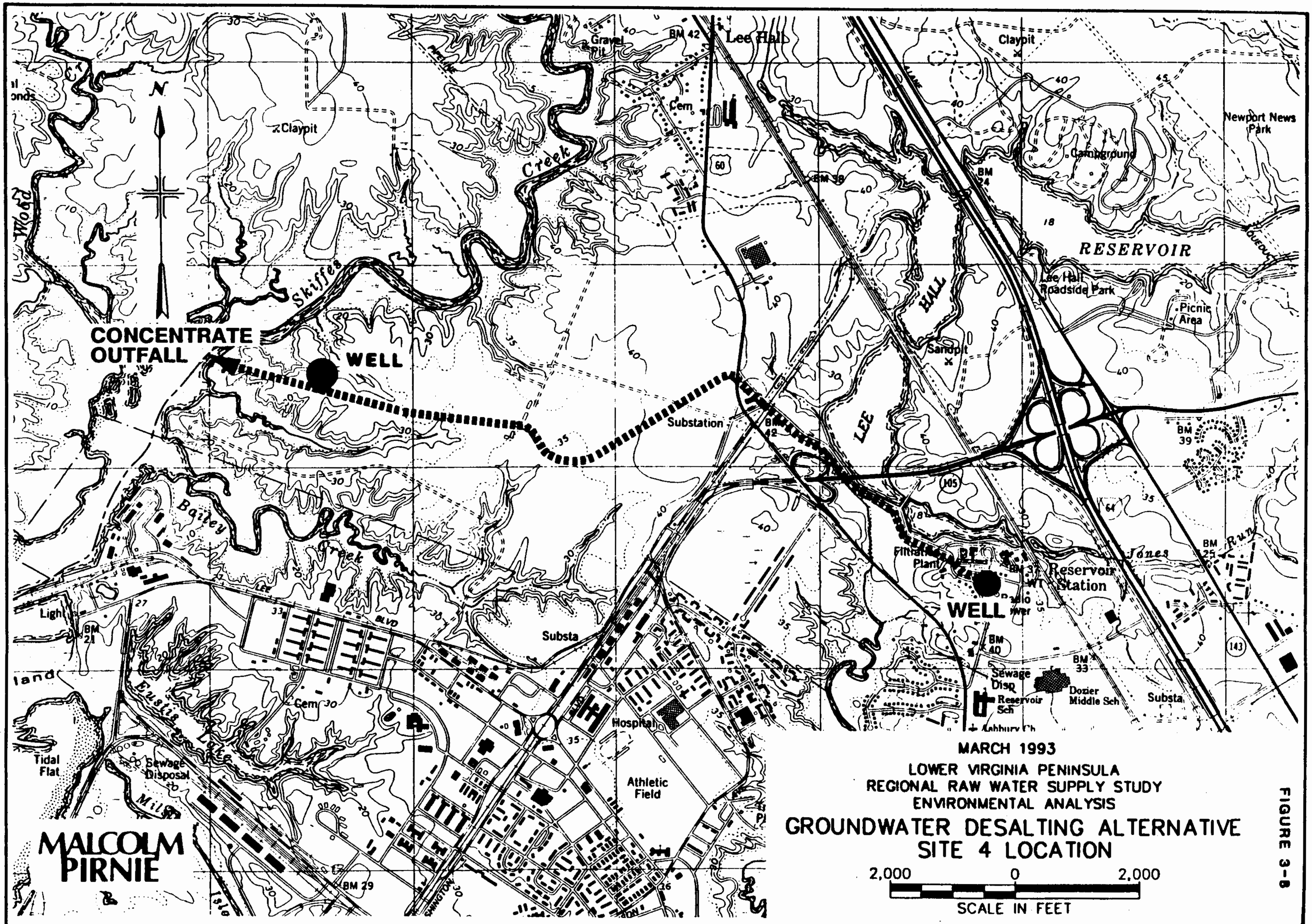
MALCOLM PIRNIE



FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
SITE 3 LOCATION

FIGURE 3-7



MARCH 1993

LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

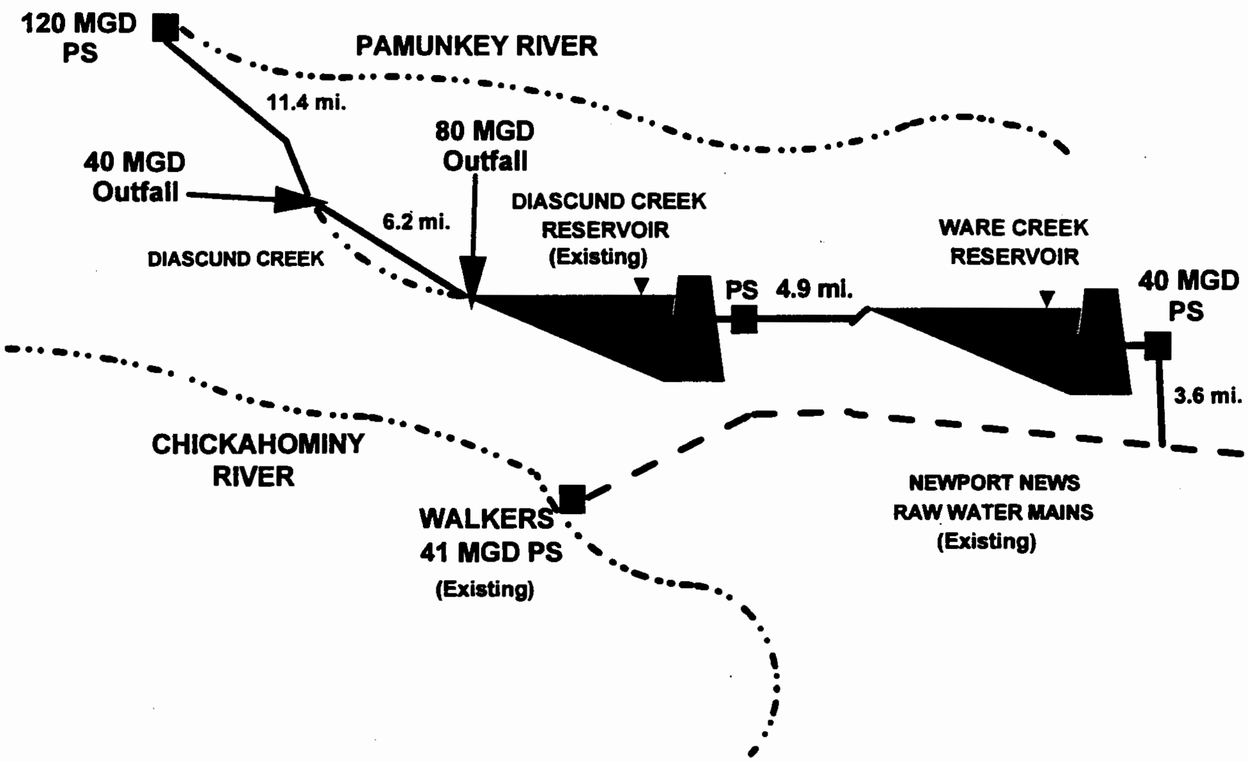
GROUNDWATER DESALTING ALTERNATIVE
SITE 4 LOCATION

2,000 0 2,000
SCALE IN FEET

FIGURE 3-8

Figure 3-9

EXPANDED WARE CREEK PROJECT CONCEPT



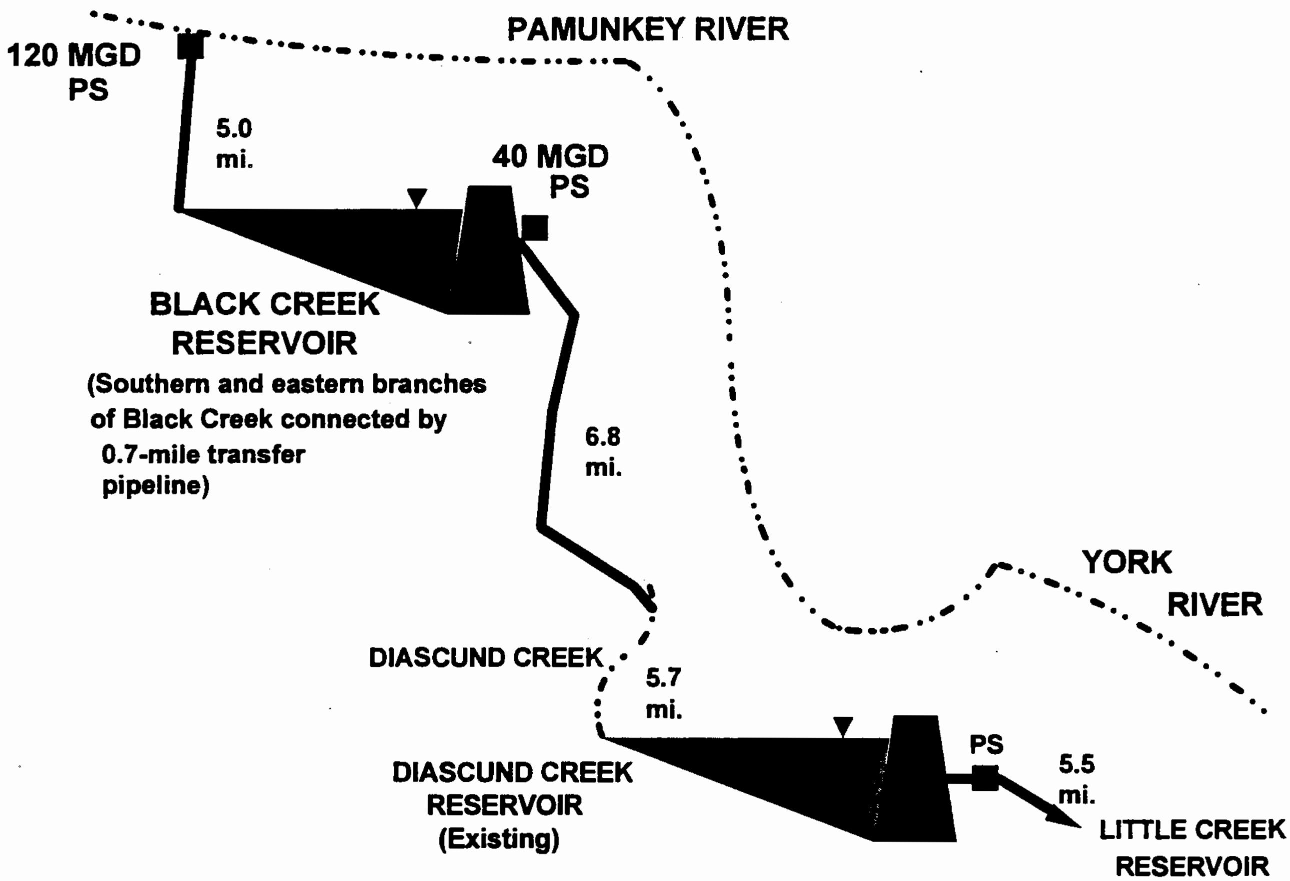
PROJECT FEATURES

- 120 mgd Pamunkey River intake and pump station near Northbury in New Kent County
- 11.4-mile, 120 mgd and 6.2-mile, 80 mgd capacity pipeline from Northbury to Diascund Creek headwaters (40 and 80 mgd outfalls)
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 4.9-mile, 40 mgd capacity pipeline from Diascund to Ware Creek Reservoir
- 40 mgd intake and pump station at Ware Creek
- 3.6-mile, 40 mgd capacity pipeline from Ware Creek to NN raw water mains (can also serve as outfall line to Ware Creek)
- Ware Creek dam 1,450 ft long at a crest elevation of 48 ft. msl
- Ware Creek Reservoir characteristics:

Total Volume	6.87 BG
Surface Area	1,238 ac
Normal Pool Elevation	35 ft. msl
Minimum Pool Elevation	16.5 ft. msl
Dead Storage Volume	25%
Reservoir Drainage Area	17.4 sq mi
Minimum Reservoir Release	0.4 - 1.6 mgd

Figure 3-10

BLACK CREEK RESERVOIR PROJECT CONCEPT

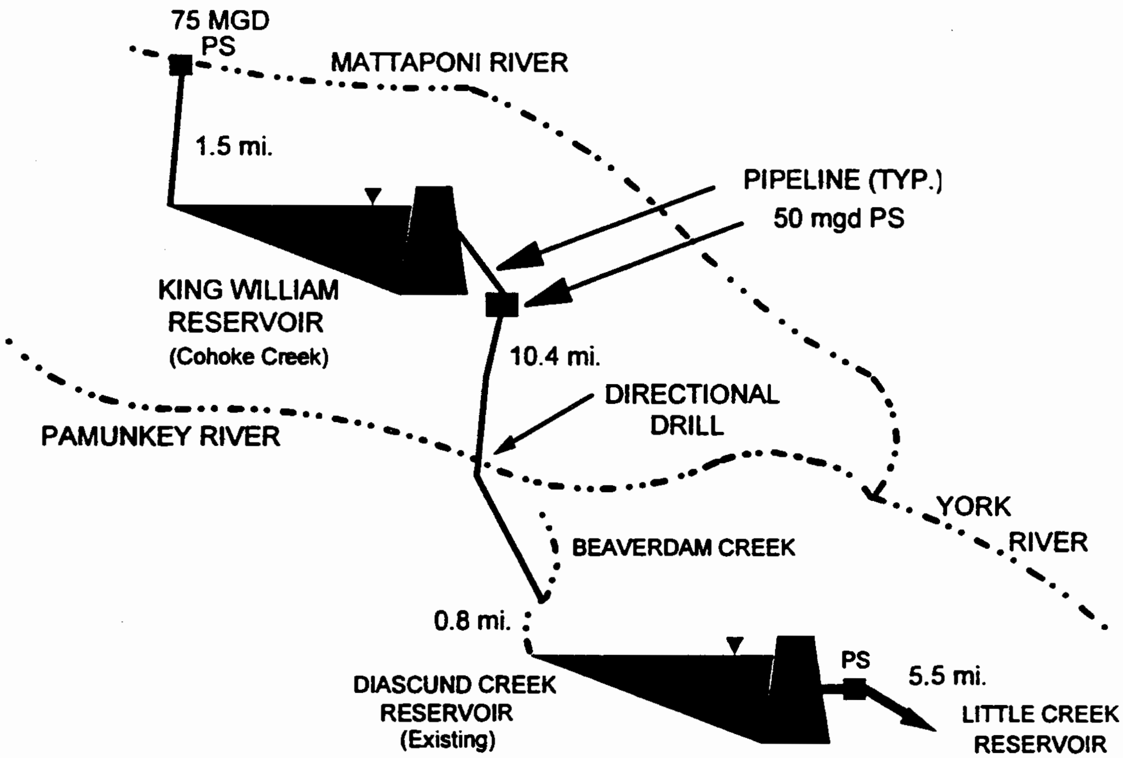


PROJECT FEATURES

- 120 mgd Pamunkey River intake and pump station in vicinity of Northbury
- 5-mile, 120 mgd capacity pipeline from Pamunkey River to Black Creek Res.
- 40 mgd intake and pump station on the eastern branch of Black Creek Res.
- 6.8-mile, 40 mgd capacity pipeline for BC Reservoir withdrawals
- Pipeline terminus at 60 ft. msl on Diascund Creek in New Kent County
- Pipeline discharge flows 5.7 miles to Diascund Creek Reservoir
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 5.5-mile, 40 mgd capacity pipeline from Diascund to Little Creek Reservoir
- Dams 73 and 87 feet high at crest elevations of 110 feet msl
- Black Creek Reservoir characteristics:

Total Volume	6.41 BG
Surface Area	910 ac
Normal Pool Elevation	100 ft. msl
Minimum Pool Elevation	76 ft. msl
Dead Storage Volume	25%
Reservoir Drainage Area	5.47 sq mi
Minimum Reservoir Release	1.2 mgd

KING WILLIAM RESERVOIR PROJECT CONCEPT
RRWSG's PREFERRED CONFIGURATION (KWR-II)

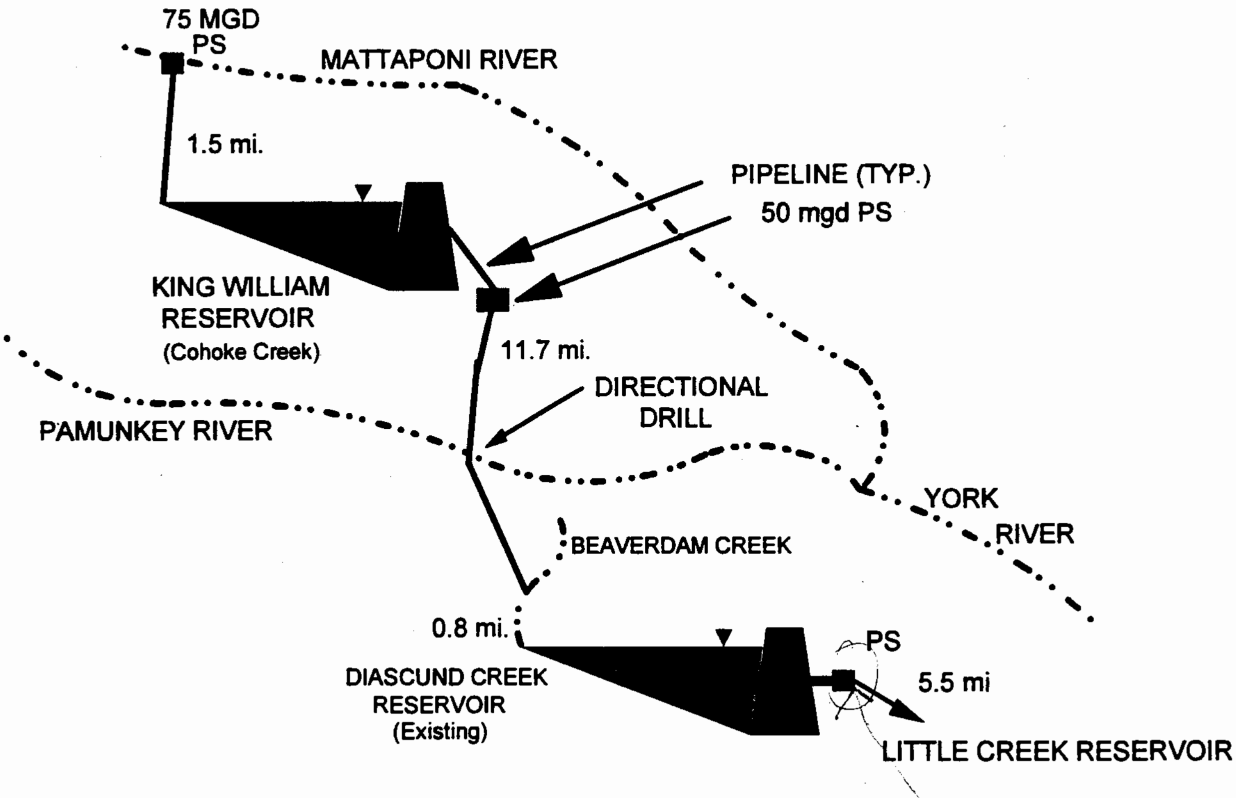


PROJECT FEATURES

- 75 mgd Mattaponi River intake and pump station at Scotland Landing
- 1.5-mile, 75 mgd capacity pipeline from Mattaponi River to K. W. Reservoir
- 50 mgd in-line pump station for K.W. Reservoir withdrawals
- 10.4-mile, 50 mgd capacity pipeline from K. W. Reservoir to Beaverdam Creek
- Pipeline discharge flows 0.8 mi downstream to Diascund Creek Reservoir
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 5.5-mile, 40 mgd capacity pipeline from Diascund to Little Creek Reservoir
- K. W. Reservoir dam 2,400 ft long and 92 ft high at a crest elev. of 106 ft. msl
- King William Reservoir characteristics:

Total Volume	21.2 BG
Surface Area	2,222 ac
Normal Pool Elevation	96 ft. msl
Minimum Pool Elevation	64 ft. msl
Dead Storage Volume	25%
Reservoir Drainage Area	11.45 sq mi
Minimum Reservoir Release (varies monthly)	3 mgd average during normal conditions 1 mgd average during critical periods

KING WILLIAM RESERVOIR PROJECT CONCEPT CURRENTLY PROPOSED CONFIGURATION (KWR-IV)



PROJECT FEATURES

- 75 mgd Mattaponi River intake and pump station at Scotland Landing
- 1.5-mile, 75 mgd capacity pipeline from Mattaponi River to K. W. Reservoir
- 50 mgd in-line pump station for K.W. Reservoir withdrawals
- 11.7-mile, 50 mgd capacity pipeline from K. W. Reservoir to Beaverdam Creek
- Pipeline discharge flows 0.8 mi downstream to Diascund Creek Reservoir
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 5.5-mile, 40 mgd capacity pipeline from Diascund to Little Creek Reservoir
- K. W. Reservoir dam 1,700 ft long and 78 ft high at a crest elev. of 106 ft. msl
- King William Reservoir characteristics:

Total Volume	12.2 BG
Surface Area	1,526 ac
Normal Pool Elevation	96 ft. msl
Minimum Pool Elevation	67 ft. msl
Dead Storage Volume	25%
Reservoir Drainage Area	8.92 sq mi
Minimum Reservoir Release (varies monthly)	2 mgd average during normal conditions 1 mgd average during critical periods

There is another factor that must be considered when assembling alternative components into an overall regional project. Fresh groundwater and groundwater desalination are not independent of one another. Some combination of fresh groundwater and brackish groundwater may be available beyond the limits of the individual components described (e.g., 10 mgd of fresh groundwater during periods of substantial reservoir drawdown to produce a 4.4 mgd treated water safe yield, or 10 mgd of brackish groundwater for desalination during any period to produce a 5.7 mgd treated water safe yield). In view of the current overused and degraded condition of the major regional aquifers and the level of state regulation under the Ground Water Management Act, the RRWSG does not consider it feasible to rely on pumping a total of 20 mgd of groundwater for permanent use on the Lower Peninsula. A groundwater modeling analysis was conducted by Malcolm Pirnie in 1993 using the USGS Coastal Plain Model to assess whether simultaneous operation of the two practicable groundwater alternatives would be permittable under state Groundwater Withdrawal Regulations (VR 680-13-07). This analysis is presented in Appendix I-21 of Report D (Volume I). The results from this analysis demonstrate that potential drawdown impacts to other existing groundwater users, and the potential for saline groundwater intrusion, could make it very difficult for such joint groundwater withdrawals to be permitted under the regulations. Therefore, an alternative that relies on the development of both groundwater components to their full capacities may not be available. Based on the above information, the project alternatives were assembled around each reservoir component as depicted in Table 3-4A.

These project alternatives have now been defined in a manner that facilitates further comparison. The Ware Creek and King William Reservoir projects would meet the projected regional deficit of 39.8 mgd through the Year 2040, and they have been assembled from components with the least potential environmental impacts. The Black Creek Reservoir project would fall just short (1.1 mgd) of meeting the 39.8 mgd deficit. The Ware Creek and Black Creek projects would rely more heavily on new groundwater development, with the Black Creek Reservoir requiring long-term reliance equaling the combined 10.1 mgd treated water safe yield benefit of the fresh groundwater and groundwater desalting alternatives (4.4 and 5.7 mgd, respectively). Because the Black Creek and Ware Creek reservoir sites are located wholly or partially within New Kent County, the County would be an integral participant in a project involving one of these reservoirs, and a region larger than the Lower Peninsula could therefore be opened to potential groundwater development.

3.6 RRWSG'S PREFERRED PROJECT ALTERNATIVE

3.6.1 Impact Comparison for Evaluated Alternatives

The DEIS compared the potential impacts of the six alternatives which were considered practicable at that time. The potential impacts of the No Action alternative also were evaluated, as required by the Council on Environmental Quality's NEPA regulations. The impact comparison was made, in part, using a matrix which contained impact scores for each of the seven alternative components carried forward in the detailed environmental analysis. The impact scores were totaled separately for the 16 aquatic ecosystem impact categories and for all 23 environmental impact categories. Differentiation for magnitude of impacts within individual impact categories was made by assigning relative numerical scores ranging from +3 to -3.

Following receipt of comments on the DEIS, the USCOE recommended that the numerical impact scoring matrix be eliminated from the EIS, since such ranking could be interpreted as biased and is not necessary for the intuitive comparison of alternatives. In accordance with the USCOE's request, the RRWSG has reassessed the favorable and unfavorable environmental impacts of the

TABLE 3-4A

PROJECT ALTERNATIVES

Alternative Component	RRWSG Treated Water Safe Yield (mgd)*											
	Ware Creek		Black Creek		King William (KWR-I)		King William (KWR-II)		King William (KWR-III)		King William (KWR-IV)	
	Interim	Long-Term	Interim	Long-Term	Interim	Long-Term	Interim	Long-Term	Interim	Long-Term	Interim	Long-term
Additional Conservation Measures and Use Restrictions**	7.1	10.5	7.1	10.5	7.1	11.1	7.1	10.8	7.1	10.5	7.1	10.5
Combination of Fresh Groundwater & Groundwater Desalting***	7.7	6.1	7.7	10.1	7.7	1.6	7.7	3.6	7.7	7.6	7.7	6.1
Reservoir with Pamunkey River	0	23.2	0	18.1	---	---	---	---	---	---	---	---
Reservoir with Mattaponi River	---	---	---	---	0	27.1	0	25.4	0	21.7	0	23.2
Total Supply	**14.8**	**39.8**	**14.8**	**38.7**	**14.8**	**39.8**	**14.8**	**39.8**	**14.8**	**39.8**	**14.8**	**39.8**

TABLE 3-4A (CONTINUED)

PROJECT ALTERNATIVES

*	Interim supply yield or demand reduction is required until the anticipated date that the reservoir component is operational (Year 2006 assumed for each reservoir in this analysis). Long-term numbers indicate the long-term supply yield or demand reduction benefits of each component of the project alternatives.
**	The estimated long-term safe yield benefit of additional conservation measures and use restrictions is 10.5 mgd for the smallest King William Reservoir configuration (KWR-IV), but may be somewhat less than this for the Ware Creek and Black Creek Reservoir alternatives.
***	The two groundwater alternatives have been combined since Newport News Waterworks currently is pursuing a brackish groundwater desalting project; and it may proceed with that project before developing new fresh groundwater sources. Therefore, an alternative that relies on the development of both groundwater components to their full capacities may not be available.

evaluated alternatives without the use of an impact matrix. Without a matrix, the comparison of impacts could be interpreted as more subjective. Nevertheless, the RRWSG concluded that, based on impact analyses performed to date, the seven alternative components compare as follows with respect to their overall net impacts after accounting for potential benefits:

Least Damaging

- Additional Conservation Measures and Use Restrictions

Minor Negative Impacts

- Fresh Groundwater Development
- Groundwater Desalination in Newport News Waterworks Distribution Area

Moderate Negative Impacts

- King William Reservoir with Pumpover from Mattaponi River
- Black Creek Reservoir with Pumpover from Pamunkey River

Major Negative Impacts

- Ware Creek Reservoir with Pumpover from Pamunkey River

Most Damaging

- No Action

The Additional Conservation Measures and Use Restrictions alternative would have very few adverse impacts and is thus a desired component of any project to meet the RRWSG's Year 2040 needs.

The two practicable groundwater alternatives would have negative impacts which, on an overall basis, are considered minor. The Fresh Groundwater Development alternative is considered somewhat less damaging than the Groundwater Desalination alternative. One of the reasons for this distinction is that the fresh groundwater would be discharged to existing reservoirs when they are drawn down to critical levels. This reservoir storage augmentation would provide benefits to aquatic biota that depend on these freshwater aquatic ecosystems. The fresh groundwater alternative also would not have the impacts associated with the long concentrate discharge pipelines and concentrate outfalls necessary for groundwater desalination. Fresh groundwater discharges to reservoirs may lead to reservoir eutrophication, however, depending on levels of phosphorus concentration in the groundwater.

Many of the adverse impacts of the various reservoir alternatives would result from conversion of existing wetland and terrestrial habitat to lacustrine habitat. Associated benefits would also result from reservoir development. For example, the proposed reservoirs would create lacustrine freshwater fisheries, offer water-related recreational opportunities, allow creation of new parks, and in some cases provide socioeconomic benefits.

Some of the environmental advantages and disadvantages of the Black Creek Reservoir and King William Reservoir alternatives are listed below:

King William Reservoir (KWR-II Configuration) Advantages Over Black Creek Reservoir

- The King William Reservoir would provide a 37 percent (8.0 mgd) greater total treated water safe yield benefit than the Black Creek Reservoir (29.0 versus 21.1 mgd). The King William Reservoir therefore would have a greater beneficial impact on the public water supply systems represented by the RRWSG -- and potentially on other public systems in the region as discussed below in Section 3.7.2 (discussion of Safe Yield Benefits) and Section 5.9.

- The King William Reservoir would provide 3¼ times more available storage than the Black Creek Reservoir (15.81 versus 4.84 billion gallons).

- A 39.8 mgd project alternative involving the King William Reservoir would require development of a long-term groundwater supply with a treated water safe yield of at least 3.6 mgd. Given the list of practicable alternatives components, a 39.8 mgd project alternative involving the Black Creek Reservoir would require development of a long-term groundwater supply with nearly three times as much safe yield as would the King William Reservoir (10.1 versus 3.6 mgd, respectively). Even with additional conservation measures and use restrictions and both groundwater alternatives, a Black Creek Reservoir project would still fall 1.1 mgd short of meeting the projected Year 2040 deficit.

- The King William Reservoir would rely on Mattaponi River withdrawals, while the Black Creek Reservoir would rely on Pamunkey River withdrawals. The risk of long-term adverse impacts of potential resource overuse, and heightened levels of local, state and federal conflicts over competing uses of increasingly limited available resources, would be much greater with a Pamunkey River withdrawal alternative. Estimated Year 1990 consumptive water use in the Pamunkey River Basin (34.2 mgd) is 11 times greater than that estimated for the Mattaponi River Basin (3.1 mgd). In the Year 2040, Pamunkey River Basin withdrawals, including those for the Black Creek Reservoir project, are projected to reach 87.0 mgd, or 9.9 percent of the estimated mean historical freshwater discharge at the mouth of the Pamunkey River (883 mgd). Mattaponi River Basin withdrawals, including those for the King William Reservoir project, are projected to be 37.1 mgd, or 6.4 percent of the estimated mean historical freshwater discharge at the mouth of the Mattaponi River (581 mgd).

- Based on simulations using a salinity model developed by VIMS, Mattaponi River withdrawals to supply the King William Reservoir, in combination with other existing and projected consumptive uses in the Mattaponi River Basin, are not expected to result in substantial salinity changes. There is a greater potential for salinity intrusion impacts on the Pamunkey River from the Black Creek Reservoir alternative in combination with other existing and projected consumptive uses.

- The King William Reservoir would result in creation of nearly 2½ times as much surface area that could be used as lacustrine fish and waterfowl habitat than would the Black Creek Reservoir (2,222 versus 910 acres).

- The King William Reservoir impoundment site, and areas immediately below the proposed dam site, are isolated from anadromous fish passage by the existing Cohoke Millpond Dam, which is located 2.4 river miles downstream of the proposed King William Reservoir Dam. By comparison, only lesser obstructions to fish passage, such as road crossings and beaver dams, exist below the proposed Black Creek Reservoir dam sites.

- Because Cohoke Creek already is impounded below the proposed King William Reservoir dam site, it is subject to a substantial degree of flow moderation during high runoff events. In contrast, the floodplain areas and associated floodplain wetland communities below the proposed Black Creek Reservoir dam sites would be subjected to greater flood flow reductions from those currently experienced.

- No existing homes would be displaced by the proposed King William Reservoir. In contrast, the Black Creek Reservoir would result in the displacement of existing homes, and the potential for inundation or other direct impacts to houses within reservoir buffer zones that would be established (e.g., septic systems relocations, restrictions on additional construction on developed parcels, etc.).

<u>Black Creek Reservoir Advantages Over King William Reservoir (KWR-II Configuration)</u>

- The Black Creek Reservoir would inundate an estimated 285 acres of wetlands and open water, whereas the King William Reservoir would inundate 574 acres.

- The Black Creek Reservoir would inundate an estimated 625 acres of uplands, as compared to 1,648 acres of uplands for the King William Reservoir. In each case, most of these losses would be forested habitats, which are common in this region. The projected losses would represent less than 1 percent and 2 percent of the forested land in New Kent and King William Counties, respectively.

- Field studies to date have revealed no individuals of the federally-listed threatened Small Whorled Pogonia within the Black Creek Reservoir site. Small Whorled Pogonia were found at two locations within the proposed King William Reservoir site. In addition, the Black Creek Reservoir site does not contain an active Great Blue Heron rookery as does the King William Reservoir site.

- The Black Creek Reservoir watershed does not contain any landfills. The King William Reservoir watershed contains a closed landfill which lies above the proposed reservoir normal pool elevation.

- The Black Creek Reservoir would be expected to have larger growth-inducing benefits to New Kent County than would the King William Reservoir for King William County. This expectation is based on the location of the Black Creek Reservoir sites in closer proximity to major transportation corridors, population centers, employment areas, and existing utility systems. In addition, substantial residential development already has occurred in the Black Creek Reservoir watershed.

Of the three reservoir alternatives, the Ware Creek Reservoir is considered by the RRWSG to be the most damaging overall. Some of the principal reasons for this conclusion are listed below:

- The proposed Ware Creek Reservoir dam site is in tidal and navigable waters of the United States. The Black Creek and King William Reservoir dam sites are located in non-tidal waters which are upstream of existing man-made obstructions such as dams and road crossings.

- Like the Black Creek Reservoir project, the Ware Creek Reservoir project would rely on Pamunkey River withdrawals, while the King William Reservoir would rely on Mattaponi River withdrawals. Both current water demands and projected long-term increases in water demands are greater on the Pamunkey than on the Mattaponi; and there would be a greater risk of long-term adverse impacts from potential resource overuse (including salinity intrusion), and increased levels of local, state and federal conflicts over competing uses of available resources.

- The Ware Creek Reservoir alternative would cause the largest reduction in streamflow levels below a proposed dam site (86 to 96 percent reduction in average flow).

- The Ware Creek Reservoir would have the largest impact on the hydrologic and salinity regimes of wetlands below a proposed dam site. The reservoir would eliminate a tidal freshwater zone and greatly reduce or eliminate oligohaline areas below the dam.

- Intense development in the "Stonehouse" community is occurring within the Ware Creek Reservoir watershed. This extensive development represents the most serious threat to continued long-term water quality in any of the three proposed reservoirs.

- Of the three reservoir alternatives, the Ware Creek Reservoir site contains the largest known population of a sensitive species (98-nest Great Blue Heron rookery).

- The Ware Creek Reservoir site is used by anadromous fish, including Striped Bass. There is no evidence, and a low probability, that either the Black Creek Reservoir or King William Reservoir sites are used by anadromous fish.

- The Ware Creek Reservoir would impact the largest and most diverse area of wetlands (590 acres of tidal and non-tidal wetlands).

- The Ware Creek Reservoir would provide a 10 percent (2.8 mgd) lower total treated water safe yield benefit than the King William Reservoir. Therefore, the Ware Creek Reservoir would have less beneficial impact on municipal water supply systems.

- The Ware Creek Reservoir would impact the largest number of existing roadways, including potential flooding of low points on Interstate 64 under conditions more severe than 100-year storm events.

The No Action alternative is considered by the RRWSG to be the most damaging overall of the seven alternatives evaluated. Major negative impacts would result if no action were taken to develop additional water supplies. These would include severe adverse impacts on municipal and private water supplies. Surface water reservoirs would be drawn down to much lower levels and for longer periods, causing more frequent and more severe water quality problems and adverse impacts to aquatic habitat in those reservoirs. In the event of a drought as severe as the controlling drought modeled for safe yield analyses, existing surface water supplies could be completely depleted under demand conditions projected to occur during this decade.

Likewise, if no action were taken, negative socioeconomic impacts likely would occur on the Lower Peninsula, such as implementation of growth-limiting measures to conserve the existing water supply. For example, water purveyors might be forced to place moratoriums on new hook-ups, which could reduce new sources of revenue for the region (e.g., state and local income taxes, state sales taxes, and local property taxes).

3.6.2 Comparison of Alternative Component Practicability

The preceding subsection compares the overall impacts of the seven alternatives carried forward in the detailed environmental impact analysis. The recommendation of specific alternative components to be included in an overall project alternative should also be supported by the results of the practicability analysis. Therefore, a discussion is presented below on the relative technical merits of the evaluated alternatives.

The No Action alternative is not considered practicable, since it would not contribute to a solution of the basic project purpose. Nevertheless, the No Action alternative was retained for this environmental impact analysis pursuant to the Council on Environmental Quality's NEPA regulations. Given these factors, the practicability of the No Action alternative is omitted from the following discussion.

Safe Yield Benefits

The available storage capacity of the King William Reservoir (15.81 billion gallons for the RRWSG's preferred KWR-II configuration) would be more than three times greater than that of either the Black Creek Reservoir (4.84 billion gallons) or the Ware Creek Reservoir (5.16 billion gallons). Therefore, the King William Reservoir alternative would serve much more of the RRWSG's projected Year 2040 needs than either of the other two reservoir alternatives.

The King William Reservoir with Mattaponi River Pumpover alternative also offers the greatest potential for future enhancement to supply water to a larger region than the Lower Peninsula and/or to meet water demands beyond the Year 2040. As discussed in Section 5.9, the King William Reservoir Project (KWR-I or KWR-II configurations) offers the ability to meet some of the additional needs of jurisdictions outside the RRWSG boundaries, with few additional wetland impacts. (These potential benefits are in addition to the host jurisdiction allowances assumed for King William and New Kent Counties.)

In Section 5.9 of the Supplement, a two river pumpover scenario (i.e., Mattaponi and Pamunkey Rivers) was discussed as a possible means of enhancing the King William Reservoir Project (KWR-II configuration) to supply the needs of a larger region. This enhancement option is not available for either the Black Creek or Ware Creek Reservoirs, because of their substantially smaller storage capacities. The RRWSG has no plans at this time to develop such an enhanced King William Reservoir Project. However, at the USCOE's direction, the RRWSG has evaluated a two river pumpover scenario for a smaller King William Reservoir that would meet the projected needs of the RRWSG (see Section 3.4.32.4).

The fresh and brackish groundwater alternatives would produce estimated treated water safe yield benefits of 4.4 mgd and 5.7 mgd, respectively. Given their relatively low supply benefits, these alternative components are considered supplementary to the reservoir alternatives which are each capable of providing more than 18 mgd of the RRWSG's projected Year 2040 treated water deficit of 39.8 mgd.

The Additional Conservation Measures and Use Restrictions alternative would provide a 7.1 to 11.1 mgd treated water safe yield benefit and is considered an integral component of any overall project developed.

Availability

Host Jurisdiction Approval

King William Reservoir. The City of Newport News has executed a host jurisdiction agreement with King William County for development of the King William Reservoir alternative. This represents a major step toward successful implementation of this reservoir alternative.

Ware Creek Reservoir. Over the past four years, no progress has been made between Newport News and James City County on a project development agreement for the Ware Creek Reservoir alternative. While an agreement with James City County still may be possible, acceptable resolution of safe yield, operational, and financing issues remains uncertain at this time.

Black Creek Reservoir. Beginning in June 1992, the RRWSG made efforts to develop a project development agreement with New Kent County for the Black Creek Reservoir alternative. In September 1994, however, New Kent County's governing body terminated those discussions and directed the RRWSG to discontinue all work concerning the Black Creek Reservoir. New Kent County further informed the RRWSG that the County has no intention at this time of cooperating with the RRWSG on Black Creek Reservoir development (R. J. Emerson, New Kent County, personal communication, 1994). This position was reiterated in April 1996 (E.D. Ringley, New Kent County, personal communication, 1996). Even if this opposition is overcome in the future, there would remain the local issues of displacement of residents and impacts to additional subdivided land with millions of dollars of assessed value.

Fresh Groundwater. James City County has taken a position of public opposition to this alternative. This opposition surfaced following a March 30, 1992 application which was submitted to the SWCB by the City of Newport News Waterworks for a smaller version of this alternative in western James City County. In formal comments to the SWCB concerning this application, the County stated: "we oppose the issuance of these withdrawal permits at least until such time as a reliable supply of surface water is available to the County" (J.T.P. Horne, James City County, personal communication, 1992). This local opposition would likely delay implementation of this alternative within (and possibly outside) James City County, until some agreement between the City of Newport News and James City County could be negotiated.

For nearly four years, the City of Newport News and New Kent County conducted negotiations designed to reach an agreement allowing fresh groundwater development in New Kent County. The two jurisdictions were considering development of deep groundwater withdrawals within New Kent County to supply future County needs and augment storage in Diascund Creek Reservoir. In April 1994, however, the County called off the proposed sale of up to 2.1 mgd of groundwater to Newport News. The County cited accelerated development, including the then-proposed horse racetrack and a new golf course, as a primary reason for terminating the sale. The County elected to retain its groundwater supply to serve these growing water demands. There were also indications that the County would have been subject to additional VDEQ permitting requirements restricting the sale of the groundwater to another jurisdiction.

Brackish Groundwater Desalination. This alternative is the most available of the evaluated water supply development alternatives from a host jurisdiction approval standpoint, because the groundwater well and reverse osmosis treatment facilities associated with this alternative would be built within the City of Newport News, or in York County on property owned by the City of Newport News Waterworks. Newport News Waterworks is actively pursuing a brackish groundwater desalting project. In August 1994 the VDEQ approved a draft groundwater withdrawal permit for Newport News. Well installation and final design of the treatment facility should be completed by the end of 1996 and start-up for the desalting facility is scheduled for mid-1998. Once the facility is on-line, a treated water safe yield benefit of 5.7 mgd is expected.

Additional Conservation Measures and Use Restrictions. This alternative would be implemented (and in fact, it already is being implemented) by the participating jurisdictions. No host jurisdiction approvals are required.

Competition for Source Water

The Mattaponi River, as the proposed river pumpover source for the King William Reservoir alternative, offers a distinct advantage over the Pamunkey River, which is the proposed pumpover source for the Ware Creek and Black Creek Reservoirs. The King William Reservoir would rely on a 45-mgd smaller river withdrawal capacity (75 versus 120 mgd), but it would provide a greater safe yield benefit than would either the Ware Creek or the Black Creek Reservoir.

Existing and projected future consumptive water uses are much greater in the Pamunkey River Basin than in the Mattaponi River Basin. This includes Hanover County's pursuit of large-scale Pamunkey River withdrawals over the past several years to supply potential new off-stream storage facilities. Less anticipated competition for Mattaponi River water is a distinct advantage associated with the King William Reservoir alternative.

Both groundwater alternatives are located within the Eastern Virginia Groundwater Management Area, where state regulation of groundwater use is stringent and competition for development of future groundwater supplies is high among local jurisdictions and private water supply developers. As previously indicated, however, the VDEQ has approved a draft groundwater withdrawal permit for Newport News that may lead to development of a brackish groundwater desalination project.

<u>Costs</u>

Life cycle costs have been estimated for all five water supply source development alternatives which were carried forward in the detailed environmental impact analysis (for the King William Reservoir with Mattaponi River Pumpover alternative, a cost estimate has only been prepared for the RRWSG's preferred KWR-II configuration.) These costs have been related to estimated total treated water safe yield benefits to provide a more equal comparison of alternatives. This cost comparison assumes that each non-RRWSG host jurisdiction receiving a water supply allotment would pay for its pro-rata share of total project safe yield.

Each of the five alternatives is considered affordable according to the screening criteria used and described in Section 3.3. As shown in the following table, the Fresh Groundwater alternative is by far the most cost-effective alternative. The King William Reservoir and Groundwater Desalination alternatives would be the next most cost-effective, followed by the Ware Creek Reservoir. The Black Creek Reservoir alternative would be the least cost-effective.

Alternative Component	Treated Water Safe Yield (mgd)		Year 1992 Present Value Cost Per mgd of Total Treated Water Safe Yield
	Total	RRWSG*	
Ware Creek Reservoir	26.2	23.2	$5.81M
Black Creek Reservoir	21.1	18.1	$6.54M
King William Reservoir (KWR-II Configuration)	29.0	25.4	$5.21M
Fresh Groundwater	4.4	4.4	$2.24M
Groundwater Desalination	5.7	5.7	$6.00M

* For reservoir alternatives, RRWSG treated water safe yield benefits are less than total benefits due to assumed host jurisdiction allowances for King William, New Kent, and/or James City Counties. For Black Creek Reservoir, the full extent of New Kent County's projected needs would not be served by the host jurisdiction allowance for this alternative (see Section 3.4.13).

Technological Reliability

For the five water supply source development alternatives, the principal reliability concerns focus on the long-term water quality of the proposed river or groundwater sources and of surface water runoff in the proposed reservoir watersheds.

River Pumpover Water Quality

Currently, there are no "major" (as classified by the VDEQ) existing or planned municipal or industrial discharges in the Mattaponi River Basin. This represents a distinct long-term advantage for the King William Reservoir alternative.

For the Ware Creek and Black Creek Reservoir alternatives, the proposed river pumpover source is the Pamunkey River. There currently are four major municipal and industrial discharges upstream of the proposed intake site at Northbury. Chesapeake Corporation operates a large Kraft pulp and paper mill in the Town of West Point which is a major industrial discharger to the lower portion of the Pamunkey River. In addition to these existing discharges, Hanover County currently plans to put in place a major sewage treatment plant (STP) discharge to the Pamunkey River upstream of Northbury. King William County currently holds a permit to develop a 25,000 gallon per day STP on Moncuin Creek, a Pamunkey River tributary which discharges to the Pamunkey approximately 6½ river miles upstream of Northbury, and it may eventually increase the STP capacity to 500,000 gallons per day (D. S. Whitlow, King William County, personal communication, 1993). In New Kent County, a new regional jail site downstream of Northbury will discharge treated wastewater into the Pamunkey River at Parham Landing. A permit has also been issued to New Kent County for a 0.25 mgd STP discharge at an existing Cumberland Hospital STP outfall point on Cumberland Thorofare (a side channel of the mainstem Pamunkey River) downstream of Northbury. The number of existing and planned wastewater discharges to the Pamunkey River raises questions about water quality that do not exist for the Mattaponi River.

The Ware Creek Reservoir project could lead to an increase in phosphorus loadings in the Diascund Creek Reservoir, which could result in eutrophic conditions in both the Diascund Creek and Ware Creek Reservoirs. This would occur because the Ware Creek Reservoir alternative would involve a direct pumpover from the Pamunkey River to the Diascund Creek Reservoir and a subsequent pipeline from the Diascund Creek Reservoir to the Ware Creek Reservoir. For the other two reservoir alternatives, water from the Pamunkey or Mattaponi River would be pumped to an intermediate storage reservoir (either the Black Creek Reservoir or the King William Reservoir) prior to transmission to the Diascund Creek Reservoir. Owing to its much larger total storage capacity (3.3 times that of the Black Creek Reservoir), the King William Reservoir would provide a much longer hydraulic retention time for incoming river water than would the Black Creek Reservoir. This would allow a higher degree of particulate settling, which would result in a substantial reduction in concentrations of phosphorus and other particulate-borne constituents in the water column and could greatly improve the quality and treatability of the raw water delivered to the Diascund Creek Reservoir and the rest of the existing Lower Peninsula raw water storage system.

The pipeline configuration for the Black Creek Reservoir alternative also would allow a portion of the Pamunkey River withdrawals to be pumped directly to Diascund Creek, bypassing the Black Creek Reservoir. Such direct discharges of Pamunkey River water could lead to increased phosphorus loadings and resulting eutrophication of the Diascund Creek Reservoir.

Reservoir Watershed Water Quality

There is minimal existing or planned development within the 11.45-square mile King William Reservoir (KWR-II configuration) watershed. However, there are some concerns regarding groundwater quality and surface water runoff quality, because the King William County Landfill is located within the reservoir drainage area (but above the proposed normal pool elevation of 96 feet msl). King William County has discontinued acceptance of waste at this landfill. Closure construction began at the site in the spring of 1994 and was completed in April 1995. As part of the closure, a final cap system was placed over the entire limits of the waste disposal area, to limit infiltration of surface water and minimize leachate generation through the post-closure period. Several alternatives exist for corrective action in the event of a release of leachate constituents from the landfill and confirmed impact on reservoir water quality.

Intense development plans associated with the "Stonehouse" community generate substantial water quality concerns associated with the Ware Creek Reservoir alternative. This 7,230-acre planned community will occupy 73 percent of the 9,903 acres that would drain to the Ware Creek Reservoir (excluding the reservoir normal pool area). Within James City County, the Stonehouse development ultimately will include 3.8 million square feet of commercial space and 4,411 dwelling units. Given the magnitude of this development, and historical water quality conditions in other highly developed reservoir watersheds, there would be a great risk of long-term reservoir water quality deterioration, despite implementation of best management practices and other measures designed to protect the quality of surface water runoff to the reservoir.

Marked residential growth has occurred and continues to occur in portions of the 5.47 square mile Black Creek Reservoir watershed. There are currently at least four residential subdivisions within the proposed reservoir watershed; and no buffers have been established between these subdivisions and the proposed reservoir normal pool area. For example, the large Clopton Forest subdivision borders the western edge of the Southern Branch Black Creek reservoir site. This residential development has the potential to impact reservoir water quality by contributing non-point source runoff from roads, sediment loads from home and road construction activities, nutrient loads from lawn fertilizer runoff, and migration of pollutants from septic tanks. The problem would be exacerbated by future development that likely would be stimulated by reservoir construction.

Groundwater Quality

A principal water quality concern associated with the Fresh Groundwater Development alternative concerns the level of phosphorus in the Middle Potomac Aquifer. Phosphorus concentrations in the Middle Potomac Aquifer near Little Creek Reservoir are not expected to be a problem. However, there appears to be an increasing trend in phosphorus concentrations to the west, toward Diascund Creek Reservoir. If phosphorus concentrations in the wells near Diascund Creek Reservoir are high, phosphorus loadings resulting from fresh groundwater discharges to the Reservoir could result in reservoir management and water treatment problems associated with increasingly eutrophic reservoir conditions.

Elevated sodium levels in the groundwater also represent a potential concern, particularly since physicians now recommend various restricted sodium intakes to a portion of the population. If drinking water were to exceed VDH-recommended maximum sodium levels, water use would be restricted for some customers.

Due to the potential for reservoir water quality impacts from fresh groundwater discharge, use of groundwater without pretreatment should be approached with caution. Screening multiple aquifer zones and blending the groundwater prior to discharge to the reservoirs would be one technique for partially mitigating these potential impacts.

For the region encompassed by the brackish groundwater desalting alternative, available water quality data for the Middle Potomac and Lower Potomac aquifers are very limited. Newport News' current brackish groundwater desalination project should provide answers as to whether successful treatment of the proposed feed water can be accomplished using a low-pressure membrane system designed for brackish waters.

Summary

Based on investigations to date, the King William Reservoir alternative appears superior to the other two reservoir alternatives with respect to each of the technical evaluation criteria discussed above. Brackish groundwater development appears at this time to be more available to the RRWSG than fresh groundwater development. If available, however, fresh groundwater withdrawals would be much more cost-effective.

3.6.3 RRWSG's Proposed Project Alternative

Based on the results of the environmental impact analysis, the practicable alternative components which appear to be the least damaging are listed below and are proposed as long-term components of an overall 39.8 mgd project alternative. The RRWSG's treated water safe yield benefits from each component are shown in the following table for each of the four King William Reservoir project configurations.

Project Component	Reservoir Configuration			
	KWR-I	KWR-II	KWR-III	KWR-IV
Additional Conservation Measures and Use Restrictions	11.1	10.8	10.5	10.5
Combination of Fresh Groundwater Development and/or Groundwater Desalination	1.6	3.6	7.6	6.1
King William Reservoir with Pumpover from Mattaponi River	27.1	25.4	21.7	23.2
Total Treated Water Safe Yield for RRWSG (mgd)	**39.8**	**39.8**	**39.8**	**39.8**

Through the Year 2040, the RRWSG's projected 39.8 mgd treated water supply deficit can be met with a combination of additional conservation measures and use restrictions, fresh and/or brackish groundwater withdrawals, and the King William Reservoir.

A tiered use restriction program has been developed and adopted by the Newport News City Council so that it may be implemented when the need arises. Other RRWSG member jurisdictions should do likewise. These use restrictions would be contingency measures, beyond routine conservation measures, employed to produce short-term demand reductions during water supply emergencies.

The environmental impact analysis and technical merits of the King William Reservoir alternative support its inclusion as part of the proposed overall 39.8 mgd project alternative. Based on these conclusions, the RRWSG has applied to the USCOE for a permit pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act to construct the King William Reservoir project.

Assuming a 10-year time to completion for King William Reservoir, interim groundwater supplies yielding at least 7.7 mgd would be required to satisfy projected interim water supply deficits before the new reservoir becomes operational. This estimate also assumes implementation of additional conservation measures and use restrictions capable of reducing short-term demands by at least 7.1 mgd.

3.7 CONCEPTUAL MITIGATION PLANS FOR RRWSG'S PREFERRED KING WILLIAM RESERVOIR PROJECT (KWR-II CONFIGURATION) AND OTHER RESERVOIR ALTERNATIVES (PREVIOUSLY NUMBERED AS 3.8 IN DEIS)

Conceptual mitigation plans have been developed for each alternative reservoir project, to allow comparison of the overall, net impacts of the three reservoir alternatives. A detailed mitigation plan was previously submitted to the USCOE for the Ware Creek Reservoir Project, as part of James City County's Section 404 permit requirements. The principal components of that plan are summarized in Section 3.7.3. This document summarizes James City County's Ware Creek Reservoir mitigation plan (James R. Reed & Associates, 1992) without modification.

Conceptual mitigation plans for each reservoir alternative have been developed to compensate for the unavoidable loss of vegetated wetlands which would be filled and/or inundated by the respective reservoir projects. Compensation is the third and final step in the mitigation sequencing process required by the February 6, 1990, Memorandum of Agreement between the USEPA and USCOE (USEPA, 1990). The first two steps, avoidance and minimization, have been addressed in the selection and configuration of the alternatives during the alternatives analysis procedure.

Numerous mitigation techniques would need to be employed to establish the number of acres of wetland mitigation required for a large water supply reservoir. To guide the selection of techniques, a hierarchy was established which reflects the mitigation priorities of the USCOE, USEPA, and USFWS. The general types of mitigation were investigated in the following order:

1. Restoration of wetlands on-site (within the reservoir watershed)
2. Creation of wetlands on-site (within the reservoir watershed)
3. Restoration of wetlands off-site (within the Pamunkey and/or Mattaponi River valleys)
4. Creation of wetlands off-site (within the Pamunkey and/or Mattaponi River valleys)

Wetland restoration is defined as the establishment of previously existing wetland character and functions at a site where wetlands have ceased to exist or exist only in a degraded condition. Wetland creation is defined as the establishment of a functional wetland where one previously did not exist. Because wetland restoration sites have previously supported wetlands, the likelihood of successful mitigation is much greater for wetland restoration than for creation of wetlands where none have previously existed. Once all restoration possibilities within the reservoir watershed have been exhausted, therefore, a balance must be struck between the benefits of on-site creation and the greater likelihood of success for off-site restoration. That balance is governed by the particular opportunities for each type of mitigation at a specific project location.

The conceptual mitigation plans present general descriptions of the primary components of each mitigation technique. Detailed designs, hydrologic budgets, and monitoring plans will be developed for the final mitigation sites selected.

3.7.1 RRWSG's Preferred Reservoir Project - King William Reservoir With Pumpover From Mattaponi River (KWR-II Configuration)

A conceptual mitigation plan has been developed by the RRWSG to compensate for the loss of vegetated wetlands that would be permanently filled or flooded by the King William Reservoir Project (KWR-II configuration). For the smaller proposed KWR-IV configuration, impacts and associated mitigation would be less. Nevertheless, the conceptual mitigation plan for the RRWSG's preferred KWR-II configuration provides a description of the type of mitigation envisioned for the project. An abridged version of the mitigation plan is described below. Additional detail is presented in the August 1996 ***King William Reservoir Project Conceptual Mitigation Plan for the Virginia Department of Environmental Quality*** (Malcolm Pirnie, 1996) which is included in Volume II of this FEIS Main Report.

Although the primary purpose of this section is to describe the wetland compensation components of the RRWSG's conceptual mitigation plan, it also describes the RRWSG's upland mitigation proposals. The RRWSG's intention with this plan is that the project's wetland impacts will be more than offset by compensatory mitigation projects. The wetland restoration/creation component was developed based on the following objectives:

- Provide a ratio of 2 acres of vegetated wetlands gained for every 1 acre of vegetated wetlands lost as a result of the reservoir project.
- Restore, enhance, or create wetlands to provide a functional capacity equal to or greater than that of the existing wetlands at the reservoir site.
- Maximize the probability of success for establishing viable wetlands.

A functional assessment, using the Evaluation for Planned Wetlands (EPW) procedure and the Habitat Evaluation Procedure (HEP), will be used to evaluate the final plan to ensure that the 2:1 level of compensation will provide a substantial net gain in wetland functional benefits. The functional assessments will be refined when the results of the HEP study are completed and final mitigation elements established.

A wetland restoration/creation plan has been developed to provide in excess of 2:1 compensation by acreage. Specific parcels on-site and off-site have been identified to provide most of these wetlands improvements. The conceptual mitigation plan places the highest priority on finding and restoring prior converted croplands to wetlands, because such efforts have a better record of success than other efforts to construct wetlands. A secondary priority is to create wetlands in sand and gravel pits and in borrow areas for dam construction materials. Because the wetland creation components of the plan possess ample hydrologic inputs, they have a great likelihood of success.

The final acreage for on-site and off-site mitigation and for each mitigation technique will depend on the particular opportunities available and will be determined during the detailed wetland mitigation design. The following summarizes the components of the conceptual mitigation plan.

On-Site Mitigation Within Reservoir Watershed

Restoration of Prior Converted Croplands and Farmed Wetlands

Prior converted croplands and farmed wetlands in the Cohoke Creek watershed were investigated. Several altered groundwater depressional wetland systems were identified as candidates for restoration. Following an evaluation of site feasibility, these potential mitigation sites were rejected as viable restoration areas. A reliance on groundwater discharges as a primary source of hydrology is considered precarious. Centuries of watershed manipulation from agricultural activities may have altered the local water table. The site locations also lack secondary sources of water. In addition, the former groundwater depressional wetlands are extremely small (<1 acre) and, as a result, are more costly per acre than the identified off-site wetland restoration areas. These small patches of potential groundwater depressional prior converted croplands and farmed wetlands would also be disruptive to farming practices because they would be located in prime agricultural farmland.

Borrow Area Constructed Wetlands

As part of the reservoir dam construction, suitable soil material must be excavated and transported to the dam site. Preliminary soil borings have indicated that suitable sandy and clay soils are available on the ridges adjacent to the rim of the proposed reservoir. The soils of the borrow area will be excavated to bring the land surface elevation down to the normal pool elevation of the reservoir. Those excavated borrow areas will provide an opportunity for the construction of wetlands adjacent to the reservoir.

A number of potential sites exist adjacent to the reservoir and in close proximity to the proposed dam site. Each of these areas was selected based on its size, its relative distance from the dam site, and its current vegetative community. The potential borrow area constructed wetland sites provide the possibility of creating large, contiguous blocks of wetland habitat for sensitive interior species such as neo-tropical migratory birds.

The plan for the borrow area wetlands calls for the creation of approximately 89 acres of diverse wetland habitat. Because the reservoir is located within the East Coast Migratory Flyway, the wetland mitigation effort includes habitat for breeding and migratory birds. Small open water and upland islands will be constructed in the borrow area wetlands to provide suitable habitat for waterfowl.

The borrow area constructed wetlands would be formed by excavating soil down to approximately the normal reservoir pool elevation. The micro-topography would vary irregularly to provide water depths from -2 feet to +2 feet, to provide a diversity of wetland types. Excavation would remain approximately 100 feet from the reservoir pool area, with the intervening undisturbed area acting as a berm to retain water when the reservoir is drawn below the minimum water elevation of the constructed wetland. The berm also would shelter the mitigation areas from wind, and thereby protect the mitigation areas from wave erosion. If necessary, the berm could be planted with emergent vegetation or armored with rip rap to reduce further the risk of erosion. The upland berm would also provide added ecosystem diversity to the mitigation areas.

Hydrologic connections to the reservoir would be provided by a series of channels between the borrow areas and the reservoir pool. Each of those channels would contain a water control weir which would act as a valve, allowing water to spill into the borrow areas when the reservoir pool was within 2 feet of its normal elevation and retaining water in the borrow area when the reservoir was drawn down more than 2 feet below its normal elevation.

The components of the planned borrow area constructed wetlands are discussed below:

- *Hydrology:* The hydrology of the proposed borrow area constructed wetlands would be supported primarily by the presence of the reservoir. Limited amounts of water also would be provided by direct precipitation and surface water runoff. Before the reservoir's entire yield is needed, water level fluctuations would be small, thereby providing a stable source of hydrology. In later years when the reservoir levels periodically fall, the berm structure would keep water from draining from the borrow area constructed wetlands.

  Seepage from the mitigation areas would be contained by the Yorktown Formation, a low permeability layer of silty to sandy clays lying beneath these areas. Seepage would also be contained by the accretion of organic material in the wetland areas. A substantial layer of organic material would develop and retain water through absorption and by clogging pore spaces of sandy substrates.

- *Soils:* After excavation, soils in the borrow areas would be composed primarily of low permeability clays and silty sands. Those soils would be amended with topsoils from wetlands within the reservoir pool area. As vegetation, particularly emergent vegetation, become established in the first few years, accumulated organic matter (detritus) would further condition the soil. Fertilizer would be applied if necessary, to ensure adequate nutrient levels.

- *Vegetation:* With irregular microtopography, the proposed borrow area constructed wetlands would contain a mosaic of wetland vegetative communities. The seed source would be supplied by the topsoil added from the wetlands within the reservoir pool area. Once the hydrologic conditions become evident, supplemental plantings could be implemented if necessary.

Portions of the 100-foot buffer zone around the borrow areas border the reservoir pool. These upland buffers would be preserved in perpetuity, therefore allowing for the establishment of mature forests retaining cove hardwood areas through natural succession.

<u>Aquatic Fringe Habitat</u>

Valuable aquatic fringe habitat would become established naturally around the perimeter of the reservoir. These areas would provide a suitable environment for many species including fish, amphibians, reptiles, shorebirds, and mammals, and their supporting food web (AWWA, 1988). Many migratory waterfowl could use these areas for feeding, resting, and wintering habitat. Similar reservoirs in the area have been examined and found to be heavily utilized by Egrets, Great Blue Herons, and Osprey for nesting, and Bald Eagles for feeding. The fringe habitat established around the reservoir would also improve water quality by filtering sediments and nutrients and would stabilize the shoreline to minimize erosive forces of waves, seiches, and boat wakes.

Open Water Habitat

In addition to the aquatic fringe habitat and open water habitat on the mitigation sites, the reservoir would provide valuable open water habitat for freshwater fish, invertebrates, and migratory waterfowl. Clearing would not occur on the reservoir fringe, leaving dead standing timber as habitat for Wood Ducks, Osprey, and Great Blue Herons. Due to the undulating topography, small islands are expected to form within the reservoir perimeter. The islands would provide valuable foraging and resting habitat for Great Blue Heron and other waterfowl; and they would create a diversity of habitat for other species in the reservoir area, as well as potential roosting/perching sites for osprey and bald eagle. Because there are only 1,000 acres of freshwater lakes in all of King William County, this reservoir would substantially increase the availability of this valuable freshwater fishery habitat and its recreational use. In addition, based upon an assessment of wetlands currently located below the project's dam site, the reservoir would dissipate flood events and may help maintain these wetlands.

Off-Site Mitigation within the Pamunkey and Mattaponi River Valleys

In addition to the mitigation areas within the King William Reservoir watershed, several hundred acres of wetland mitigation areas would be located along the Pamunkey and Mattaponi River valleys within King William County. Several off-site mitigation areas have already been identified in King William County and are depicted on Figure 3-12C. The generic design features of those sites are discussed below:

Berm Construction

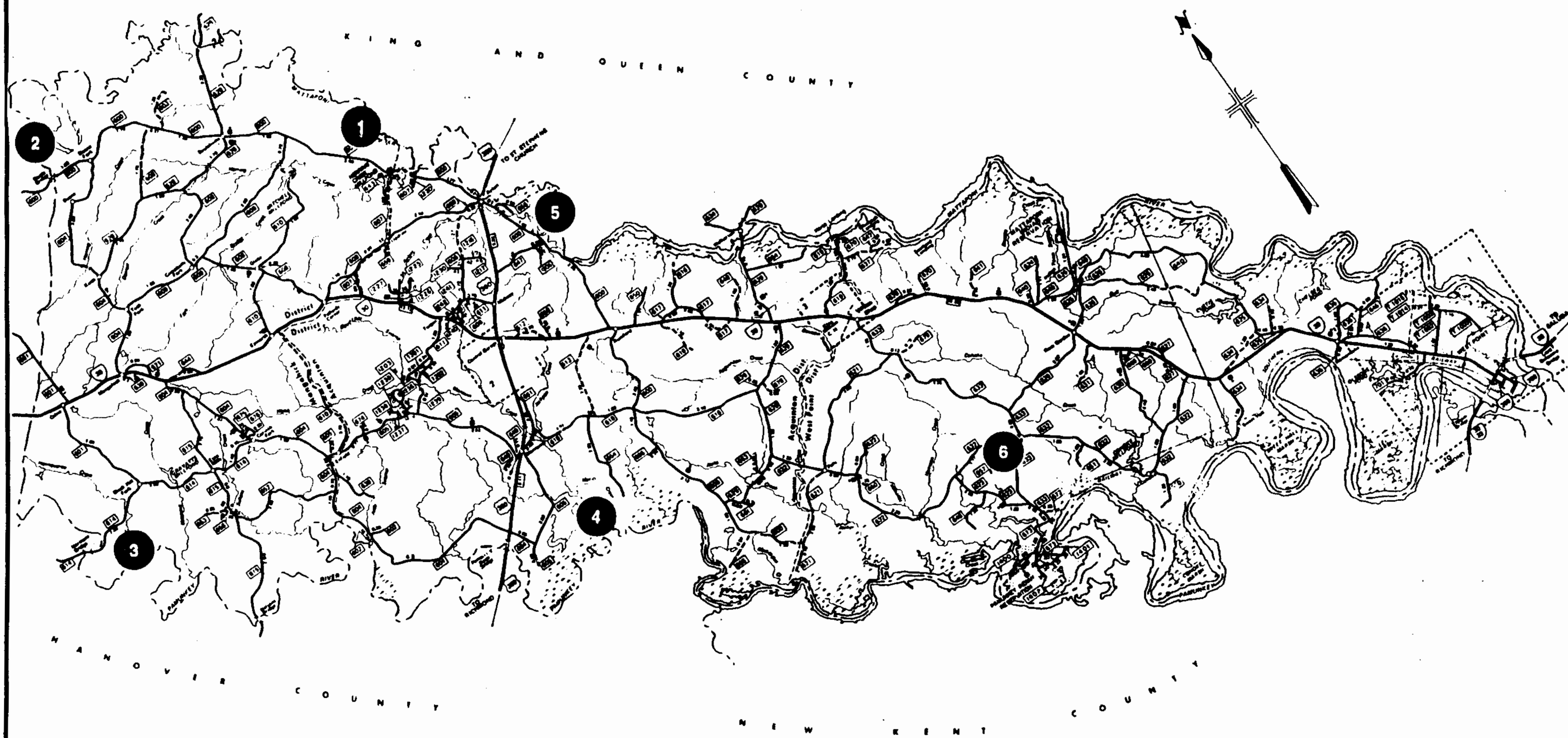
The establishment of specific wetland vegetation types requires water containment areas and precise water-level control. Some of the selected wetland mitigation sites may require small berms with gentle slopes to maintain proper hydrology. Berms would extend to the wetland areas, providing large upland/wetland transition zones around the mitigation sites. To protect berm integrity during storm events, emergency spillways would be constructed. The spillways would prevent excess flow from overtopping the berm or water control structure.

Water Control Structure

Water control structures may be required in some areas to facilitate adaptive management practices. These water control structures would reduce water velocities and dissipate energy. The resultant conversion of channel flow to sheet flow would enhance the water quality functions of the restored wetland areas. Water gages would be placed in the vicinity of the control structures to facilitate monitoring.

Buffer Areas

Although specific mitigation sites may have geographic and legal constraints, the mitigation plan would attempt to maximize the interdependence and interaction of wetlands and adjacent upland landscape areas. The establishment of adjoining upland restoration areas would promote the long-term existence of the constructed wetland systems. These buffers would serve to protect the wetland from off-site disturbances.



LEGEND:

# DENOTES SITE LOCATION

SITE DESCRIPTION:

1 MEADOW FARM
2 KW SAND & GRAVEL
3 BLEAK HILL FARM
4 THE "ISLAND"
5 DIXON CREEK
6 LANESVILLE

MALCOLM PIRNIE

AUGUST 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
OFF-SITE WETLAND RESTORATION/
CREATION SITES IN
KING WILLIAM COUNTY
NOT TO SCALE

FIGURE 3-12C

Species Diversity

The mitigation areas would be designed to optimize species diversity. The larger mitigation sites would have an undulating landscape, thereby creating integrated patches of vegetation classes and high cover type interspersion. The established vegetative communities would, therefore, contain emergent, scrub-shrub, and forested wetland systems.

Site 1

One identified mitigation site is located north of Aylett, Virginia. The site is bordered by existing farm operations to the northwest and southeast and the Mattaponi River to the east. The mitigation areas on the property are illustrated on Figure 3-12D. The three mitigation areas proposed on the property would contain 183 acres of wetland creation from sand and gravel mining operations and restoration of prior converted cropland. The mitigation site would also include upland preservation and restoration allowing for the establishment of a buffer which would be preserved in perpetuity.

On-going sand and gravel operations may allow for additional mitigation areas at the site.

Site 2

The Site 2 mitigation area is located on the northwestern border of King William County (see Figure 3-12C). The mitigation area would include 186 acres of restored prior converted cropland and wetland creation in the areas of on-going sand and gravel mining. As shown in Figure 3-12E, the southern section of Site 2 (Site A) is bordered to the south and west by Boot Swamp Creek and existing wetlands. The northern section (Site B) is also bordered by existing wetlands to the west, north, and east (see Figure 3-12F). The existing wetlands located adjacent to the mitigation sites would be preserved, therefore enhancing the continuity and long-term viability of the mitigation effort.

Site 3

Site 3 is situated in the western corner of King William County across the Pamunkey River from Hanover County as indicated in Figure 3-12C. The Pamunkey River borders the southern extent of the property, including the mitigation areas. The wetland restoration area is located on the lowest terrace of the property and is bounded by a defining bluff to the north, Hornquarter Creek to the east, and agricultural land along the western perimeter. The existing site topographic information for the 53-acre wetland restoration site is identified on Figure 3-12G and 3-12H. The mitigation site would also consist of upland restoration, upland preservation, and wetland preservation. Hydrologic inputs to the wetland restoration area include precipitation, surface water from the flooding of Hornquarter Creek, and seepage from the northern bluff. Any existing drainage tiles on the PC cropland would be broken and the numerous drainage ditches filled.

Site 4

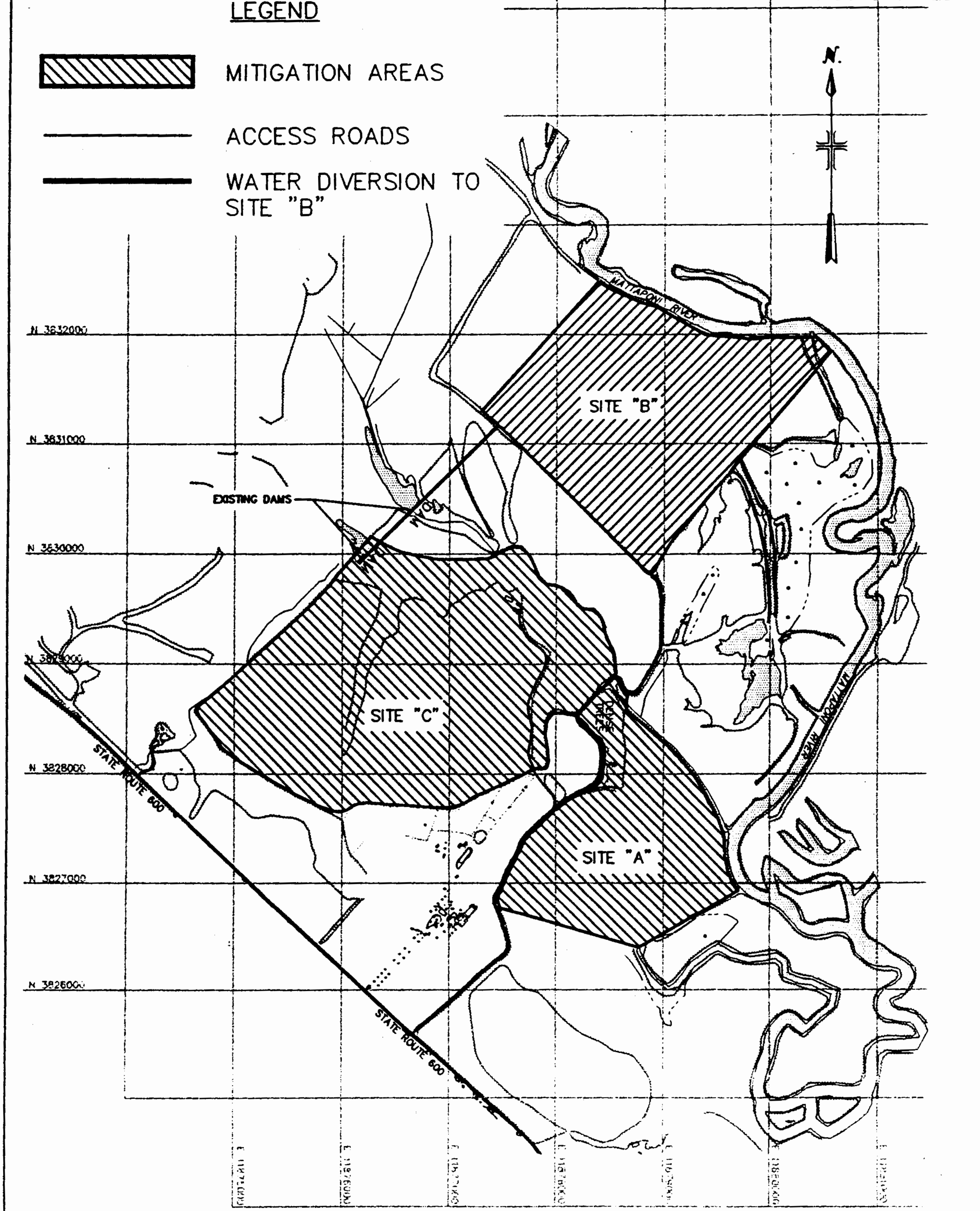
The Site 4 mitigation area is located in the vicinity of Manquin, Virginia. The site is completely encircled by surface water from Monquin Creek and a second perennial creek that also flows into the Pamunkey River. The lower sections of the streams are influenced by Pamunkey River tidal fluctuations. The mitigation effort on the site would result in the construction of 66 acres of various wetland communities and would include upland restoration forming a buffer around the

IMPACT CATEGORY	WARE CREEK RESERVOIR	BLACK CREEK RESERVOIR	KING WILLIAM RESERVOIR
PHYSICAL RESOURCES			
SUBSTRATE			
Impacts	Permanently impacts 0.34 ac and temporarily impacts 1.2 ac	Permanently impacts 0.21 ac and temporarily impacts 1.4 ac	Permanently impacts 0.21 ac; temporarily impacts 1.5, 3.0, 2.9, & 3.0 ac for KWR- I, II, III, & IV, respectively
WATER QUALITY			
Stream/Groundwater Quality	Elimination of tidal freshwater zone	Black Creek surface water depth increased to maximum of 63' & 77' at the two dams	Cohoke Creek water depth increased to maximum of 82', 82', 73', & 68' for KWR- I, II, III, & IV, respectively
Stream/Wetland Crossings	21 stream/wetland crossings	34 stream/wetland crossings	65, 60, 58, & 60 stream/wetland crossings for KWR- I, II, III, & IV, respectively
Cumulative Impacts	Increased phosphorus loading to proposed WCR and DCR	Increased phosphorus loading to DCR especially during BCR by-pass operation	Increased phosphorus loading to DCR
Development	Stonehouse runoff impacts and minor impacts from construction	Residential development runoff impacts	Monitoring recommended for potential reservoir contamination from closed landfill
River Salinity Impacts	Negligible	Incrementally negligible. Some potential for cumulative impacts	Negligible
HYDROLOGY			
Source	Year 2040 average river withdrawals = 25 mgd (3.2% of Pamunkey R. flow)	Year 2040 average river withdrawals = 33.3 mgd (4.4% of the Pamunkey R. flow)	Year 2040 average river withdrawals = 31.6 mgd (6.5% of Mattaponi R. flow) for KWR- II
Streams/Aquifer Drawdown	Basin wide projected cumulative average streamflow reduction at Year 2040 = 8.8% (77.1 mgd)	Basin wide projected cumulative average streamflow reduction at Year 2040 = 9.9% (87.0 mgd)	Basin wide projected cumulative average streamflow reduction at Year 2040 = 6.4% (37.1 mgd) for KWR- II
Perennial/Intermittent Streams	37.1 miles of channels impounded	13.7 miles of channels impounded	28.3, 26.5, 24.4, & 21.0 miles of channels impounded for KWR- I, II, III, & IV, respectively
Impact To Tidal Waters	Would impound tidal waters	No impact anticipated	No impact anticipated
GROUNDWATER RESOURCES			
Aquifer Impact	Seepage recharge to shallow aquifers Alleviates current and future demand on groundwater supply	Seepage recharge to shallow aquifers Alleviates current and future demand on groundwater supply	Seepage recharge to shallow aquifers Alleviates current and future demand on groundwater supply
SOIL/MINERAL RESOURCES			
Prime Agricultural Soils	20 acres	17 acres	342, 298, 277, & 228 acres for KWR- I, II, III, & IV, respectively
AIR QUALITY			
Construction Impacts	Cause elevated fugitive dust and fuel combustion, minor & temporary Greatest potential to impact nearby residents with elevated air pollution	Cause elevated fugitive dust and fuel combustion, minor & temporary	Few residences near area so dust is not a concern, temporary & minor
BIOLOGICAL RESOURCES			
ENDANGERED, THREATENED AND SENSITIVE SPECIES	Inundates 590 ac of wetlands and open water habitat Impacts to tidal spp. from change in hydrology and water quality Inundates one Small Whorled Pogonia location	Inundates 285 ac of wetlands and open water habitat	Inundates 653, 574, 511, & 437 ac of wetlands and open water habitat for KWR- I, II, III, & IV, respectively Inundates two Small Whorled Pogonia locations
FISH AND INVERTEBRATES	Creates 1,238 ac of fish and invertebrate habitat Closes access to anadromous fish in Ware Creek Salinity distribution changes will impact present habitat	Creates 910 ac of fish and invertebrate habitat	Creates 2,284, 2,222, 1,909, & 1,526 ac of fish and invertebrate habitat for KWR- I, II, III, & IV, respectively
OTHER WILDLIFE			
Habitat Lost	625 ac of forested upland habitat Loss of 98 nest Great Blue Heron rookery	546 ac of forested upland habitat	1,588, 1,394, 1,182, & 875 ac of forested upland habitat for KWR- I, II, III, & IV, respectively Loss of 17 nest Great Blue Heron rookery
Habitat Gained	1,194 ac of open water habitat	864 ac of open water habitat	2,210, 2,181, 1,868, & 1,490 ac of open water habitat for KWR- I, II, III, & IV, respectively
SANCTUARIES/REFUGES	No impacts anticipated	No impacts anticipated	No impacts anticipated
WETLANDS/VEGETATED SHALLOWS	Inundates 590 ac of nontidal and tidal wetlands and open water Conversion of tidal freshwater zone	Inundates 285 ac of nontidal wetlands and open water	Inundates 653, 574, 511, & 437 ac of nontidal wetlands and open water for KWR- I, II, III, & IV, respectively
MUD FLATS	No impacts anticipated	No impacts anticipated	No impacts anticipated
CULTURAL RESOURCES			
ARCHAEOLOGICAL AND HISTORICAL SITES	1 prehistoric site within the vicinity of the proposed river pumping station Impacts 45 identified cultural resources within the proposed reservoir pool area 5 sites are located in the vicinity of the proposed pipeline Additional survey work recommended	1 prehistoric site within the vicinity of the proposed river pumping station Impacts 4 identified sites within the proposed reservoir pool area 2 sites located within the vicinity of the proposed pipeline Additional survey work recommended	5 sites located within the vicinity of the proposed river pumping station 131, 120, 103, & 92 cultural resources identified within impoundment area for KWR- I, II, III, & IV, respectively 19 sites located within the vicinity of the proposed pipeline Phase I survey work complete
SOCIO-ECONOMIC RESOURCES			
MUNICIPAL AND PRIVATE WATER SUPPLIES			
RRWSG Safe Yield Benefits	23.2 mgd, 25% dead storage (1.7 BG) Requires long-term groundwater safe yield of 6.1 mgd Benefits greatly outweigh negative impacts to private water supplies	18.1 mgd, 25% dead storage (1.6 BG) Requires long-term groundwater safe-yield of 10.1 mgd Benefits greatly outweigh negative impacts to private water supplies	27.1, 25.4, 21.7, & 23.2 mgd for KWR- I, II, III, & IV, respectively. 25 % dead storage Requires long-term groundwater safe yield of 1.6, 3.6, 7.6, & 6.1 mgd for KWR- I, II, III, & IV, respectively Benefits greatly outweigh negative impacts to private water supplies
RECREATIONAL AND COMMERCIAL FISHERIES			
Commercial Importance	Ware Creek damming negatively impacts anadromous fisheries		
Recreational Importance	1,238 ac of habitat created	Creates 910 ac of habitat	Creates 2,284, 2,222, 1,909, & 1,526 ac of habitat for KWR- I, II, III, & IV respectively
OTHER WATER-RELATED RECREATION	350 ac of recreational facilities for Stonehouse Community Creates more open water areas stocked with fish Reduced land area for hunting	Portions of proposed reservoir designated as county parks Creates more open water areas stocked with fish Reduced land area for hunting	5 recreational sites developed with reservoir access Creates more open water areas stocked with fish Reduced land area for hunting
AESTHETICS	144 houses within 500' of reservoir pool or 300' of pump station or pipeline Unique and pristine wetlands lost but replaced by visually appealing open water area	104 houses within 500' of reservoir pool or 300' of pump station or pipeline Unique and pristine wetlands lost but replaced by visually appealing open water area	73, 72, 72, & 69 houses within 500' of reservoir pool or 300' of pipeline for KWR- I, II, III, & IV, respectively Unique and pristine wetlands lost but replaced by visually appealing open water area
PARKS AND PRESERVES	Positive impact due to potential for designation of parks at these sites	Positive impact due to potential for designation of parks at these sites	Positive impact due to planned designation of parks at these sites
LAND USE			
Total Land Disturbance	Negative impacts to 1,400 ac	Negative impacts to 1,032 ac	Negative impacts to 2,381, 2,322, 2,013, & 1,633 ac for KWR- I, II, III, & IV, respectively
Agricultural / Forestal Districts	Inundates 226 ac	Inundates 376 ac	No impacts
Houses Displaced	0 houses	3 houses	0 houses
NOISE			
Affected areas	Increase in levels associated with pump stations Noise generated could be excessive due to combination with I-64	Increase in levels associated with pump stations	Increase in levels associated with pump stations
INFRASTRUCTURE	Minor navigation impacts in Pamunkey River Dam in navigable waters of Ware Creek, recreational navigation impacted Abandon portion of Rt. 606, modify 4 roads (including I-64) 13 miles of new or upgraded electrical transmission lines	Minor navigation impacts in Pamunkey River No known commercial or recreational navigation in Black Creek impoundment areas Modify Rt. 249 15 miles of new or upgraded electrical transmission lines	No navigation impacts in Mattaponi River No known commercial or recreational navigation in Cohoke Creek impoundment area Replace portion of Rt. 626 2.5 miles of new or upgraded electrical transmission lines
SOCIO-ECONOMICS			
Affected Municipality	Major growth-inducing benefit No house displacement	Growth-inducing benefit Displaces 3 houses	Minor growth-inducing benefit since site is not readily accessible No house displacement

SUMMARY OF ENVIRONMENTAL CONSEQUENCES

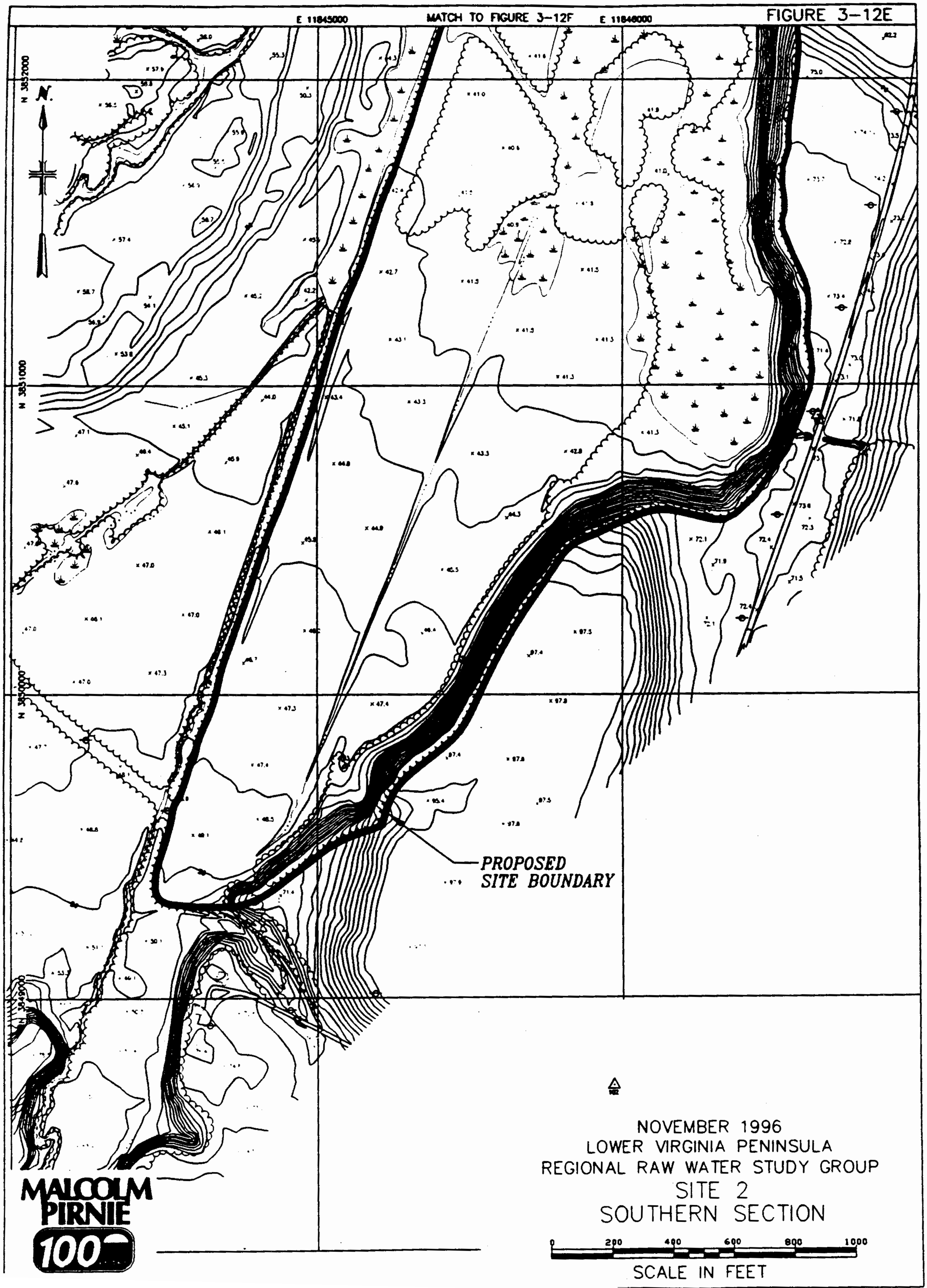
IMPACT CATEGORY	FRESH GROUNDWATER	GROUNDWATER DESALINATION	ADDITIONAL CONSERVATION MEASURES AND USE RESTRICTIONS	NO ACTION
PHYSICAL RESOURCES				
SUBSTRATE Impacts	Permanently impacts 0.18 ac	Permanently impacts 0.09 ac and temporarily impacts 0.18 ac	No impacts anticipated	No impacts anticipated
WATER QUALITY Source Stream/Groundwater Quality Wetland Crossings Cumulative Impacts Development Salinity Impacts	Possible short term chemical changes Increased Cl, HCO3, Na, SO4, Fl, and P in DCR and LCR No impacts anticipated	Concentrate pipeline discharges to polyhaline and meso/oligohaline water bodies which could pose some water quality problems Concentrate discharge	No impacts anticipated	Excessive drawdown of existing reservoirs Could cause short term hypereutrophic conditions
HYDROLOGY Source Streams/Aquifer Drawdown Perennial/Intermittent Streams Impact To Tidal Waters	May reduce yield of existing wells in vicinity	Middle and Lower Potomac aquifer may experience slight drawdown	No impacts anticipated	Increased stress on limited surface water and groundwater sources
GROUNDWATER RESOURCES Aquifer Impact	Reduce groundwater availability and reduce yield of existing wells Increased potential for saltwater encroachment	Drawdown in Middle and Lower Potomac aquifer on regional scale	No impacts anticipated	Dewatering aquifer portions leads to adverse impacts on groundwater Increased potential for saltwater encroachment
SOIL/MINERAL RESOURCES Predominant Soil Type Prime Agricultural Soils	Permanent impacts to 4 ac due to construction	Permanent construction impacts to less than 5 ac	No impacts anticipated	No impacts anticipated
AIR QUALITY Construction Impacts	Impacts should be minor and temporary	Elevated levels of air pollution expected from increased traffic flow	No impacts anticipated	No impacts anticipated
BIOLOGICAL RESOURCES				
ENDANGERED, THREATENED AND SENSITIVE SPECIES	No impacts anticipated	No impacts anticipated	No impacts anticipated	Negatively affects species using current reservoirs
FISH AND INVERTEBRATES	Beneficial to fish and invertebrate spp. by preventing reservoir drawdown	Minor impacts due to concentrate pipeline discharges	No impacts anticipated	Increased drawdown of existing reservoirs negatively impacts habitat
OTHER WILDLIFE Habitat Lost Habitat Gained	Temporary species displacement during construction	Temporary species displacement during construction	No impact anticipated	Increased drawdown could impact existing species
SANCTUARIES/REFUGES	No impacts anticipated		No impacts anticipated	No impacts anticipated
WETLANDS/VEGETATED SHALLOWS	<1 ac of impact to wetlands associated with outfall structures	<1 ac of impact to wetlands associated with outfall structures	No impacts anticipated	Negatively affects wetlands associated with current reservoirs and groundwater drawdown
MUD FLATS	No impacts anticipated	Negatively impacts mud flats in vicinity of concentrate discharge outfalls	No impacts anticipated	Dewatering during extended periods of reservoir drawdowns
CULTURAL RESOURCES				
ARCHAEOLOGICAL AND HISTORICAL SITES	Could result in very minor negative impacts	Concentrate discharge pipelines could impact archaeological sites Well locations can be relocated if cultural areas identified on site	No impacts anticipated	No impacts anticipated
SOCIO-ECONOMIC RESOURCES				
MUNICIPAL AND PRIVATE WATER SUPPLIES Safe Yield Benefits	4.4mgd, 11% of Lower Peninsula's projected water supply deficit Cause minor groundwater drawdown and groundwater quality impacts Benefits > Cost	5.7mgd, 14% of Lower Peninsula's projected water supply deficit Cause minor groundwater drawdown and groundwater quality impacts Benefits > Cost	7.1- 11.1 mgd; 18% to 28% of Lower Peninsula's projected water supply deficit	Severe adverse impacts on municipal and private water supplies
RECREATIONAL AND COMMERCIAL FISHERIES Commercial Importance or Recreational Importance	Reduces drawdown of existing reservoirs	No impacts anticipated	No impacts anticipated	Negative impact associated with reservoir drawdown
OTHER WATER-RELATED RECREATION	No impacts anticipated	Minimal and temporary impacts to York County New Quarter Park No impacts to other recreational areas anticipated	Adverse impacts to private & public facilities reliant on non-essential water	Adverse impacts due to existing reservoir drawdown
AESTHETICS	Minor and temporary impacts to 9 houses	Results in temporary and long term visual impact to 224 houses	Minor negative impacts to existing reservoirs & recreational facilities	Negative impacts to existing reservoirs
PARKS AND PRESERVES	No impacts anticipated	1 ac in Newport News Park temporarily impacted 6.9 ac in York County New Quarter Park temporarily impacted No impacts to Colonial National Historic Parkway	Negative impacts due to limited irrigation	Negative impacts associated with reservoir drawdown
LAND USE Total Land Disturbance Agricultural Forested Districts Houses Displaced	Negative impacts to 8 ac	Negative impacts to 5 ac at well sites and RO facilities, 65 ac impacted by R-O-W	Negative impacts to parklands, residential areas, and businesses	Severely limit future land use development
NOISE Affected areas	Long term impacts result from operation of groundwater wells	Long term impacts result from operation of groundwater wells combined with traffic	No impacts anticipated	No impacts anticipated
INFRASTRUCTURE	Transportation and navigation impacts negligible Limited impacts to energy sources 17 miles of new or upgraded electrical transmission lines	Outfall structures not located near navigable channels Transportation impacts negligible Limited impacts to energy sources	No impacts anticipated	No impacts anticipated
SOCIO-ECONOMICS Affected Municipality	Feasible with respect to cost Impacts result from costs incurred by water purveyors	Feasible with respect to cost Impacts result from costs incurred by water purveyors	Negative impacts to Lower Peninsula water users	Negative impact due to constraint on future economic growth

FIGURE 3-12D

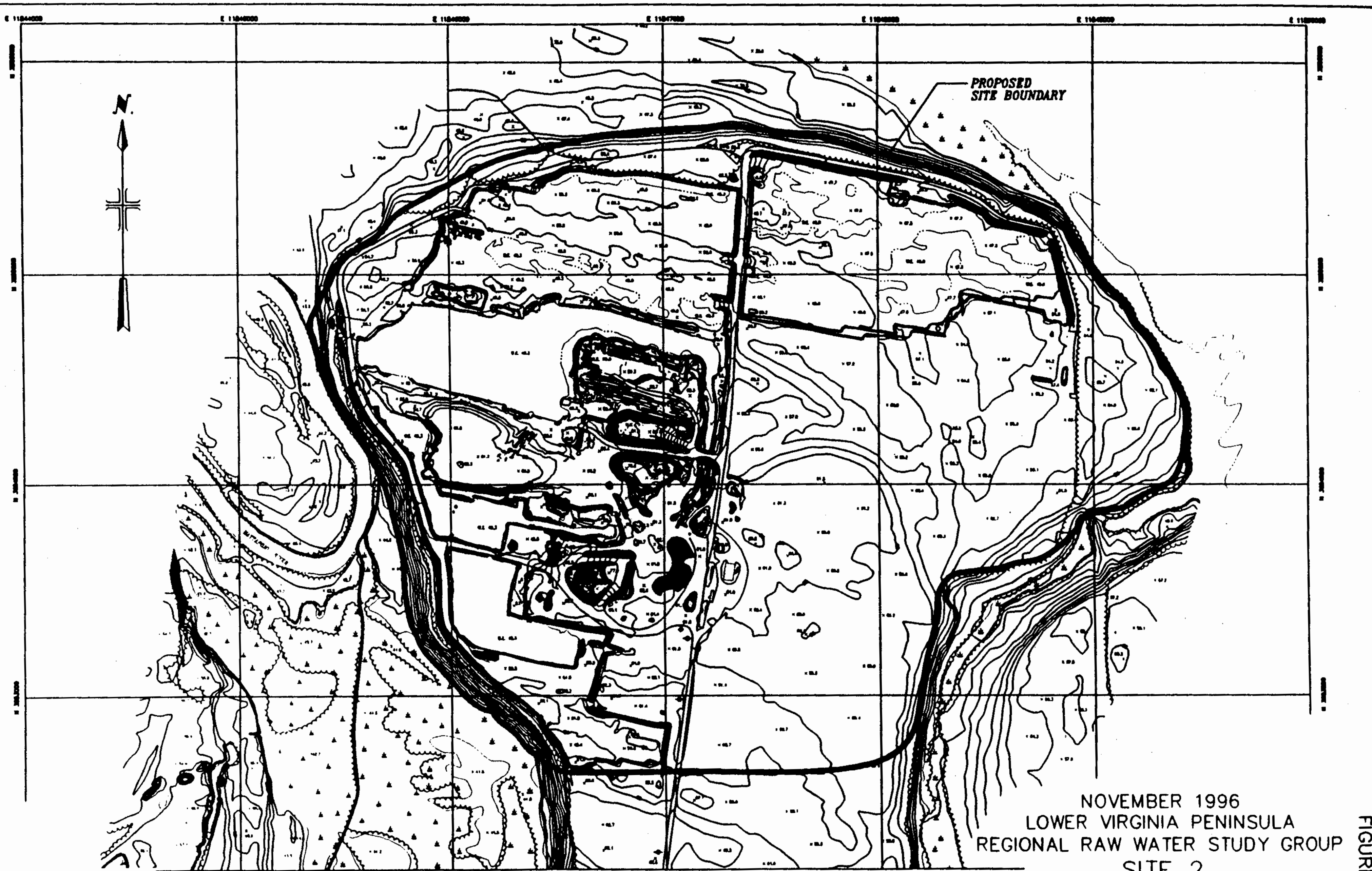


NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
COUNTY OF KING WILLIAM, VIRGINIA
SITE 1
NOT TO SCALE

MALCOLM PIRNIE 100



NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 2
SOUTHERN SECTION



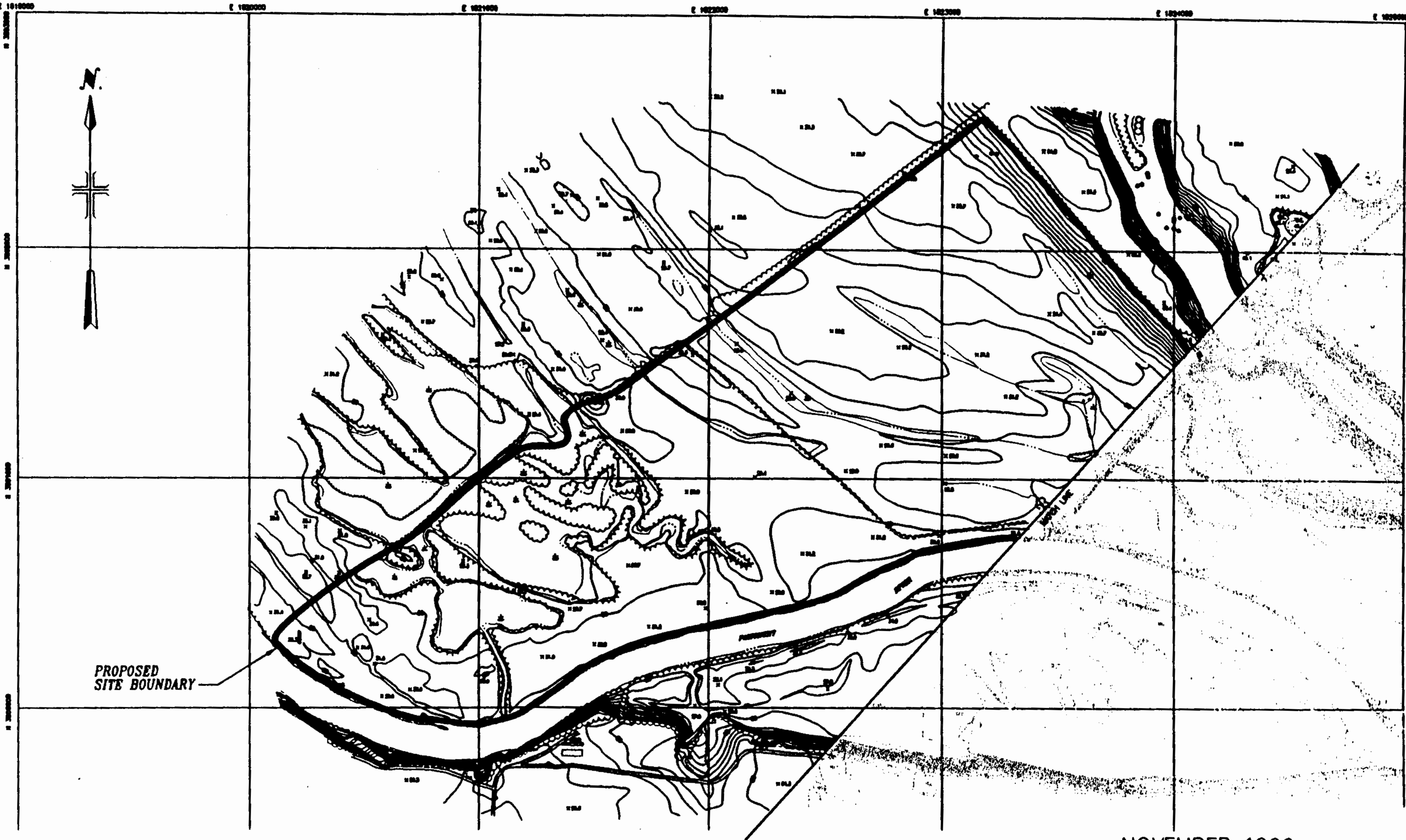
MATCH TO FIGURE 3-12E

NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 2
NORTHERN SECTION

0 400 800
SCALE IN FEET

FIGURE 3-12F

MALCOLM PIRNIE 100

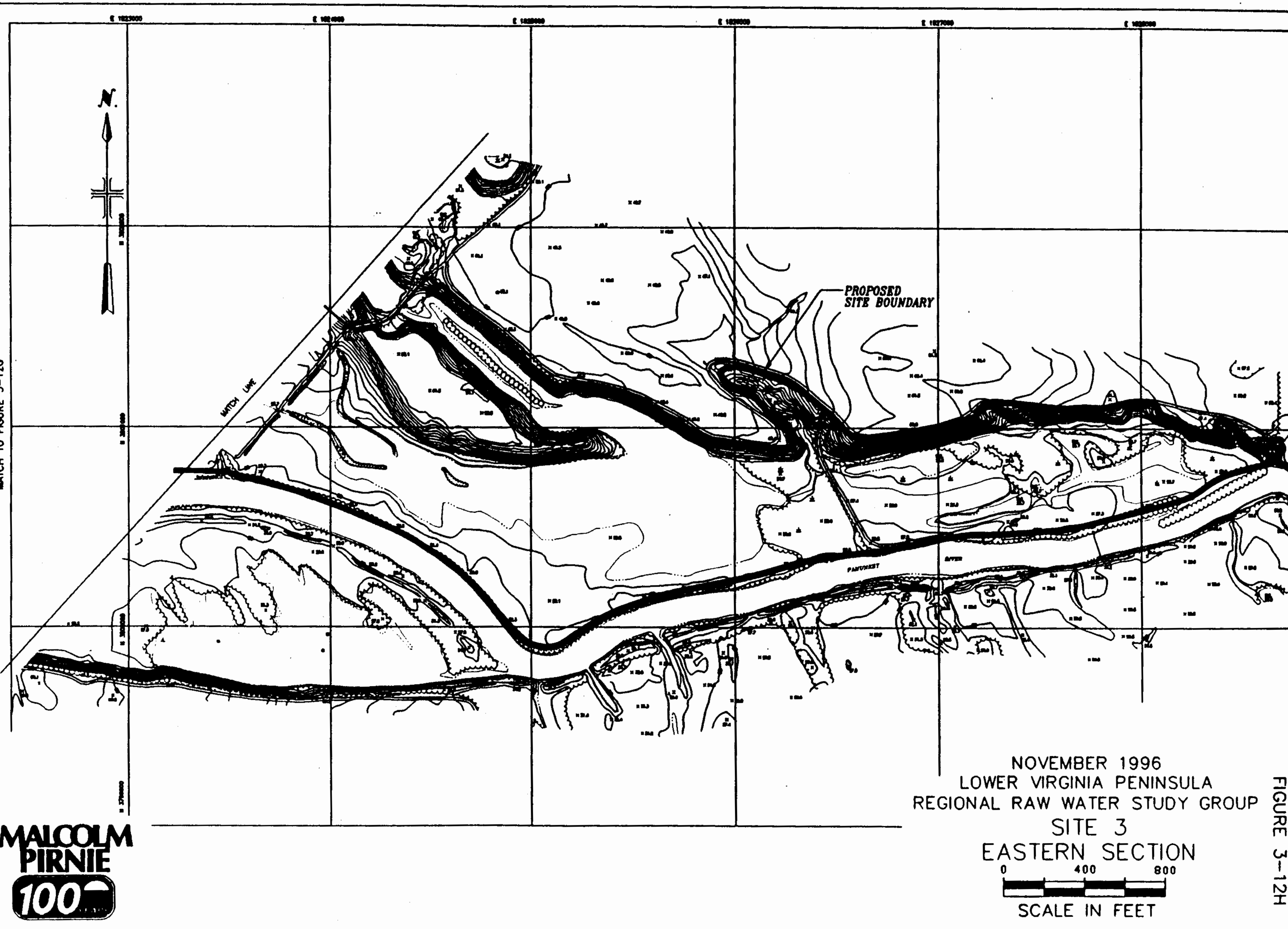


NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 3
WESTERN SECTION

0 400 800
SCALE IN FEET

FIGURE 3-12G

MALCOLM PIRNIE 100



NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 3
EASTERN SECTION

MALCOLM PIRNIE 100

FIGURE 3-12H

mitigation site. Figure 3-12I provides current site topographic information of the proposed mitigation site.

An artificial channel excavated below the water table currently drains the eastern side of the site from north to south. A control structure adjacent to the access road has deepened the northern section of this channel. This weir structure would be removed and placed farther downstream. The wetland construction would contain a mosaic of wetland types.

Site 5 and Site 6

Two additional small mitigation sites located on PC croplands have been identified in the County. Mitigation activities at Site 5 would include the restoration of 7 acres of wetlands. Site 6, located at the bottom of a large swale, would include the restoration of 4.6 acres of wetlands. Existing contours and site information for mitigation Site 5 and Site 6 are depicted in Figures 3-12J and 3-12K, respectively. The hydrology for the two sites would be acquired mainly from surface water runoff along intermittent and spring fed headwater streams.

Additional Mitigation Sites

The wetland restoration/creation portion of the conceptual mitigation plan would be expanded to provide restoration/creation of at least twice the acreage lost. The plan also includes wetland preservation, upland restoration, and upland preservation. Preservation of these areas would occur through the imposition of deed restrictions which would forbid their future disturbance. Investigations are continuing on additional sites in King William County and elsewhere along the Mattaponi and Pamunkey Rivers. As sites are identified, conceptual designs will be developed based on site-specific characteristics.

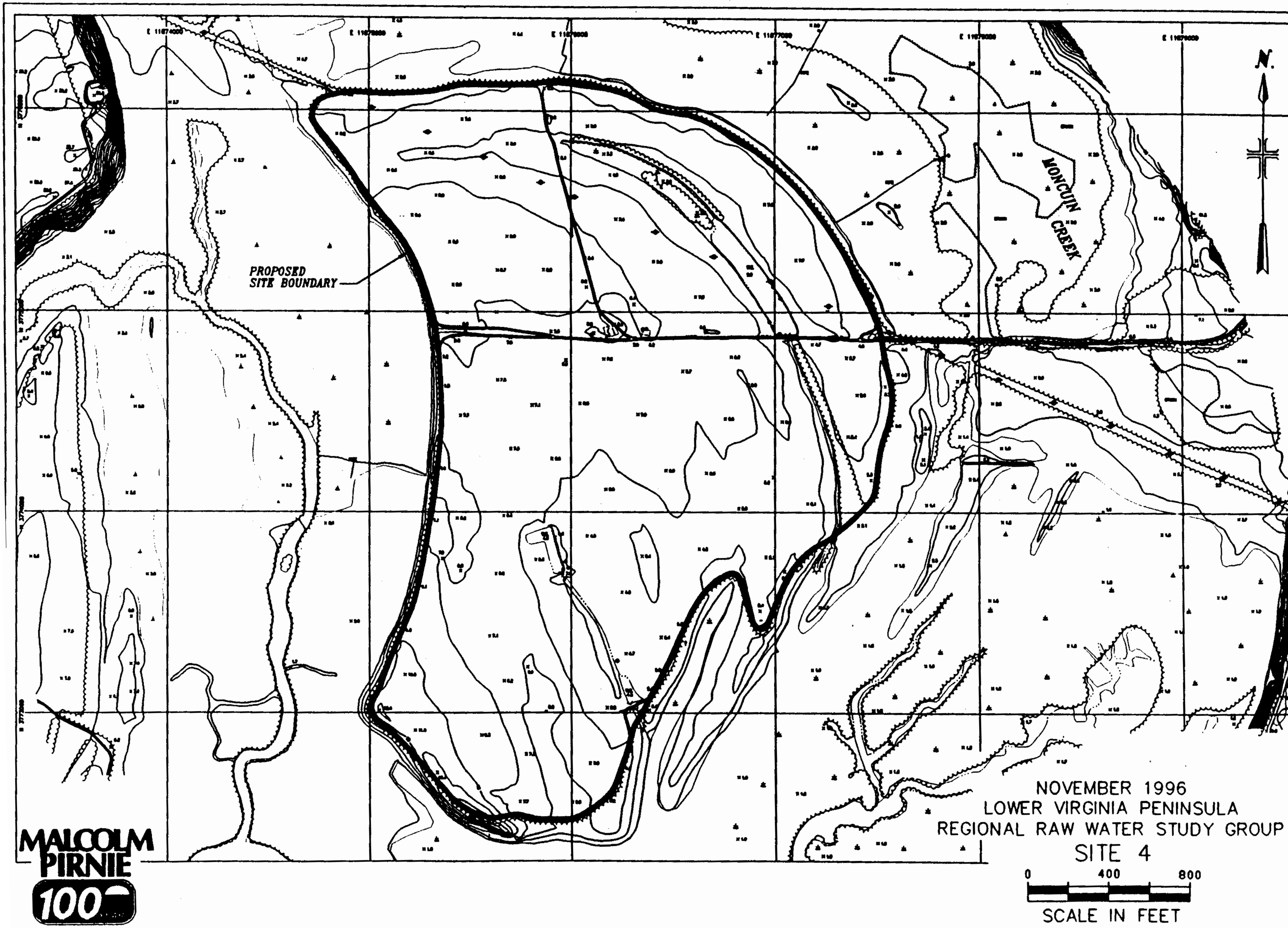
Riverine Restoration

The RRWSG is committed to a program of riparian habitat restoration and preservation. This program is expected to include:

- Opening stream segments to anadromous fish passage.
- River corridor preservation.
- Fish hatchery improvements.

The RRWSG is currently working with VDGIF's fish passage unit to identify one or more priority streams in the York River Basin to open to fish passage. Potential streams identified include:

Stream	Miles
South Anna River	10
Herring Creek	9.5
Gravett's Mill Pond	4

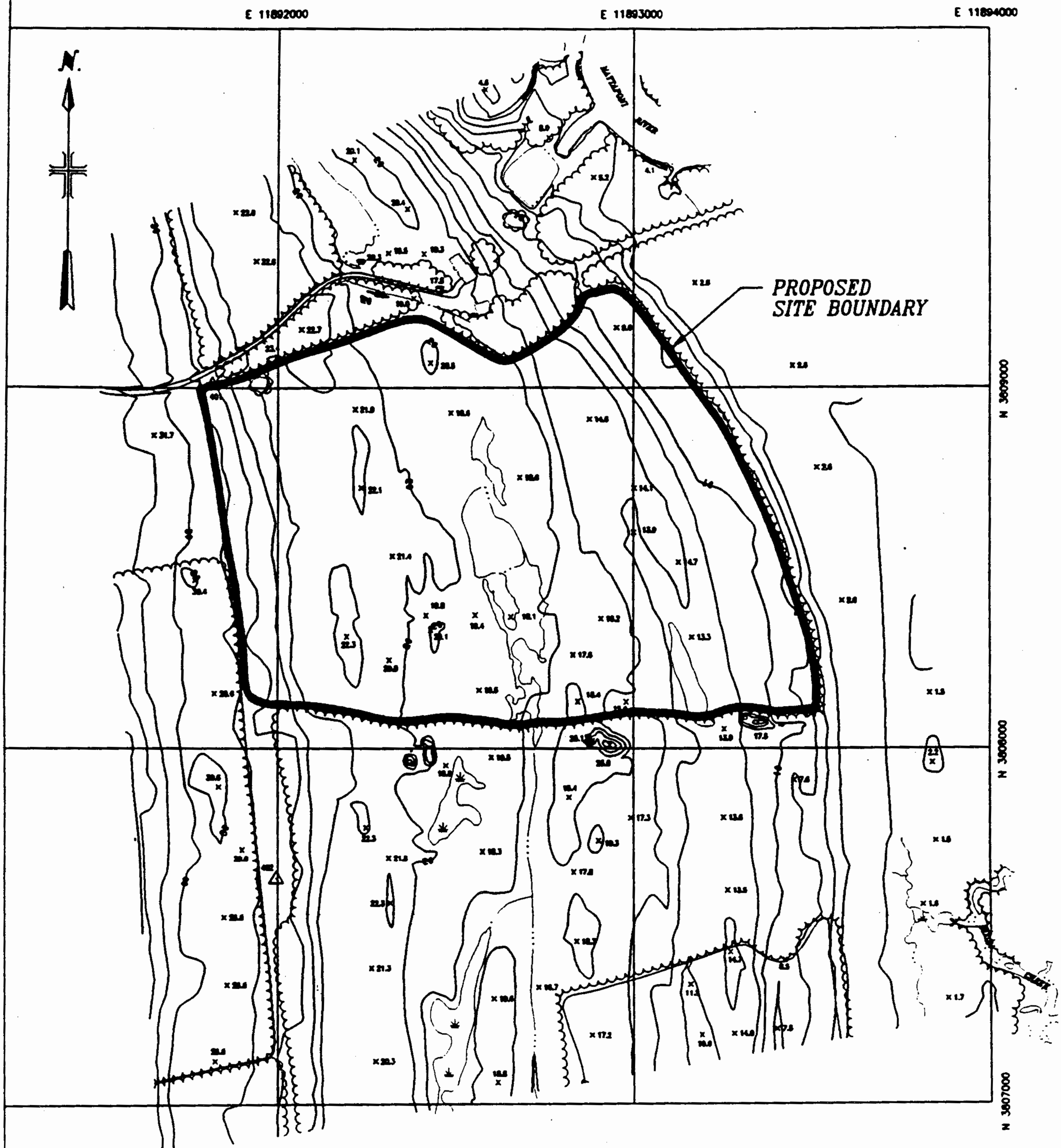


NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 4

FIGURE 3-12 I

MALCOLM PIRNIE 100

FIGURE 3-12J

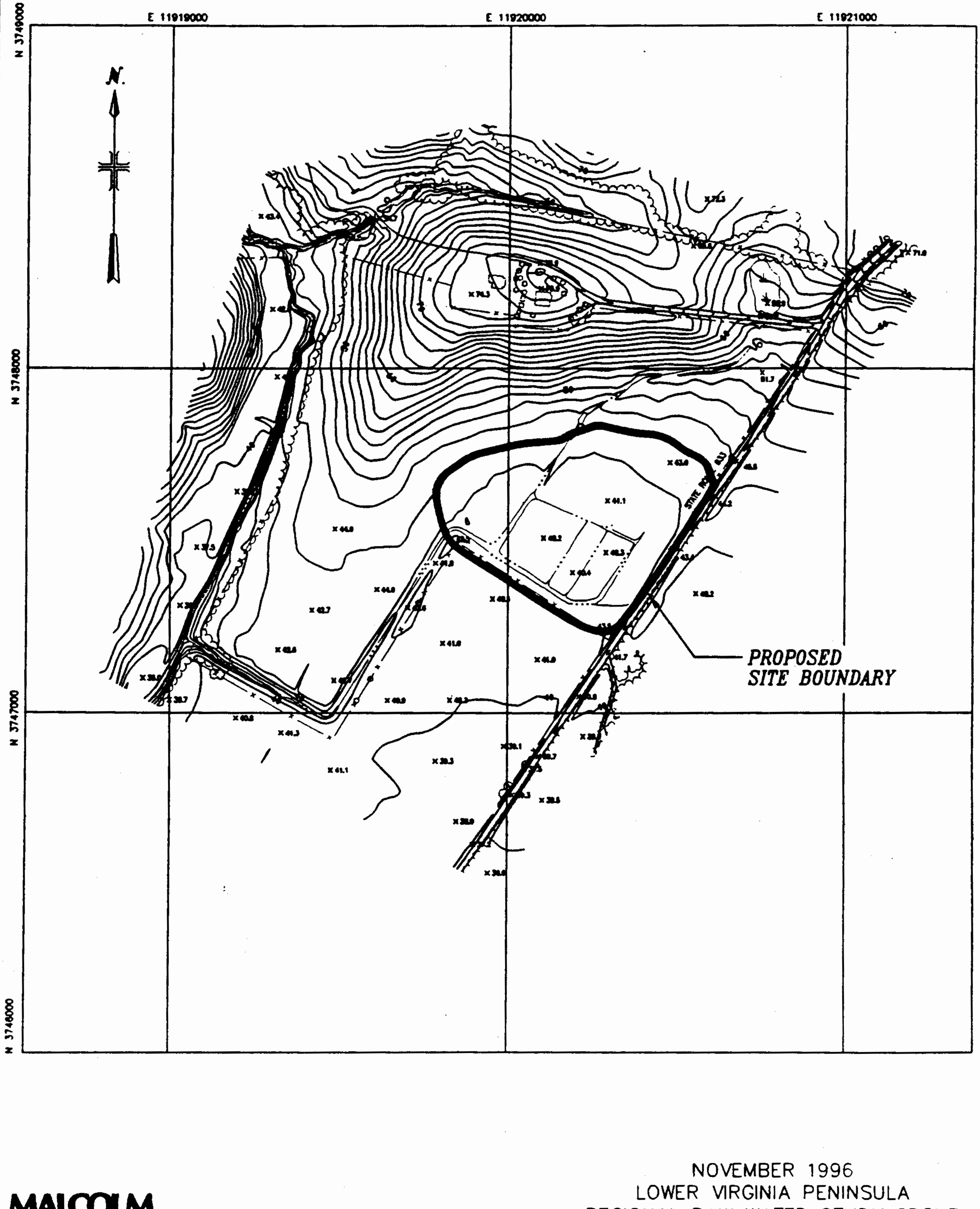


NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 5

0 200 400 600 800 1000
SCALE IN FEET

MALCOLM PIRNIE 100

FIGURE 3-12K



NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER STUDY GROUP
SITE 6

MALCOLM PIRNIE 100

Once the details of these passage ways are determined, specific plans will be developed in consultation with the VDGIF and USFWS.

River corridor sites are being considered for preservation. Evaluations will lead to the identification of priority sites and possible preservation of one or more sites. A stream corridor (upper reaches of Poquoson River, York River Tributary) consisting of 2 miles, which is under extreme development pressure, is being considered for preservation. This action would prevent water quality deterioration in the upper reaches of the Poquoson River and in Harwood's Mill Reservoir, as well as preserve a valuable wildlife corridor link between the National Battlefield and the watershed protection area around the existing reservoir.

Fish hatchery improvements are proposed to facilitate the replenishment of shad in Chesapeake Bay tributaries. Other anadromous fish species may also be included.

Wetland Education

Wetland education opportunities are among the valuable functions provided by wetland systems. The RRWSG intends to support a proposal by the Pamunkey Indians to provide wetland education opportunities to the public on reservation wetlands adjacent to the Pamunkey River.

Upland Restoration and Preservation

As required by the November 13, 1990 Project Development Agreement amended May 14, 1992 and August 8, 1995 between the City of Newport News and King William County, a minimum 100-foot buffer, to extend at least seven vertical feet above the pool elevation, would be established around the King William Reservoir. An additional 100-foot construction setback would extend beyond the buffer area. Preservation of the buffer area around the reservoir would preserve contiguous upland habitat in perpetuity.

The restored and/or preserved uplands associated with each mitigation site would be preserved in perpetuity along with the wetland mitigation areas. Management of these areas would allow the uplands to mature into mixed deciduous forests and cove hardwood areas. Most of the mitigation sites are also located adjacent to existing forested areas; therefore, restoration of adjacent forested areas would provide additional large contiguous upland tracts in King William County.

Small Whorled Pogonia

Approximately 20 acres in either James City or Gloucester County that contain a healthy population of Small Whorled Pogonia would be acquired or otherwise set aside for permanent preservation. A buffer area around individual Pogonia populations would be maintained.

Sensitive Joint-Vetch

The RRWSG would assist the Nature Conservancy and the Virginia Institute of Marine Science in the development and management of a long-term monitoring program to evaluate any changes in Sensitive Joint-vetch colonies in Mattaponi River tidal marshes.

Summary

In summary, the mitigation plan involves the following elements to compensate for the inundation of vegetated wetlands, open water, and uplands:

Elements

- Wetland Restoration/Creation
- Open Water Habitat
- Aquatic Fringe Habitat
- Wetland Preservation
- Upland Restoration
- Upland Preservation
- Riparian/Riverine Corridor Restoration/Preservation
- Stream Channel Opening
- Fish Hatchery Improvements
- Wetland Education Opportunities
- Small Whorled Pogonia Preservation
- Sensitive Joint-Vetch Monitoring

The RRWSG's intention with this plan is that the project's wetland impacts will be more than offset by compensatory mitigation projects.

3.7.2 Black Creek Reservoir with Pumpover from Pamunkey River

The RRWSG has developed a conceptual mitigation plan to compensate for the loss of an estimated 239 acres of vegetated wetlands that would be permanently filled and/or inundated by the Black Creek Reservoir Project. This number represents the total estimated amount of wetlands and waters of the United States within the impact area (285 acres), minus the amount of unvegetated open water (46 acres). The RRWSG's intention with this conceptual mitigation plan is that the project's wetland impacts will be more than offset by compensatory mitigation projects. The proposed conceptual mitigation plan for the Black Creek Reservoir Project was developed based on the same objectives as the mitigation plan for the King William Reservoir Project, i.e.:

- Provide a ratio of 2 acres of vegetated wetlands gained for every 1 acre of vegetated wetlands lost as a result of the reservoir project.

- Restore, enhance, or create wetlands to provide a functional capacity equal to or greater than that of the existing wetlands at the reservoir site.

- Maximize the probability of success for establishing viable wetlands.

The Black Creek Reservoir mitigation plan consists of the creation of wetlands within the reservoir watershed, and the restoration or creation of wetlands along the Pamunkey River valley. Based on aerial photography interpretation, there appears to be little opportunity for wetland restoration within the Black Creek Reservoir watershed; therefore, all on-site mitigation would be accomplished with wetland creation.

Two techniques would be used to create wetlands within the reservoir watershed: borrow area wetland construction and headwater wetland construction. Mitigation along the Pamunkey River valley would be accomplished by restoration of prior converted croplands and farmed wetlands, and creation of wetlands in low-lying croplands. Figures 3-12L and 3-12C present the conceptual mitigation plan and depict the possible location of various plan components. Various additional proposed wetland mitigation techniques are described below.

The final acreage for on-site and off-site mitigation and for each mitigation technique would depend on the particular opportunities available and would be determined during the detailed wetland mitigation design.

On-Site Mitigation within Reservoir Watershed

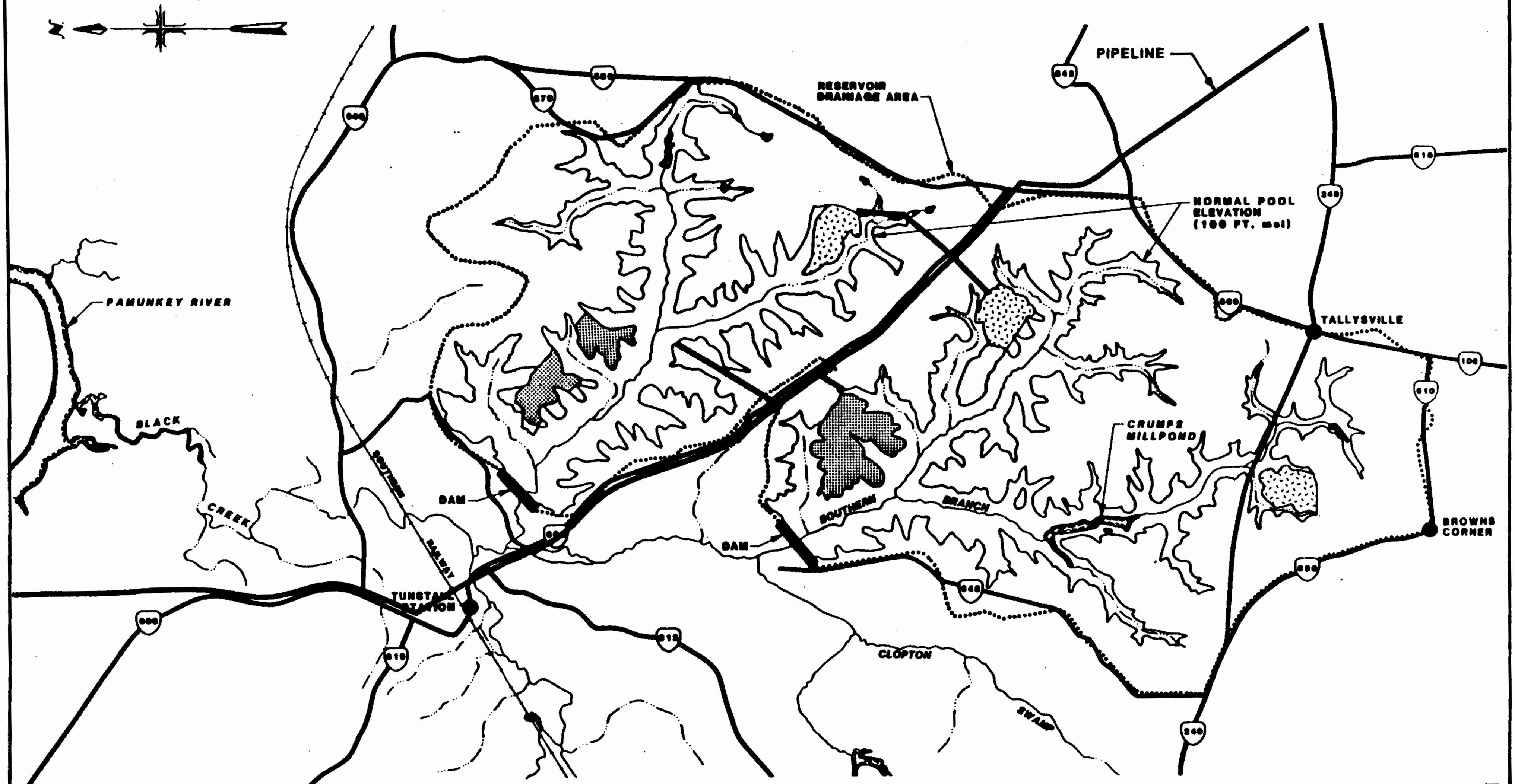
Prior converted croplands and farmed wetlands in the Black Creek watershed were investigated. Several altered groundwater depressional wetland systems were identified as candidates for restoration. Following an evaluation of site feasibility, these potential mitigation sites were rejected as viable restoration areas. A reliance on groundwater discharges as a primary source of hydrology is considered precarious. Centuries of watershed manipulation from agricultural activities may have altered the local water table. The site locations also lack secondary sources of water. In addition, the former groundwater depressional wetlands are extremely small (<1 acre) and, as a result, are more costly per acre than the identified off-site wetland restoration areas. These small patches of potential groundwater depressional prior converted croplands and farmed wetlands would also be disruptive to farming practices because they would be located in the midst of prime agricultural farmland.

<u>Borrow Area Constructed Wetlands</u>

Constructed wetlands would be developed in the soil borrow areas using the same techniques described in Section 3.7.1. The plan for the borrow area constructed wetlands calls for the creation of diverse wetland habitat, including forested, scrub-shrub, and emergent wetlands, with open water channels. Because the reservoir would be located within the East Coast Migratory Flyway, the wetland mitigation plan includes habitat for breeding and migratory birds. Islands would be constructed in the borrow area wetlands to provide nesting and roosting sites for waterfowl.

A number of potential sites exist adjacent to the reservoir and in close proximity to the proposed dam site (see Figure 3-12L). Each of these areas was selected based on its size and its relative distance from the dam site. The potential borrow area constructed wetland sites provide the possibility of creating large, contiguous blocks of wetland habitat for sensitive interior species such as neo-tropical migratory birds.

The conceptual design and operation of the borrow area constructed wetlands would be the same as described in Section 3.7.1, including the variable microtopography, the 100-foot undisturbed area or berm between the mitigation areas and the reservoir, and the channels between the borrow areas and the reservoir pool. The components of the planned borrow area constructed wetlands are discussed below:



LEGEND

POTENTIAL BORROW AREAS

POTENTIAL HEADWATER CONSTRUCTED WETLAND

MALCOLM PIRNIE

APRIL 1995
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
POTENTIAL ON-SITE MITIGATION AREAS
BLACK CREEK RESERVOIR

2,000 0 2,000
SCALE IN FEET

FIGURE 3–12L

- *Hydrology:* The elevated groundwater levels associated with the reservoir would be the primary source of wetland hydrology, with additional inputs from direct precipitation and surface water runoff. Before the full reservoir yield is needed (projected Year 2040 water demands), water level fluctuations would be small, thereby providing a stable source of hydrology. When the projected Year 2040 water demand is reached and the reservoir is in full operation, the pool level is projected to remain above elevation 98 feet msl (i.e., within 2 feet of the normal pool elevation) approximately 70 percent of the time. One of the potential sites could receive additional water by diversion of a portion of the Pamunkey River pumpover through the mitigation area.

- *Soils:* The same soil amendments as mentioned in Section 3.7.1 would be required to provide a suitable planting substrate.

- *Vegetation:* With irregular microtopography, the proposed borrow areas constructed wetlands will contain a mosaic of wetland vegetative communities. The seed source would be supplied by the topsoil added from the wetlands within the reservoir pool area, obtained primarily from areas that currently support facultative species which can survive extended dry periods.

Headwater Constructed Wetlands

The Black Creek Reservoir mitigation plan includes headwater constructed wetlands, which would be constructed in a fashion similar to the borrow area constructed wetlands, but in headwater areas adjacent to the normal pool instead of in excavated borrow areas. Disturbed upland areas (i.e., clear cuts) with less than 10 percent slopes immediately above the normal pool elevation would be targeted. Those areas would be graded to achieve elevations between -2 feet and +2 feet of normal pool elevation. If possible, the existing slope would be used to create a berm; otherwise, a berm would be constructed from the graded material.

Connection with the reservoir would be provided by channels similar to those associated with the borrow area constructed wetlands. Two of the potential sites could receive additional water by diversion of a portion of the Pamunkey River pumpover through the mitigation areas. Potential headwater constructed wetland sites are shown in Figure 3-12L.

Aquatic Fringe Habitat

Valuable aquatic fringe habitat would become established naturally around the perimeter of the reservoir. These areas would provide a suitable environment for many species including fish, amphibians, reptiles, shorebirds, and mammals, and their supporting food web (AWWA, 1988). Many migratory waterfowl could use these areas for feeding, resting, and wintering habitat. Similar reservoirs in the area have been examined and found to be heavily utilized by Egrets, Great Blue Herons, and Osprey for nesting, and Bald Eagles for feeding. The fringe habitat established around the reservoir would also improve water quality by filtering sediments and nutrients and would stabilize the shoreline to minimize erosive forces of waves, seiches, and boat wakes.

Open Water Habitat

In addition to the aquatic fringe habitat and open water habitat on the mitigation sites, the reservoir would provide valuable open water habitat for freshwater fish, invertebrates, and migratory waterfowl. Clearing would not occur on the reservoir fringe, leaving dead standing timber as habitat for Wood Ducks, Osprey, and Great Blue Herons. Due to the undulating topography, small islands are expected to form within the reservoir perimeter. The islands would provide valuable foraging and resting habitat for Great Blue Heron and other waterfowl; and they would create a diversity of habitat for other species in the reservoir area, as well as potential roosting/perching sites for osprey and bald eagle. This reservoir would substantially increase the availability of valuable freshwater fishery habitat and its recreational use in New Kent County. In addition, based upon an assessment of wetlands currently located below the project's dam site, the reservoir would dissipate flood events and may help maintain these wetlands.

Off-Site Mitigation within the Pamunkey River Valley

In addition to the mitigation areas within the Black Creek Reservoir watershed, wetland mitigation areas would be located along the Pamunkey River valley. The mitigation sites would be located in prior converted croplands and farmed wetlands, and the constructed wetlands would be located in low-lying agricultural areas. Several mitigation areas have already been identified in the Pamunkey River and Mattaponi River drainage basins as shown on Figure 3-12C. The generic design features of those sites are discussed in Section 3.7.1.

3.7.3 Ware Creek Reservoir with Pumpover from Pamunkey River

Through consultation with the USCOE, a detailed mitigation plan for the Ware Creek Reservoir was developed by James City County as part of its Section 404 permit requirements (James R. Reed & Associates, 1992). James City County's mitigation plan consists of the following six components, which are summarized in the following subsections.

- Cranston's Pond - Functional Replacement Wetlands
- Island Mitigation and Blue Heron Replacement Habitat
- Tidal Wetlands Mitigation Plan
- Perimeter Pond Mitigation - Mitigation Above the Normal Pool Elevation
- Perimeter Reservoir Pond Mitigation - Mitigation within the Reservoir Pool Elevation
- Conservation Zone Wetlands

James City County's Ware Creek Reservoir mitigation plan has been summarized without modification. It is assumed that functional replacement issues have been addressed. Therefore, a functional assessment of the compensatory mitigation is not included in this discussion.

James City County's Ware Creek Reservoir mitigation plan would result in approximately 337 acres of wetland mitigation and 18.4 miles of stream restoration. However, it should be noted that revised wetland estimates have identified 590 acres of wetlands at the Ware Creek Reservoir site. Therefore, additional mitigation would be needed to meet the goal of "no net loss" of wetland function or acreage at a replacement ratio of 2:1.

Cranston's Pond

As proposed, the Ware Creek Reservoir would dam a tidal creek documented as habitat for anadromous fish and would interrupt 20.3 miles of free-flowing stream. To compensate for that impact, James City County's mitigation plan includes a project to breach the dam at Cranston's Pond, thereby restoring the free-flowing nature of 18.4 miles of Yarmouth Creek (see Figure 3-22C). Yarmouth Creek presently is disconnected from the tidal Chickahominy River by a dam which interrupts fish passage and detrital export from the Yarmouth Creek headwaters and associated wetlands. Breaching the dam and draining the lake would reconnect 18.4 miles of stream and approximately 506 acres of wetlands to documented anadromous fish habitat in Yarmouth Creek.

As part of the dam breaching project, 37 acres of Bald Cyprus swamp would be restored at the location of the existing Cranston's Pond. Immediately below Cranston's Pond dam, fish passage is restricted by culverts at the Route 632 crossing. James City County's Ware Creek Reservoir mitigation plan also includes upgrading the Route 632 crossing with a bridge or larger culverts.

Island Mitigation and Blue Heron Replacement Habitat

The Ware Creek Reservoir impoundment area contains a 98-nest Great Blue Heron rookery that would be flooded by the reservoir. James City County's Ware Creek Reservoir mitigation plan includes building 16 small islands within the reservoir pool area to provide Great Blue Heron habitat after construction (see Figure 3-22D). The islands would range in size from 0.1 to 0.6 acres and would be constructed by physically severing small points of land along the perimeter of the reservoir.

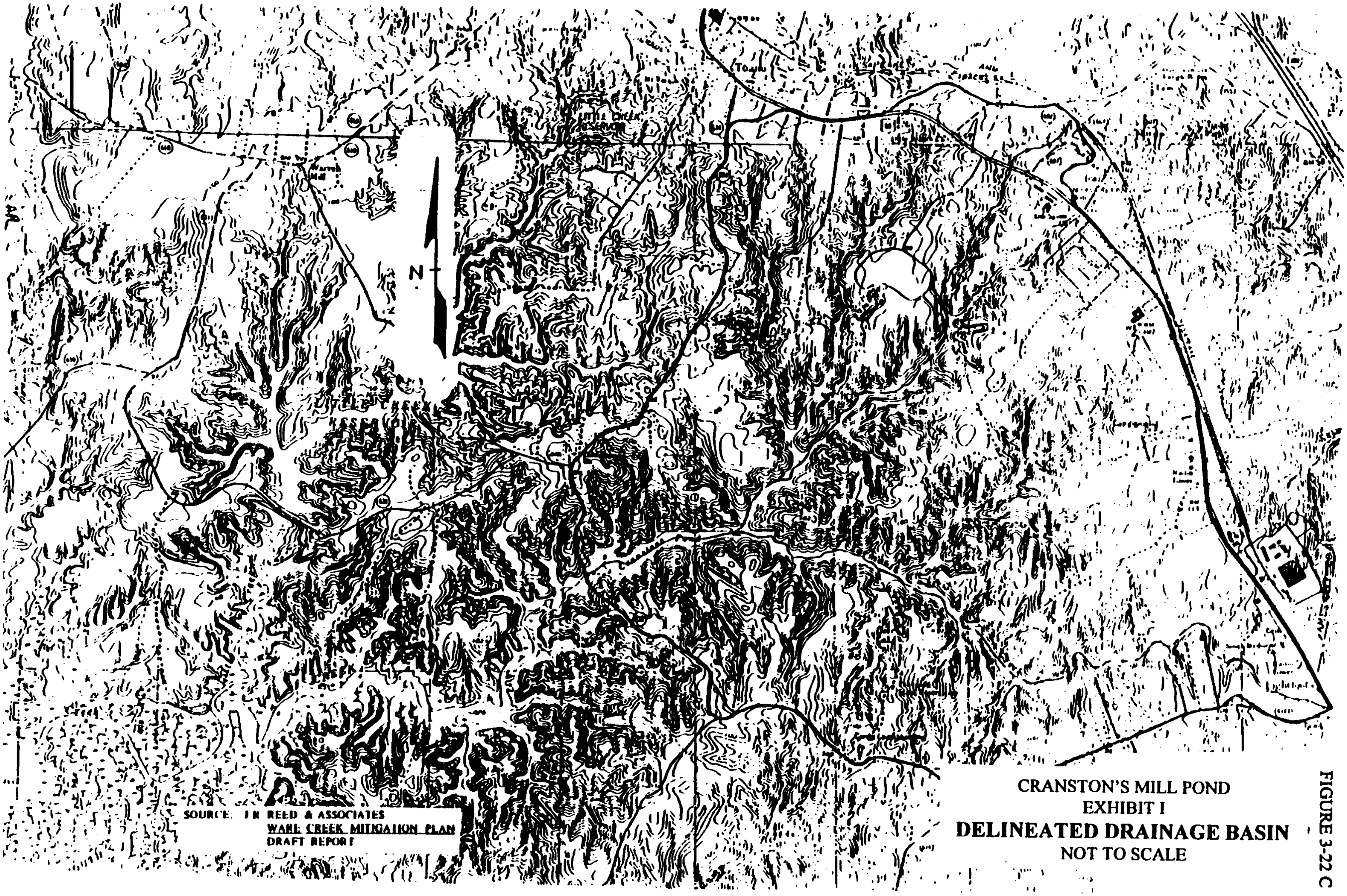
Field investigation during a Blue Heron study indicated that the islands would not possess certain critical requirements for Blue Heron nesting and colonization. Specifically, the islands would be too small (minimum required size is two acres), they would not provide the Herons' preferred tree species, and they would not have a large tree canopy (James R. Reed & Associates, 1992). The islands nevertheless would provide valuable foraging and resting habitat for Great Blue Heron and other waterfowl; and they would create a diversity of habitat for other species in the reservoir area, as well as potential roosting/perching sites for osprey and bald eagle.

Tidal Wetlands Mitigation Plan

The Ware Creek Reservoir dam is located in the upper reaches of the Ware Creek tidal system. As a result, the Ware Creek Reservoir would fill and/or inundate 49 acres of tidal freshwater wetlands. To replace the acreage of tidal wetlands lost, the mitigation plan includes the construction of 27 acres of tidal wetlands at five sites downstream of the proposed dam (see Figure 3-22E). That mitigation would be provided in borrow area sites, by removing dam construction material in upland soils and grading the areas down to an elevation slightly below that of the adjacent marshes. The mitigation areas then would be backfilled to marsh grade with organic topsoil excavated from the dam site wetlands.

The existing seed bank in the topsoil and surrounding marshes was assumed to be adequate to revegetate the mitigation areas. If necessary, supplemental sprigging or seeding would be conducted to cover unvegetated areas. Because the wetlands at the dam site are tidal freshwater marshes, freshwater species would have an early advantage in colonizing the mitigation areas. However, the reduction in freshwater flow caused by the reservoir would convert most of the marshes downstream of the dam, including the mitigation areas, to mesohaline marsh communities.

FIGURE 3-22 C



CRANSTON'S MILL POND
EXHIBIT I
DELINEATED DRAINAGE BASIN
NOT TO SCALE

FIGURE 3-22 D

SOURCE: J.R. REED & ASSOCIATES
WARE CREEK MITIGATION PLAN
DRAFT REPORT

ISLAND MITIGATION SITE
LOCATION MAP
SCALE: 1"= 2000'

FIGURE 3-22 E

USGS QUADRANGLE MAP, TOANO, VA.

Perimeter Headwater Impoundment Mitigation - Mitigation above the Normal

Pool Elevation

James City County's mitigation plan includes the construction of 39 acres of wetlands by constructing headwater impoundments in swales and valleys above the normal reservoir pool elevation, to compensate for the inundation of non-tidal wetlands. A total of 35 potential sites were identified where a minimum 1-acre mitigation area could be located without disturbing existing wetlands (see Figures 3-22F and 3-22G). The headwater impoundments would be constructed by building a berm to retain surface water and groundwater. The elevation of the berm would be 5 feet above the existing grade. Within the mitigation area, the existing grade would be cut to 1 foot below desired grade and then backfilled with topsoil from wetlands within the reservoir impoundment area. The topsoil would provide the seed bank to naturally revegetate the mitigation area.

The headwater impoundments would be seasonally inundated and permanently saturated, similar to many of the existing beaver ponds in the Ware Creek Reservoir watershed. Because the headwater impoundments above the normal pool elevation would not be dependent on the reservoir for hydrology, those impoundments could be constructed prior to reservoir construction, thereby minimizing temporal wetland losses.

Perimeter Headwater Impoundment Mitigation - Mitigation within the Normal

Pool Elevation

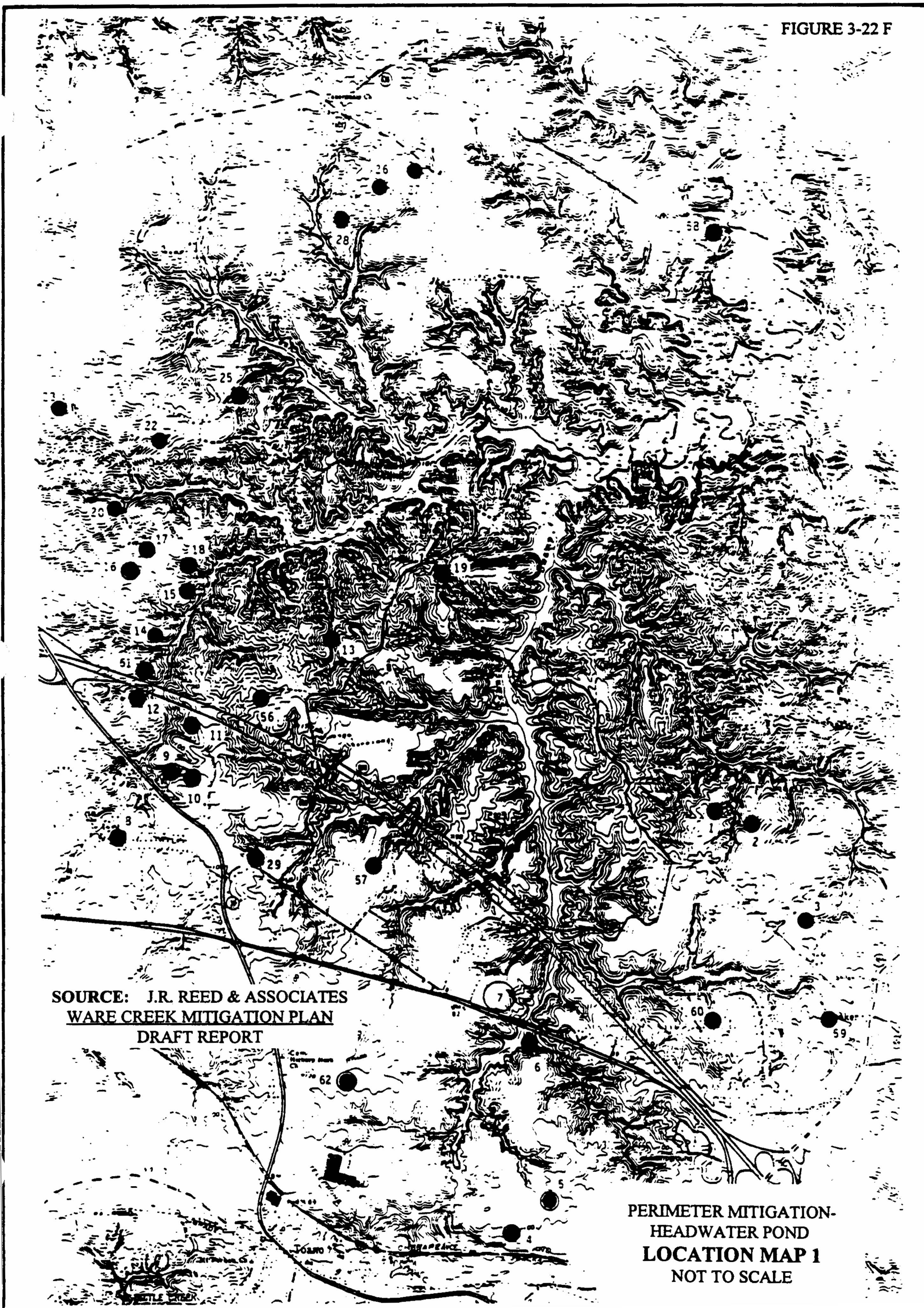
To compensate further for the loss of non-tidal wetlands that would be inundated by the Ware Creek Reservoir, 64 acres of headwater impoundments would be constructed within the normal pool elevation. The impoundments would be constructed and would operate in a similar fashion to the headwater impoundments above the reservoir's normal pool elevation, except that the top of the berm would be at the normal pool elevation. Therefore, the impoundments would receive additional hydrologic inputs from the reservoir when the reservoir was at normal pool elevation. When the reservoir was drawn down, the impoundments would retain water and thereby extend the hydroperiod of the mitigation areas.

The headwater impoundments would be designed to consist of 25 to 30 percent open water and 70 to 75 percent vegetated wetlands, with an ultimate goal of 70 percent forested wetland coverage. A total of 11 sites encompassing 72 acres have been identified as potential headwater impoundments within the normal pool area (see Figure 3-22H). However, beaver activity could eliminate some of these sites from future consideration. There is a large beaver population in the Ware Creek watershed, which could substantially alter the potential headwater impoundment areas before and after the reservoir is built. By cutting down trees, beavers could convert mostly wooded habitats to mostly open water areas. They could also dam the spillways, thereby increasing the water depth, which could prevent vegetation from becoming established and threaten the integrity of the berms. If necessary, management measures could be implemented to ensure the success of the mitigation.

Conservation Zone Wetlands

The final component of James City County's mitigation plan involves designating existing wetland areas between elevations 35 and 50 feet msl for inclusion in the James City County Reservoir Protection Overlay District. This would provide the designated wetlands protection from

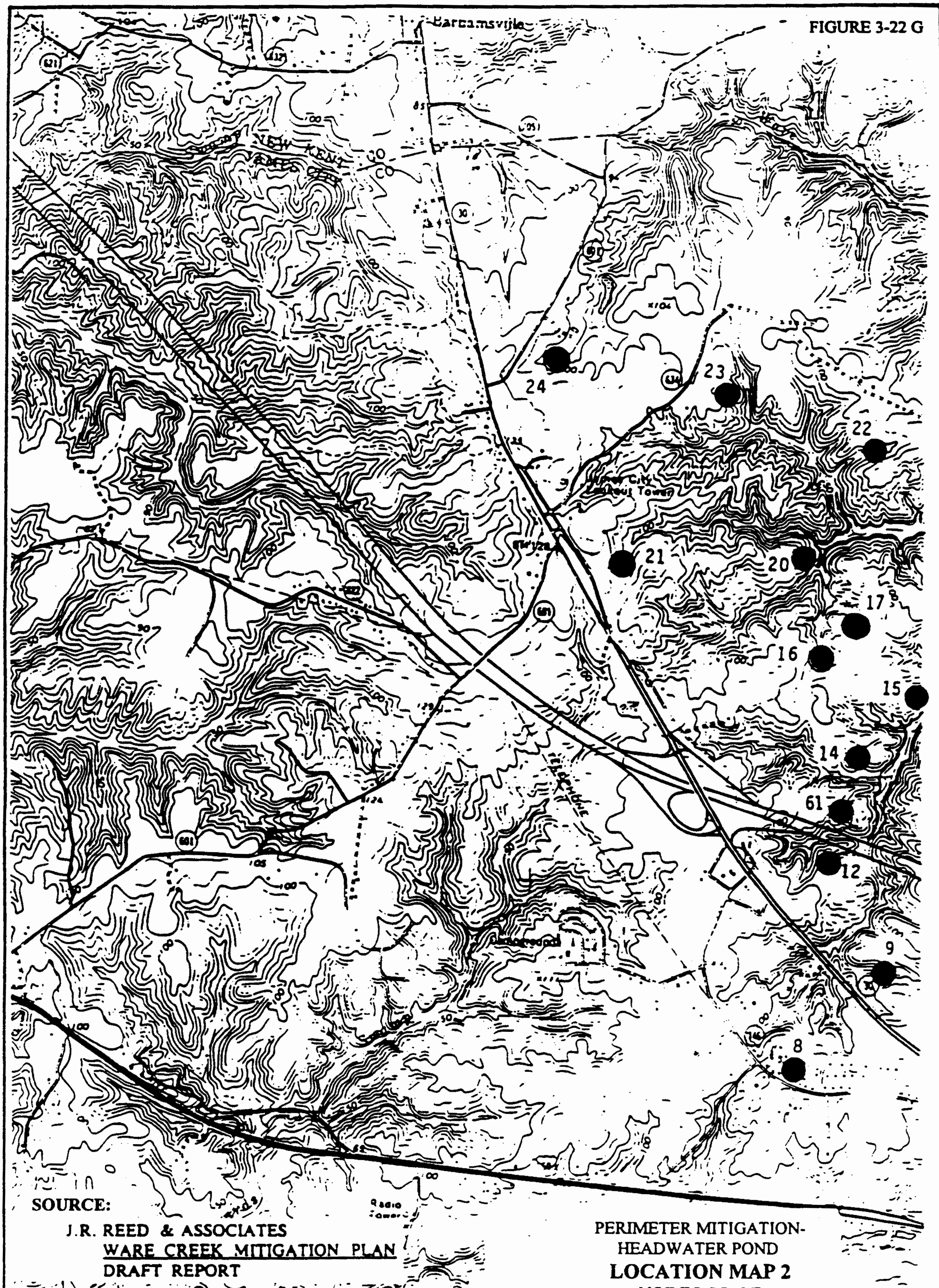
FIGURE 3-22 F



SOURCE: J.R. REED & ASSOCIATES
WARE CREEK MITIGATION PLAN
DRAFT REPORT

PERIMETER MITIGATION-
HEADWATER POND
LOCATION MAP 1
NOT TO SCALE

FIGURE 3-22 G

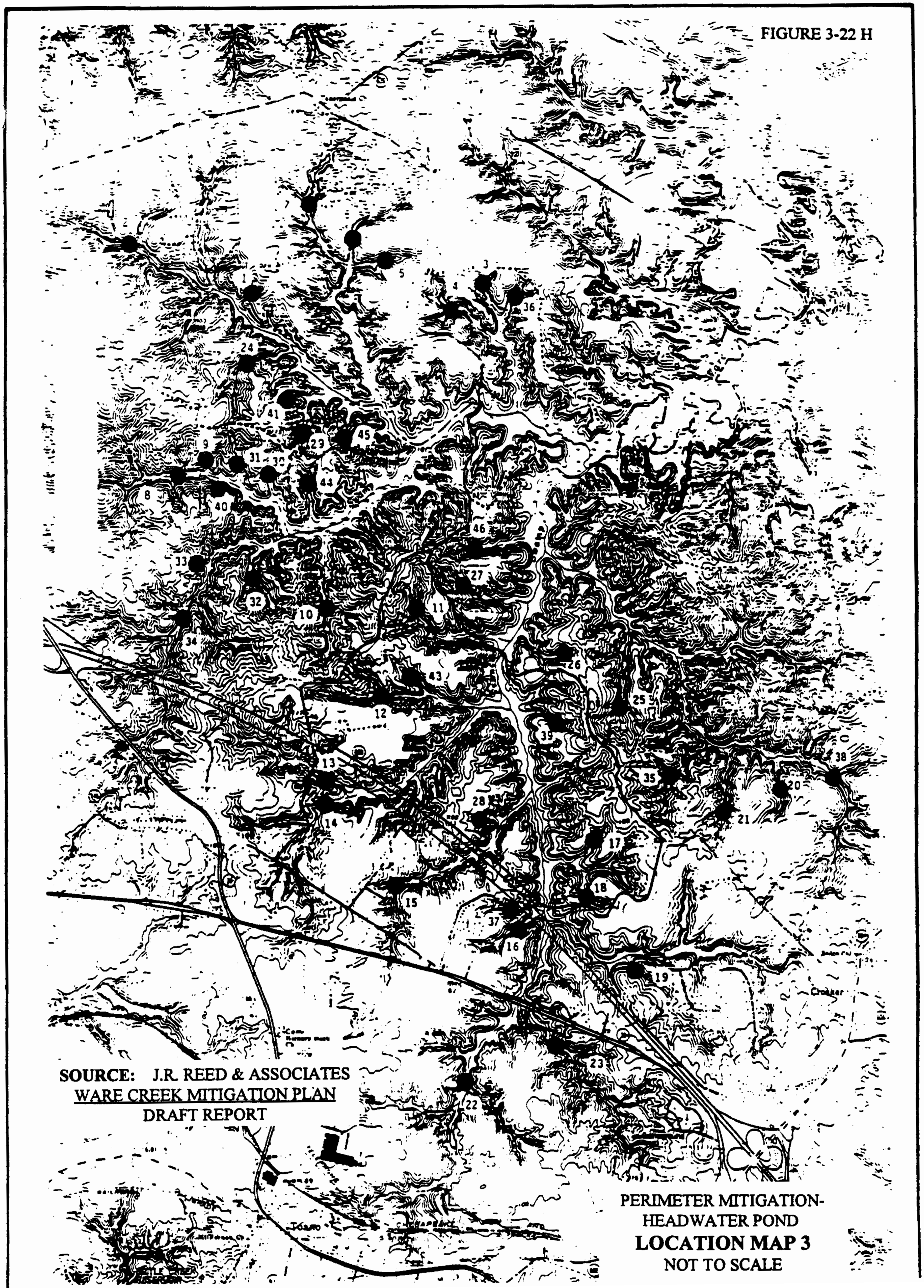


SOURCE:

J.R. REED & ASSOCIATES
<u>WARE CREEK MITIGATION PLAN</u>
DRAFT REPORT

PERIMETER MITIGATION-
HEADWATER POND
LOCATION MAP 2
NOT TO SCALE

FIGURE 3-22 H



SOURCE: J.R. REED & ASSOCIATES
WARE CREEK MITIGATION PLAN
DRAFT REPORT

PERIMETER MITIGATION-
HEADWATER POND
LOCATION MAP 3
NOT TO SCALE

development, beyond the protections which are provided by Section 404 of the Clean Water Act. A total of 67 potential sites comprising 163 acres of wetlands have been identified within the Ware Creek Reservoir watershed and would be included in the Overlay District (see Figure 3-22I). As specified in the County ordinance, the designated wetlands would be protected by a 200-foot buffer zone above the 50 foot msl elevation. The buffer zone would be approximately 2,500 acres in size.

3.7.4 Mitigation Plan Implementation

Future Protection of Mitigation Areas

To ensure the future protection of the mitigation areas, conservation easements would be established on the mitigation areas and some surrounding land.

Conservation easements are deed restrictions placed upon the land to ensure that it will be preserved in perpetuity. Such restrictions may be imposed by landowners voluntarily in exchange for fair market compensation and are not necessarily imposed by the government. If necessary, however, easements can be acquired by condemnation. The deed restrictions would not have any effect upon the ownership of the land, except by restricting the character of its use to protect the existing or enhanced character of the property. The easements may grant interests in the property to an appropriate public agency or civic organization (such as the Virginia Outdoors Foundation or the Nature Conservancy), pursuant to the Open-Space Land Act (Virginia Code §§ 10.1-1700, et seq.) or the Virginia Conservation Easement Act (Virginia Code §§ 10.1-1009, et seq.), however, to ensure that the easement restrictions could be enforced if necessary.

The conservation easement is a flexible concept, because no specific conservation plan is required. The landowner can tailor the conservation plan to suit his wishes. Only the specific use rights that landowners choose to give up (or which are acquired by condemnation) would become restrictions on their properties. Landowners would be allowed to own, sell, lease, mortgage, or otherwise use the properties consistent with the terms of the conservation easements.

The conservation easements proposed in these mitigation plans would remove the designated mitigation areas from agricultural use and dedicate them for wetland protection in perpetuity. The present landowners would retain ownership (aside from the easements), and they could reserve the right to allow hunting and other activities which are compatible with wetland preservation. The land would remain private, and the easements would not give the general public any rights to the land unless the landowners decided to include such rights in the easements.

Monitoring Plan

The vegetation, soils, and hydrology of each mitigation area would be monitored as part of the mitigation plan implementation. The monitoring period for each site would depend on the lifecycle of the wetland community planned for a particular site. Emergent wetlands would be monitored for 4 years, and scrub-shrub and forested wetlands would be monitored for a period of 10 years.

During the monitoring period, two site visits would be made during the first growing season, in the early spring (April through May) and in mid-summer (July through August). During the spring visit, inspectors would look for evidence of soil erosion, plant success, and wildlife utilization of the site. During the summer visit, the inspectors would determine the health and vigor of the plantings, note insect damage, and identify colonization of undesirable plant species (i.e., Common Reed

FIGURE 3-22 I

SOURCE: J.R. REED & ASSOCIATES
WARE CREEK MITIGATION PLAN
DRAFT REPORT

CONSERVATION ZONE
LOCATION MAP
NOT TO SCALE

(Phragmites) and Purple Loosestrife). For the duration of the monitoring period, an annual visit would be made during the height of the growing season (July and August).

During the monitoring period, the following data related to vegetation, soils, hydrology, and wildlife would be collected for each site:

Emergent Wetlands	Scrub-Shrub and Forested Wetlands
Percent Areal Coverage	Stem Density
Species Composition	Species Composition
Soil profile	Soil profile
Quarterly water table elevations	Quarterly water table elevations
Wildlife species present	Wildlife species present

Invasion by noxious plants can negatively affect the success of a mitigation project. The vegetative diversity of the mitigation area may be reduced, thereby compromising the created or restored wetland functions. Potential invader species and proposed corrective actions are discussed below.

Purple Loosestrife (*Lythrum salicaria*), a Eurasian weed, has little wildlife value and is extremely prolific. It can easily take over recently planted areas, creating a monotypic stand with little wildlife value. The most effective way to control the plant is to remove by hand the first plants that emerge. It is essential to carefully bag and remove the plants from the site. If the plants were allowed to go to seed, control would become more difficult because a seed bank would become established (Eggars, 1992).

If Purple Loosestrife becomes established to the point where hand removal is not feasible, application of an herbicide approved for use in wetlands/waters is the next option. Herbicide treatment on an annual basis may be required to control the species. Herbicide application would comply with state and federal requirements.

Common Reed *(Phragmites)* is another invasive species which can interfere with mitigation projects. That plant also has the potential to form persistent monotypic stands. One of the few proven methods of removing *Phragmites* from mitigation areas is to create water depths where it cannot survive. Persistent water depths of 18 to 24 inches usually will suppress *Phragmites*, but also would suppress other emergent plants.

Under certain circumstances, an herbicide application would be used to eliminate *Phragmites*. Application during the late summer when the plant is in bloom and treatment early during the following growing season would effectively eliminate *Phragmites*.

If either Purple Loosestrife or *Phragmites* infestation became an issue at the proposed mitigation sites, the following steps would be taken:

- Evaluate extent of infestation.
- Remove individual plants by hand from the mitigation area.
- If removal by hand is not effective, evaluate and implement other control techniques, such as herbicide application or temporary flooding of the mitigation area.
- Once the invasive species are controlled, regrade and replant the area, as necessary, to achieve 85 percent areal coverage.

If proper wetland hydrology were not being maintained in any of the mitigation areas, due to drought or excessive water drawdowns, the feasibility of modifying reservoir operations or re-contouring mitigation areas would be examined.

Another potential problem is the inability to achieve sufficient vegetative cover in the mitigation areas. If designated areal coverages or stem densities are not achieved, supplemental planting would be initiated during the monitoring period. Mitigation areas would be regraded and replanted only as a last resort, after all other attempts to achieve an appropriate coverage had failed. The planted species also may be reviewed to determine whether other species would be better suited to the mitigation sites.

3.7.5 Summary

Conceptual mitigation plans for the King William Reservoir, Black Creek Reservoir, and Ware Creek Reservoir would include the following mitigation projects:

Mitigation Technique	King William Reservoir	Black Creek Reservoir	Ware Creek Reservoir
ON-SITE MITIGATION			
Borrow Area Wetland Construction	X	X	X
Headwater Wetland Construction		X	
Headwater Impoundments			X
Fringe Wetlands	X	X	
Island Creation	X	X	X
Open Water	X	X	X

Mitigation Technique	King William Reservoir	Black Creek Reservoir	Ware Creek Reservoir
Wetland Preservation			X
Upland Preservation	X	X	
OFF-SITE MITIGATION			
Wetland Restoration	X	X	X
Wetland Creation	X	X	
Wetland Preservation	X		
Upland Restoration	X	X	
Upland Preservation	X	X	
OTHER MITIGATION COMPONENTS			
Stream Restoration	*	*	X
Stream Channel Opening	X		X
Fish Hatchery Improvements	X		
Wetland Education Opportunities	X		
Small Whorled Pogonia Preservation	X		
Sensitive Joint-Vetch Monitoring	X		

* To be determined.

3.8 SUMMARY OF ENVIRONMENTAL CONSEQUENCES
(Previously Numbered as 3.6 in DEIS)

Environmental consequences of the seven alternatives carried forward for detailed environmental analysis are summarized in Table 3-14. Detailed discussions of environmental consequences are presented in Section 5.0.

4.0 AFFECTED ENVIRONMENT

4.1 INTRODUCTION

This section describes the affected environment in terms of the physical, biological, cultural, and socioeconomic resources that would be impacted by each of the candidate alternatives and the No Action alternative. A more detailed review of these topics is contained in Report D (Volume II), ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document.

Each of the alternatives identified in Section 3.5 are evaluated regarding the affected environment in each of the following general categories:

- Physical Resources: Descriptions of the physical resources associated with the alternatives are provided. Substrate, water quality, hydrology, groundwater resources, soil and mineral resources, and air quality are included in this general category. Riffle and pool complexes were also considered. However, these complexes are not generally found in the Coastal Plain of Virginia. Because all of the practicable alternatives under evaluation would be located in the Coastal Plain, these features are not analyzed in this document.

- Biological Resources: Descriptions of endangered, threatened, and sensitive species; fish and invertebrates; other wildlife; sanctuaries and refuges; wetlands and vegetated shallows; and mud flats are provided for each of the alternatives.

- Cultural Resources: Descriptions of archaeological and historical sites associated with the alternatives are provided.

- Socioeconomic Resources: Descriptions of the socioeconomic resources associated with the alternatives are provided. Municipal and private water supplies, recreational and commercial fisheries, other water-related recreation, aesthetics, parks and preserves, land use, noise, infrastructure, and other socioeconomic resources are included in this general category.

A comparative summary of the affected environment associated with each alternative is also included at the conclusion of this section.

4.2 PHYSICAL RESOURCES

This section provides a general description of the physical environment at the proposed project sites for each of the seven alternatives evaluated. Physical resource categories evaluated are described below.

Substrate

This section identifies the existing aquatic ecosystem substrate at project areas associated with each alternative. Aquatic ecosystem substrate is considered to be the benthic material underlying all open water areas and constitutes the soil-water interface of wetlands. It is distinguished from soils by permanent or frequent inundation.

In some cases the difference between aquatic ecosystem substrate and soil is difficult to distinguish. For example, in such cases where the predicted effect would occur at a shore-water interface the effect was assumed to be greater on the submerged substrate, and therefore, considered affecting primarily the substrate.

The substrate impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines for potential impacts on physical and chemical characteristics of the aquatic ecosystem (40 CFR § 230.20).

Water Quality

This section describes the existing water quality of surface waters in project areas, including all existing lakes, reservoirs, streams, and rivers. The water quality impact category was developed from portions of the Clean Water Act Section 404 (b)(1) Guidelines which address potential impacts on physical and chemical characteristics of the aquatic ecosystem. These characteristics include suspended particulates/turbidity (40 CFR § 230.21), water (40 CFR § 230.22), and salinity gradients (40 CFR § 230.25).

Hydrology

This section describes the existing surface water or groundwater hydrology in project areas associated with each alternative. The hydrology impact category was developed from portions of the Clean Water Act Section 404 (b)(1) Guidelines which address potential impacts on physical characteristics of the aquatic ecosystem. These characteristics include current patterns and water circulation (40 CFR § 230.23) and normal water fluctuations (40 CFR § 230.24).

Groundwater Resources

This section describes the groundwater resources which could be impacted by each of the proposed alternatives. This impact category was included as a public interest factor to consider pursuant to the National Environmental Policy Act.

Soil and Mineral Resources

This section describes soils and mineral resources located within project areas associated with the alternatives. The soil and mineral resources impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Air Quality

This section identifies the existing air quality in the vicinity of project areas associated with each alternative component. The air quality impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

4.2.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Substrate

Intake

Lanexa Mucky Silty Clay appears to be the parent soil of the river substrate that would be affected in the vicinity of the proposed intake station.

Reservoir

Soils located within the proposed Ware Creek Reservoir pool area are the parent material for the substrate that would be affected by construction of the proposed Ware Creek Reservoir. Generally, the soils found in the proposed reservoir area are considered coastal plain upland soils, given the group designation of Emporia-Craven-Uchee.

Pipeline

The area of substrate disturbance at each minor stream/wetland crossing was assumed to be 2,500 square feet (pipeline right-of-way (ROW) width (50 feet) multiplied by the length of the crossing). Substrate types at the proposed crossings include: Johnston Mucky Loam, Roanoke Silt Loam, Tomotely Loam, and substrates of the Nevarc-Remlik and Slagle-Emporia complexes.

There are four pipeline outfall locations associated with this component. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Typical substrate found at this outfall site originates from Johnston Mucky Loam soil. The second outfall would be located on Diascund Creek, approximately 0.6 river miles upstream of the normal pool area of Diascund Creek Reservoir. The affected substrate at this location is similar to the substrate found at the first outfall location. The third outfall would be located on the Bird Swamp arm of the proposed Ware Creek Reservoir. Typical substrate at this location originates from the Emporia Complex soils. The fourth outfall structure would be located on the France Swamp arm of the proposed Ware Creek Reservoir. Typical substrate at this location originates from the Emporia Complex soils.

Water Quality

Intake

At the proposed Pamunkey River intake location at Northbury (Pamunkey River mile 40), the Pamunkey River is designated as "effluent limited" by the Virginia State Water Control Board (SWCB, 1992). Downstream of Northbury, between Sweet Hall Landing and West Point, the Pamunkey River is designated as "nutrient enriched." A SWCB monitoring station for the Chesapeake Bay Tributary Monitoring Program is located at White House, approximately 5.8 river miles downstream from Northbury. General water quality data for this station for the Water Years 1984 through 1987 are summarized in Table 4-1.

TABLE 4-1

PAMUNKEY RIVER WATER QUALITY AT WHITE HOUSE

Parameter	Units	Number Samples	Mean	Minimum	Maximum
pH	SI	108	6.93	5.60	8.29
Salinity	g/L	177	0.004	0	0.1
Transparency	M	53	0.7	0.3	1.4
Dissolved Oxygen	mg/l	198	7.1	2.9	12.9
Chlorophyll a	mg/l	41	5.34	0.38	29.01
Total Organic Carbon	mg/l	115	7	4	14
Total Phosphorus	mg/l	121	0.07	0.02	0.21
Dissolved Phosphorus	mg/l	121	0.03	0.01	0.05
Orthophosphate	mg/l	115	0.02	0.01	0.05
Nitrate	mg/l	121	0.23	0.01	0.65
Nitrite	mg/l	121	0.01	0.01	0.30
Total Kjeldahl Nitrogen	mg/l	121	0.06	0.05	0.25
Ammonia	mg/l	120	0.6	0.1	1.9
Silicon	mg/l	121	10	1.1	38

Source: Tributary Water Quality 1984-1987 Data Addendum - York River (SWCB, 1989).

The SWCB has identified two permitted point source discharges to the Pamunkey River segment between River Miles 29.5 and 57.3 (SWCB, 1992). Both of these permitted discharges are downstream from the proposed intake site at River Mile 40. Currently, there are no notable point source discharges in the immediate vicinity of Northbury. However, there are currently four SWCB-designated "major" municipal and industrial discharges upstream of Northbury. In addition, non-point sources, such as agricultural runoff, drain into the Pamunkey River and impact water quality.

A recent study conducted for Hanover County recommended the construction of a 5 mgd wastewater treatment plant (WWTP) that would discharge treated sewage into the Pamunkey River in the vicinity of Totopotomoy Creek, east of U.S. Route 360 (Wasson, 1996). This site was selected because it would cause the least environmental impact on the river, and thereby allows for a future 10 mgd plant expansion. Hanover County has also identified a potential 1 mgd WWTP discharge point on the Pamunkey River near the U.S. Route 301 Bridge, approximately 45 river miles upstream of Northbury.

A regional water quality model was developed by Hanover County to assess the ability of the Pamunkey River and its tributaries to assimilate these wastewater needs. A QUAL2E model was applied to 73 miles of river to evaluate the combined effects of current wastewater dischargers. Model data were acquired from previous modeling studies and monitoring data collected by Hanover County. Summer and winter critical conditions were used to calibrate the model. The model results demonstrated that the dissolved oxygen criterion of 5.0 mg/L may be violated in several river reaches during the summer 7Q10 condition. Although the modeling simulation was upstream of the Northbury site, a U.S. Route 360 river reach dissolved oxygen concentration of 4.9 mg/L was modeled during this summer critical condition (Quinlan and Dumm, 1996).

In June 1993, King William County submitted a VPDES permit application to the Virginia Department of Environmental Quality (VDEQ), Water Division (formerly SWCB) for a 25,000 gallon per day WWTP discharge to an unnamed branch of Moncuin Creek (a tributary of the Pamunkey River), upstream of a bridge crossing by U.S. Route 360. Ultimately this discharge may be increased to 0.5 mgd (D. S. Whitlow, King William County, personal communication, June 1993). This proposed discharge location is approximately 10.5 river miles upstream of Northbury.

In July 1992 the SWCB issued a VPDES permit to New Kent County for a planned 0.25-mgd WWTP discharge at an existing outfall for the Cumberland Hospital WWTP at the northern end of Route 637 just north of the community of New Kent. This discharge to Cumberland Thorofare (a side-channel of the mainstem Pamunkey River) is approximately 17 river miles downstream of Northbury. Also in New Kent County, a new regional jail site will discharge treated wastewater into the Pamunkey River at Parham Landing, 5.6 river miles above the mouth of the Pamunkey River.

Given the great amount of current and planned development in the Pamunkey River basin, the number of municipal and industrial WWTP discharges in the basin is expected to grow. This growth will continue to represent a water quality reliability concern with respect to potential use of the Pamunkey River as a drinking water supply.

Reservoir

Water quality in both Ware Creek and Diascund Creek reservoirs would be affected under this alternative, since water from the Pamunkey River would be discharged directly to Diascund Creek prior to pumping to Ware Creek.

Most of the flow to Diascund Creek Reservoir is contributed through five main tributaries in the reservoir watershed area. The largest of these tributaries are Diascund Creek to the northwest of the reservoir, Beaverdam Creek to the north of the reservoir, and Wahrani Swamp to the northeast of the reservoir. Water quality characteristics for Diascund Creek and Beaverdam Creek are summarized in Table 4-2.

Presently, there are no permitted facilities discharging directly to Diascund Creek Reservoir. However, there is an active WWTP which was constructed for use at the Virginia Department of Corrections (VDC) Camp 16, off of State Route 634, northeast of Wahrani Swamp. The point of discharge for the WWTP is in New Kent County on an unnamed tributary of Wahrani Swamp. In June 1992, the SWCB issued a VPDES permit to the VDC for this facility. Henrico, Goochland, and New Kent counties are building a regional jail in New Kent County that will house the inmates currently located at the VDC's old Camp 16. Consequently, the Camp 16 WWTP will be taken off-line in 1997 (D.Cook, VDEQ, personal communication, 1996). The SWCB issued a VPDES permit for the new jail on November 8, 1994, allowing direct low flow, advanced high quality discharges to the Pamunkey River.

Diascund Creek Reservoir stratifies in the summer months, typically between June and August (CDM, 1989). Principally because of the depth of Diascund Creek Reservoir, an anoxic hypolimnion can develop. The water in Diascund Creek Reservoir is designated as eutrophic by the SWCB (SWCB, 1992). Some water quality parameters measured for Diascund Creek Reservoir and its tributaries are summarized in Table 4-2.

Below the reservoir, Diascund Creek is a tidal freshwater tributary of the Chickahominy River. There is no minimum flow-by requirement, and the preferred mode of operation is not to allow any water to spill over the dam or emergency spillway. Flow to Diascund Creek from the reservoir is from seepage through the dam and overflow during periods of wet weather.

Ware Creek is a relatively small and shallow system, with saline water at the mouth of the creek (10 to 19 ppt), brackish water between River Miles 2.5 and 5.6 from the mouth of the creek, and fresh water (less than 1 ppt) upstream from River Mile 5.6. Water quality data are available for Ware Creek from a USGS monitoring station at Richardson Millpond. Water quality samples taken at this station between 1985 and 1991, on a quarterly basis, are included in Table 4-3.

The water quality in Ware Creek has been described as *"relatively good despite the fact that phosphorus, iron, manganese and zinc have exceeded Virginia or USEPA criteria"* (USCOE, 1987). Previous studies have attributed these excess values, phosphorus in particular, to the prior location of a WWTP at the headwaters of France Swamp which operated until November 1979. However, based on the data obtained for Ware Creek and France Swamp, there is no longer an extreme difference in phosphorus concentrations between these two streams. It is therefore unlikely that the former WWTP is still the primary source of phosphorus. It is more likely that non-point sources are now the greatest contributors of nutrients.

In March 1977, due to high coliform bacteria levels, the waters of Ware Creek were condemned by the VDH, thereby prohibiting shellfishing. The shellfish condemnation area extends from the mouth of Ware Creek to its headwaters including the tributaries (SWCB, 1992).

In January 1992 the SWCB issued a VPDES permit to Branscome Concrete, Inc. for the Branscome Concrete Toano Plant in James City County. This permit allows discharge of truck

TABLE 4-2

DIASCUND CREEK RESERVOIR AND TRIBUTARY WATER QUALITY

RESERVOIR

Parameter	Units	Depth	Number Samples	Mean	Min.	Max.
pH	SI	3 ft	36	7.3	6.6	8.3
pH	SI	18	34	6.9	6.4	8.0
Chlorophyll a	mg/l	3 ft	96	31	0.5	147
Total Phosphorus	mg/l	3 ft	88	0.04	0.005	0.26
Total Nitrogen	mg/l	3 ft	35	0.53	0.2	1.3
Total Nitrogen	mg/l	18 ft	33	1.5	0.2	5.6
Dissolved Oxygen	mg/l	3 ft	91	8.3	4.4	13.2
Dissolved Oxygen	mg/l	18 ft	91	4.3	0.0	13.1
Total Organic Carbon	mg/l	3 ft	45	8.2	5.5	11
Total Organic Carbon	mg/l	18 ft	37	9.3	6.3	15

Source: Newport News Raw Water Management Plan, CDM, 1989.

RESERVOIR TRIBUTARIES

		Diascund Creek				Beaverdam Creek			
Parameter	Units	Number Samples	Mean	Min.	Max.	Number Samples	Mean	Min.	Max.
pH	SI	30	6.9	6	8.8	32	6.9	6.2	8.3
Fluoride	mg/l	ND	ND	ND	ND	3	< 0.1	< 0.1	< 0.1
Chloride	mg/l	29	9.7	4.1	75	32	12	5	75
Sulfate	mg/l	ND	ND	ND	ND	3	2	1.8	2.3
Total Phosphorus	mg/l	35	0.082	0.011	0.23	32	0.077	0.01	0.186
Orphosphate	mg/l	35	0.014	< 0.001	0.59	31	0.014	< 0.001	0.59
Iron	mg/l	35	2.5	0.63	4.8	31	3.1	0.65	9.6
Manganese	mg/l	35	0.11	0.04	0.26	35	0.21	0.02	0.9

Sources: Prugh et al., 1988, 1989, 1990, 1991, and 1992.
USGS Station 02042726 - Diascund Creek at State Route 628.
USGS Station 02042736 - Beaverdam Creek at State Route 632.

Note: ND = No Data

TABLE 4-3

WARE CREEK WATER QUALITY AT RICHARDSON MILLPOND

Parameter	Units	Number Samples: Total	Number Samples: Above DL	Mean	Min.	Max.
pH	SI	33	33	7.3	6.1	8.7
Specific Conductance	μS/cm	33	33	123	90	180
Alkalinity	mg/l	23	23	36	24	53
Dissolved Oxygen	mg/l	30	30	9.1	3.4	13.2
Dissolved Oxygen (Sat.)	mg/l	30	30	92	44	134
Total Organic Carbon	mg/l	32	32	7	3.5	12
Total Phosphorus	mg/l	32	28	0.04	0.01	0.08
Dissolved Phosphorus	mg/l	32	12	0.01	0.01	0.03
Nitrate+Nitrite	mg/l	32	11	0.09	0.005	0.52
Nitrite	mg/l	32	4	0.01	0.005	0.03
Total Kjeldahl Nitrogen	mg/l	33	32	0.8	0.2	1.9
Ammonia	mg/l	32	29	0.03	0.01	0.13
Iron	μg/l	33	33	498	70	2,000
Manganese	μg/l	33	28	30	4	140

Sources: Prugh et al., 1988, 1989, 1990, 1991, and 1992.

USGS Station 01677000 - Ware Creek at State Route 600.

Note: DL = Detection Limit

washdown and storm water runoff to a tributary of France Swamp in the proposed Ware Creek Reservoir drainage area.

The Massie Debris Landfill is also located within the proposed Ware Creek Reservoir watershed. This active landfill is located immediately south of State Route 168/30 (H. J. Winer, VDWM, personal communication, 1992), at the confluence of France Swamp and one of its tributaries. Based on USGS topographic information and aerial photography, a portion of the landfill may be within the normal pool area for the proposed reservoir.

Stonehouse Inc., a wholly-owned subsidiary of Chesapeake Corporation, formally announced plans for its proposed "Stonehouse New Community" in March 1989. This would be a 7,230-acre planned community within the 11,141-acre Ware Creek watershed of James City and New Kent counties. The James City County portion of the Stonehouse development would occupy 4,000 acres (J. C. Dawson, James City County, personal communication, September 1992) or approximately 40 percent of the 9,903 acres (excluding the normal reservoir pool area) that would drain to Ware Creek Reservoir. Additional areas within the New Kent County portion of Stonehouse would also be within the reservoir watershed. As a consequence, activities both directly and indirectly associated with the development could have a substantial impact on the water quality of Ware Creek. Rezoning for the 5,750 acres of this development within James City County was approved by the James City County Board of Supervisors in November 1991.

According to James City County, plans for Stonehouse include a reservoir buffer zone extending 50 feet beyond the 50-foot elevation contour or 100 feet from the reservoir pool level (R. P. Friel, James City County, personal communication, 1991). A storm water management plan has been developed for this community to reduce the impact of development on the proposed reservoir (Langley and McDonald, 1990). Oil/water separators would be required at all stream/wetland area crossings, and the sewer system would be designed to minimize potential threats to reservoir water quality. Best management practices (BMPs) would be maintained by James City County at Stonehouse's expense. The quantity and quality of the storm water runoff would be monitored. If runoff quantity or quality exceeds limits set based on previous storm water analysis, the BMPs for subsequent phases would be modified and existing development might be retrofitted to meet the limits (J. C. Dawson, James City County, personal communication, September 1992). These control measures previously described for Stonehouse should afford some degree of water quality protection for Ware Creek. However, given the magnitude of the Stonehouse project, there would still be a noteworthy risk of long-term reservoir water quality deterioration due to the extensive nature of planned residential and commercial development in the watershed.

The Stonehouse project is proceeding without the Ware Creek Reservoir. The construction of the 800 homes associated with the first phase of planned community is planned for late 1996 or early 1997. The community golf course for the first phase of construction has been completed.

Pipeline

Construction of 26.3 miles of pipeline for this alternative would involve minor crossings of 21 stream/wetland areas. Pamunkey River withdrawals would be pumped to the Diascund Creek Reservoir drainage basin, discharging to two outfall locations on Diascund Creek. Raw water would then be pumped from Diascund Creek Reservoir to either Ware Creek Reservoir or the existing Newport News Waterworks mains. Diascund Creek Outfall Site 1 would be near the headwaters of Diascund Creek, where the estimated average flow is 1.0 mgd. Projected maximum raw water discharge from the Pamunkey River to this outfall location is 40 mgd. Diascund Creek Outfall Site 2 would be just upstream of the reservoir, where the estimated average flow is 8.7 mgd. Projected maximum raw water discharge from the Pamunkey to this outfall location is 80 mgd.

Existing water quality data for the Pamunkey River near the proposed intake site are presented in Table 4-1. The closest USGS water quality monitoring station for Diascund Creek is approximately 2.8 river miles downstream from Outfall Site 1 and approximately 1.1 river miles upstream from Outfall Site 2. Water quality data from this station are summarized in Table 4-2, and are used to represent existing water quality conditions for Diascund Creek.

Hydrology

Intake

The proposed intake site on the Pamunkey River at Northbury would be located in New Kent County, approximately 40 river miles upstream of the mouth of the Pamunkey River (see Plate 1 and Figure 4-1). Tidal freshwater conditions exist at the proposed intake location and the mean tidal range is 3.3 feet at Northbury (USDC, 1989).

Contributing drainage area at Northbury is approximately 1,279 square miles. The proposed 120-mgd maximum withdrawal capacity represents 15.5 percent of the estimated average freshwater discharge at Northbury (774 mgd). More detailed streamflow characteristics of the Pamunkey River at the proposed intake site are presented in Table 3-A.

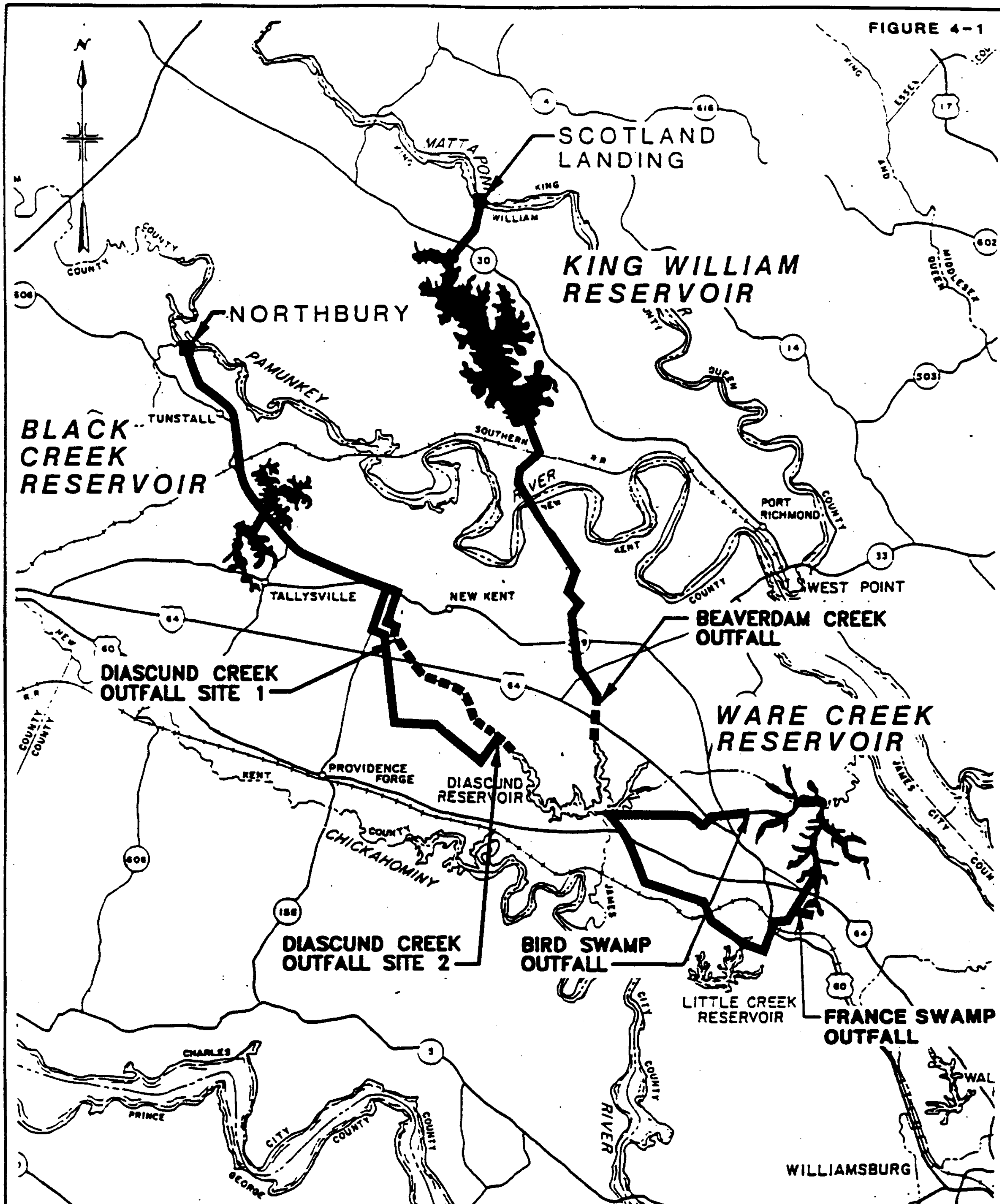
Reservoir

Ware Creek and its principal tributaries, France Swamp, Cow Swamp, and Bird Swamp, drain a generally undisturbed watershed of approximately 17.4 square miles above the proposed dam site. The proposed dam site is situated approximately 1,000 feet downstream of the confluence of Ware Creek and France Swamp and is located 4.7 river miles upstream of the mouth of Ware Creek where it empties into the York River (Wilber et al., 1987).

Ware Creek flows in a northeasterly direction into the York River. The hydrologic system of the drainage area primarily consists of tidally and non-tidally influenced, perennial and intermittent streams. While drainage from Bird Swamp and Ware Creek is interrupted by a minor impoundment, Richardson's Millpond, flow from the remainder of the Ware Creek basin is unobstructed by manmade impoundments.

The proposed dam site would be located in tidal waters where the channel is approximately 75 feet wide (Wilber et al., 1987). The variable discharge of freshwater from Ware Creek and the creek's depth relative to the estuarine tidal influx of the York River results in large-scale fluctuations in the salinity of waters in the creek system over relatively short periods of time (USEPA, 1992).

For this analysis it is assumed that all streams up to the proposed normal pool elevation of 35 feet msl would be affected. A total of 37.1 river miles of perennial and intermittent streams are located within the proposed reservoir pool area up to elevation 35 feet msl. Data concerning the stream system within the drainage area are presented in Table 4-5.



APRIL 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

LOCATIONS OF RESERVOIR/PUMPOVER ALTERNATIVES

MALCOLM PIRNIE

TABLE 4-5

WARE CREEK RESERVOIR STREAM ORDER ANALYSIS

Stream Order [1]	River Miles		Total
	Perennial [2]	Intermittent [3]	
First	1.82	19.37	21.19
Second	3.30	7.44	10.74
Third	3.96	0.00	3.96
Fourth	1.06	0.00	1.06
Fifth	0.15	0.00	0.15
		Total	37.10

1 Smallest tributaries are classified as "order 1". The point at which two first order streams join the channel is the beginning of a second order segment, and so on.

2 A perennial stream maintains water in its channel throughout the year.

3 An intermittent stream flows only in direct response to precipitation. It may be dry for a large part of the year, ordinarily more than three months.

To estimate existing streamflow at the proposed dam site, the streamflow record from Ware Creek near Toano (10/79 to 10/81 and 3/82 to 9/90) was adjusted to the contributing reservoir drainage area of 17.4 square miles. Average streamflow at the proposed dam site is estimated to be 11.1 mgd.

Pipeline

The construction of 26.3 miles of pipeline would be required for this alternative. The pipeline would cross 21 stream/wetland areas. This alternative component would also involve raw water discharges into the headwaters of Diascund Creek and Ware Creek reservoirs. Two raw water outfalls (40 mgd and 80 mgd capacities) would be located on perennial segments of Diascund Creek. The Ware Creek Reservoir headwaters (Bird Swamp and France Swamp) discharges would be located at intermittent portions of these stream/wetland areas. Existing average streamflows at the Diascund Creek outfall locations were estimated based on the same streamflow record listed previously in the description of Ware Creek Reservoir streamflows, and were adjusted to the drainage areas at the points of discharge.

Field studies were conducted in July 1992 and January 1993 to obtain stream cross-sectional measurements at the proposed raw water discharge locations on Diascund Creek. To identify the potential hydrologic impacts of the proposed raw water discharges, Manning's Equation for Open Channel-Uniform Flow was used to approximate the depth of flow which could result from each proposed raw water discharge.

At Outfall Site 1 on Diascund Creek, estimated average discharge is 1.0 mgd based on a 1.6-square mile drainage area. It is assumed that the maximum discharge would be the maximum pipeline capacity at the outfall (40 mgd), plus the estimated average discharge at the site. Therefore, maximum discharge at Outfall Site 1 during pumpover operations is assumed to be 41 mgd. Diascund Creek Outfall Site 1, based on Manning's Equation, has an estimated channel capacity of at least 53 mgd. Therefore, the existing channel should be capable of accommodating maximum flows during pumpover operations.

At Outfall Site 2 on Diascund Creek, estimated average discharge is 8.7 mgd based on a 13.55-square mile drainage area. It is assumed that the maximum discharge would be the combined maximum raw water discharge of the two outfalls (120 mgd), plus the estimated average discharge at the site. Therefore, the maximum discharge at Outfall Site 2 during pumpover operations is assumed to be 128.7 mgd. The channel of Diascund Creek at Outfall Site 2 is easily capable of accommodating maximum flows during pumpover operations. At this proposed outfall site, two main Diascund Creek channels exist, each of which is at least 20 feet wide. The total bottom area of Diascund Creek at this point is 150 to 200 feet wide.

The Bird Swamp and France Swamp discharges would be directly to Ware Creek Reservoir.

<u>Groundwater Resources</u>

Setting

The surface of the Virginia Coastal Plain consists of a series of broad, gently sloping, highly dissected north-south trending terraces, bounded by seaward-facing, ocean escarpments (Meng and Harsh, 1988). The geology is characterized by a series of southeastward dipping beds of marine and nonmarine sand, silt, clay, and gravel. This wedge of unconsolidated deposits ranges in thickness from only several feet near Richmond to over 2,000 feet near Hampton, Virginia. In western James City County this sediment veneer is estimated at 1,100 feet in thickness (Brown et al., 1972).

The unconsolidated sediments overlie a crystalline bedrock basement that also slopes gently to the east. In general, the stratigraphic section consists of a thick sequence of nonmarine sediments overlain by a thinner sequence of marine deposits. The age of the sediments range from Quaternary to Late Cretaceous.

The primary aquifers in order of increasing depth consist of the Quaternary or Columbia, the Yorktown, the Chickahominy-Piney Point, the Aquia, and the Cretaceous or Potomac system. Water occurs under leaky artesian conditions in the multi-layer aquifer system. The Columbia and Yorktown Aquifers are both exposed at the surface and in river and stream valleys throughout most of the Virginia Coastal Plain. Therefore, these individual units will be characterized with respect to the proposed reservoir location and the Pamunkey River intake.

Columbia Aquifer

The upper surface of the water table lies within this unit and ranges from several feet to as much as 40 feet below land surface. The aquifer thickness ranges from 10 to 60 feet and is estimated at 20 feet in the vicinity of the reservoir (Harsh, 1980). The aquifer is used for small water supplies with yield ranging from 3 to 30 gal/min (Lichtler and Wait, 1974). This unit contains approximately 25 to 60 billion gallons of water in storage in the James City County area, and water levels have not declined appreciably due to local or regional pumping. Estimated withdrawals from the Columbia Aquifer in 1983 totaled approximately 0.1 mgd in southeastern Virginia. The water table elevation currently ranges from approximately elevation 5 to 20 feet msl at the proposed location of the dam site (Gannett Fleming, 1992).

Because this aquifer lies at the surface, it is recharged directly by precipitation. Discharge is by evaporation and transpiration, seepage into rivers and streams, downward leakage to confined aquifers, and pumping. Water in the aquifer moves from areas of high elevation (generally corresponding to land-surface topographic highs) toward streams, lakes, and swamps. Because the sand intervals of this unit are recharged by local rainfall, this unit is subject to extreme fluctuation in water level during drought periods. The Columbia Aquifer is an important part of the hydrologic system because it is a source of recharge to the underlying multi-layer, confined aquifer system.

Table 4-6 summarizes water quality data for the Columbia Aquifer across the entire York-James Peninsula.

Yorktown Aquifer

Also referred to as the Yorktown-Eastover Aquifer, this unit is present throughout the coastal plain, except along stream valleys in the western third where it has been removed by erosion. The thickness of the aquifer is highly variable and generally depends on the elevation of the land surface. Thickness ranges from a featheredge at the up-dip limit to 160 feet at a well in the City of Hampton. The lithology of the aquifer varies from gravelly-to-silty sand, interbedded with silt, clay, and shell. West of James City County this aquifer is the water-table aquifer and is overlain by the Yorktown confining unit in James City County and to the east.

TABLE 4-6

SUMMARY OF WATER QUALITY ANALYSES FROM COLUMBIA AQUIFER IN THE YORK-JAMES PENINSULA

Water Quality Constituent	N	Maximum	Minimum	Mean	Median	Standard Deviation
Calcium, dissolved, mg/l	17	86.00	2.90	42.21	43.00	25.51
Magnesium, dissolved, mg/l	17	14	.09	5.02	4.3	3.77
Potassium, dissolved, mg/l	12	4.3	.6	2.22	1.85	1.14
Sodium, dissolved, mg/l	13	55	5.2	25.2	20	16.55
Alkalinity as $CaCO_3$, mg/l	5	406	15	169.6	126	154.94
Chloride, dissolved, mg/l	19	93	9.7	34.28	27	22.48
Sulfate, dissolved, mg/l	17	29	1.32	9.81	6	9.13
Specific conductance, μs/cm	7	628	114	345.43	339	177.38
pH, standard units	15	8.05	6.5	7.56	7.8	.5
Nitrogen, nitrite plus nitrate dissolved, mg/l	1	__	--	--	<.01	--
Phosphate, ortho., dissolved, mg/l	0	__	--	--	--	--
Organic carbon, total, mg/l	0	__	--	--	--	--
Hardness, total as $CaCO_3$, mg/l	18	220	16	102.17	107.5	62.54
Fluoride, dissolved, mg/l	18	0.5			.21	--
Silica, dissolved, mg/l	13	40	6.6	21.31	20	11.14
Iron, total, μg/l	7	710	80	408.57	350	248.29
Iron, dissolved, μg/l	4	5200	90	1477.5	310	2484.17
Manganese, total, μg/l	5	5900	30	1250	70	2600
Manganese, dissolved, μg/l	2	610	200	405	405	--
Dissolved solids, residue at 180°C, mg/l	15	762	63	262	227	168

[N is number of samples, $CaCO_3$ is calcium carbonate, mg/l is milligrams per liter, μg/l is micrograms per liter, μs/cm is microsiemens per centimeter, °C is degrees Celsius, -- indicates insufficient number of constituent analyses, < indicates less than value shown.]

Source: Laczniak and Meng, 1988.

Water enters the aquifer by downward vertical leakage from the Columbia Aquifer and by groundwater flow from the west along the outcrop of the Pliocene and Miocene sediments. Discharge is likely by flow to the east to surface water bodies, slow downward leakage to underlying aquifers, and by pumping. Approximately 45 to 100 billion gallons of water is contained in storage in the aquifer (Harsh, 1980) with well yields ranging from 5 to 80 gallons per minute.

A summary of water quality data for the Yorktown-Eastover Aquifer across the entire York-James Peninsula is presented in Table 4-7. The Yorktown-Eastover Aquifer has not been used as a primary source of water supply in the project area because higher well yields have been developed in underlying aquifers. However, several domestic supply wells have been identified in the City of Williamsburg and the community of Norge in James City County.

Soil and Mineral Resources

Intake

In the vicinity of the proposed Pamunkey River intake site at Northbury, the major soil grouping present is the Altavista-Dougue-Pamunkey (Hodges et al., 1985). The two major soils expected to be affected are the Nevarc-Remlik complex and the Pamunkey Fine Sandy Loam, the latter soil is considered a prime agricultural soil (Hodges et al., 1985). There are no mineral resources presently mined at or near the proposed intake facility site (Virginia Division of Mineral Resources (VDMR), 1976; Sweet and Wilkes, 1990).

Reservoir

Soils located within the proposed pool area of Ware Creek Reservoir constitute the affected environment. The major soil grouping in this area is the Emporia-Craven-Uchee soils (Hodges et al., 1985). These soils are found on mostly upland ridges and side slopes. Approximately 20 acres of these soils are considered prime agricultural soils. There are no mineral recovery facilities located within the vicinity of the proposed Ware Creek Reservoir area (VDMR, 1976; Sweet and Wilkes, 1990).

Construction of the Ware Creek Reservoir dam would disturb 42 acres of soil. The dam footprint would cover approximately 13 acres, while the emergency spillway would cover approximately 16 acres. Portions of the dam embankment and access roads would account for the remaining 13 acres of disturbed soil.

Pipeline

This alternative would include the construction of approximately 26.3 miles of raw water pipeline. Assuming a construction right-of-way (ROW) of 50 feet, the expected total soil disturbance for this alternative would be 159 acres. Table 4-8 lists the types of soils along the pipeline route that would be affected.

There are four pipeline outfall locations associated with this alternative. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Soil at this location consists of Johnston Mucky Loam (Hodges et al., 1985) which is included in the hydric soils list of Virginia (USDA, 1985). Because the Johnston series of soils are deep and poorly drained, flooding and ponding are typical for this area

TABLE 4-7

SUMMARY OF WATER QUALITY ANALYSES FROM YORKTOWN-EASTOVER AQUIFER IN THE YORK-JAMES PENINSULA

Water Quality Constituent	N	Maximum	Minimum	Mean	Median	Standard Deviation
Calcium, dissolved, mg/l	34	261.00	1.80	59.93	65.50	45.18
Magnesium, dissolved, mg/l	34	39	.1	5.82	3.45	8.02
Potassium, dissolved, mg/l	25	16	.8	4.4	2.6	4.11
Sodium, dissolved, mg/l	26	804	3.5	86.84	20.5	182.84
Alkalinity as $CaCO_3$, mg/l	11	294	12	154.18	167	82.79
Chloride, dissolved, mg/l	35	1190	3.1	96.47	21.5	248.53
Sulfate, dissolved, mg/l	35	119	1.13	16.24	9.9	21.32
Specific conductance, μs/cm	18	4380	285	720.89	427	938.04
pH, standard units	21	8.9	7.1	7.63	7.55	.42
Nitrogen as NO_2 + NO_3, dissolved, mg/l	4	.25	<.01	--	.1	--
Phosphate, ortho., dissolved, mg/l	5	.52	<.01	--	.09	--
Organic carbon, total, mg/l	1	--	--	--	4.6	--
Hardness, total as $CaCO_3$, mg/l	30	812	5.	170.71	165	139.14
Fluoride, dissolved, mg/l	29	.9	<.01	--	.1	--
Silica, dissolved, mg/l	26	40	9.7	18.04	15.5	8.48
Iron, total, μg/l	11	8700	30	1909.09	710	3677.08
Iron, dissolved, μg/l	13	120	<.01	--	20	--
Manganese, total, μg/l	3	210	40	123.33	120	85.05
Manganese, dissolved, μg/l	2	170	110	140	140	--
Dissolved solids, residue at 180°C, mg/l	29	2280	108	328	248	390

[N is number of samples, $CaCO_3$ is calcium carbonate, mg/l is milligrams per liter, μg/l is micrograms per liter, μs/cm is microsiemens per centimeter, °C is degrees Celsius, -- indicates insufficient number of constituent analyses, < indicates less than value shown.]

Source: Laczniak and Meng, 1988.

TABLE 4-8

WARE CREEK RESERVOIR ALTERNATIVE SOILS WITHIN THE PIPELINE ROUTE

Map * Symbol	Soil Name	Description
1A	Altavista	Fine sandy loam, 0-2 % slopes. Very deep, nearly level, moderately well drained
2A	Altavista-Dogue complex	0-2% slopes. Very deep, nearly level, moderately well drained
3A	Augusta	Fine sandy-loam, 0-2% slopes. Very deep, nearly level, poorly drained
5A	Bojac	Loamy-sand, 0-2% slope. Very deep, nearly level, well drained
6B	Caroline	Loam, 2-6% slope. Very deep, gently sloping, well drained
7B	Caroline-Emporia complex	2-6% slope. Very deep, gently sloping, well drained. On broad upland ridges
7C	Caroline-Emporia complex	6-10% slope. Very deep, gently sloping, well drained. On broad upland ridges
9A	Conetoe	Loamy sand., 0-4% slopes. Very deep, nearly level, well drained. On low river terraces
10B	Craven	Loam, 2-6% slope.Very deep, gently sloping, moderately well drained
10C	Craven	Loam, 6-10% slopes. Very deep, strongly sloping, moderately well drained
11B	Craven-Caroline complex	2-6% slopes. Very deep, gently sloping soils. On narrow ridgetops and side slopes
12B	Craven-Uchee complex	2-6% slope. Very deep, gently sloping. On narrow ridgetops.
13A	Dogue	Fine sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained
15B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, well drained
16A	Johnston	Mucky-loam, 0-2% slopes. Very deep, nearly level. very poorly drained
18B	Kempsville	Gravelly fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
19C	Kempsville-Emporia complex	6-10% slopes. Very deep, strongly sloping, well drained. On upland ridges
20B	Kempsville-Suffolk complex	2-6% slope. Very deep, gently sloping, well drained. On medium upland ridges
21A	Lanexa	Mucky-silty clay, 0-1% slope, frequently flooded. Deep, nearly level, poorly drained
23A	Munden	Sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained. On ridges
26D	Nevarc-Remlic complex	6-15 % slope. Very deep, moderately steep. On side slopes along rivers
26E	Nevarc-Remlic complex	15-25% slopes. Very deep, steep. On sides of slopes along rivers and creeks
26F	Nevarc-Remlic complex	25-60% slopes. Very deep, very steep. On sides of slopes along rivers & creeks
28B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
30B	Pamunkey	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, and well drained
31A	Roanoke	Silt-loam, 0-2% slopes. Very deep, nearly level, and poorly drained
33A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, and moderately well drained
34B	Slagle-Emporia complex	0-2% slope. Very deep, gently sloping. On upland ridges and depressions
35A	State	Very fine sandy-loam., 0-2% slope. Very deep, nearly level, well drained
37A	Tarboro	Loamy sand, 0-4% slope. Very deep, nearly level to gentle slope and excessively drained
40B	Uchee	Loamy-fine sand, 2-6% slope. Very deep, gently sloping, and well drained
41B	Udorthents	Loamy, gentle slope. Consists of pits providing foundation materials and areas of landfills

Map ** Symbol	Soil Name	Description
10B	Craven	Loam, 2-6% slope.Very deep, gently sloping, moderately well drained
10C	Craven	Loam, 6-10% slopes. Very deep, strongly sloping, moderately well drained
11C	Craven-Uchee complex	6-10% slope. Moderately well drained Craven soil & well drained Uchee soil
14B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, well drained
15D	Emporia complex	10-15% slope. Deep, moderately well drained Emporia soils & similar soils over fossil shells
15E	Emporia complex	15-25% slope. Deep, steep, well drained Emporia soils & similar soils over fossil shells
15F	Emporia complex	25-50% slope. Deep, very steep, well drained Emporia soils & similar soils over fossil shells
17	Johnston complex	Mucky-loam, 0-2% slopes. Very deep, nearly level. very poorly drained
18B	Kempsville	Gravelly fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
20B	Kenansville	Loamy-fine sand, 2-6% slope. Deep, gently sloping, and well drained. On upland ridges
25B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
29A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
29B	Slagle	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, & moderately well drained
31B	Suffolk	Fine-sandy loam, 2-6% slope. Deep, gently sloping and well drained
34B	Uchee	Loamy-fine sand, 2-6% slope. Very deep, gently sloping, & well drained

* Source used for the identification of soil types was the Soil Survey of New Kent County, Virginia (Hodges et al, 1989)

** Source used for the identification of soil types was the Soil Survey of James City and York Counties and the City of Williamsburg, Virgina (Hodges et al, 1985) and it is common to find these soils mainly along streams where channel overflow is frequent. The second outfall would be located on Diascund Creek, approximately 0.6 river miles upstream of the normal pool area of Diascund Creek Reservoir. The soils found at this location are similar to those found at the first outfall location. The third outfall would be located on the Bird Swamp arm of Ware Creek Reservoir. The soil series at this location is Emporia Complex (Hodges et al., 1985). These soils are deep, very steep, well drained, and formed over layers of fossil shells. Emporia complex soils are typically found on side slopes along rivers, creeks, and drainage ways. The fourth outfall structure would be located on the France Swamp arm of Ware Creek Reservoir. Soils at this location are similar to those found at the third outfall location.

Air Quality

The intake and most of the pipeline would be located in New Kent County and the balance of the pipeline would be built in James City County. The reservoir would be located mostly in James City County with a portion extending into New Kent County. The VDAPC has classified New Kent County as attainment (or unclassifiable) for all criteria air pollutants. James City County has been classified as non-attainment for ozone and attainment for all other criteria air pollutants. Residential development near the proposed reservoir area might be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded.

4.2.2 Black Creek Reservoir with Pumpover from Pamunkey River

Substrate

Intake

The existing substrate that would be affected due to construction of the proposed intake facilities on the Pamunkey River is discussed in Section 4.2.1.

Reservoir

Substrates found in the proposed Black Creek Reservoir area originate from soils which are considered of the Coastal Plain Uplands, Side Slopes, and Upland Flood Plains category (Hodges et al., 1989). There are two soil groupings from this category affected by this alternative component, Caroline-Emporia and Nevarc-Remlik-Johnston.

Pipeline

The area of substrate disturbance at each minor stream crossing was assumed to be 2,500 square feet (pipeline ROW width (50 feet) multiplied by the length of pipeline crossing). Substrate types at the proposed pipeline crossings include: Johnston Mucky Loam, Roanoke Silt Loam, Slagle Fine Sandy Loam, Tomotely Loam, and substrates of the Nevarc-Remlik and Slagle-Emporia complexes.

There are two outfall locations associated with this component that would affect existing substrate. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Typical substrate found at this outfall site originates from Johnston Mucky Loam soil. The second outfall would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610.

The affected substrate is similar to the substrate found at the first outfall location.

Water Quality

Intake

Existing water quality conditions at the proposed Pamunkey River intake site are discussed in Section 4.2.1.

Reservoir

Potential reservoir water quality concerns exist due to the growing presence of homes in close proximity to the proposed reservoir boundaries. Examination of aerial photography flown in March 1989, review of New Kent County plats of subdivision and 1992 House Numbering Maps, and a windshield survey conducted in June 1992 confirm that the Clopton Forest residential subdivision borders the western edge of the proposed Southern Branch Black Creek reservoir site. This large subdivision has the potential to impact reservoir water quality by contributing non-point source runoff. No point source discharges have been identified within the proposed reservoir watershed.

Estimates of the water quality for Black Creek in this report are based on water quality information from Crump Creek and Matadequin Creek. Crump Creek is a tributary of the Pamunkey River located in central Hanover County east of U.S. Route 301 and northeast of the City of Richmond. Matadequin Creek is also a tributary of the Pamunkey River and, near its mouth, is located on the New Kent County - Hanover County line. Matadequin Creek flows into the Pamunkey River approximately 0.2 river miles upstream of Northbury. Water quality data for Crump Creek and Matadequin Creek were used as surrogates for Black Creek water quality conditions because all three creeks have similar watershed areas, topography (morphology), and land use within the watershed areas. This information is used only as a best estimate of existing water quality for Black Creek and is not intended to represent the actual water quality. Water quality data for Crump Creek and Matadequin Creek are summarized in Tables 4-9 and 4-10, respectively.

Pipeline

The construction of 19.6 miles of pipeline for this alternative would involve 34 stream/wetland area crossings. One major crossing of an arm of Little Creek Reservoir would also be required. Under this alternative, Pamunkey River withdrawals would either be pumped to Black Creek Reservoir for intermediate storage or directly to Diascund Creek Reservoir headwaters. Average flow at the point of discharge on Diascund Creek is estimated at 1.0 mgd. The maximum proposed discharge at this point is 40 mgd for this alternative.

Water quality data for the Pamunkey River near the proposed intake site are presented in Table 4-1. Water quality data from Diascund Creek are included in Table 4-2.

Hydrology

Intake

The hydrologic characteristics of the Pamunkey River in the vicinity of the proposed Northbury intake site are described in Section 4.2.1.

TABLE 4-9

CRUMP CREEK WATER QUALITY

Parameter		Units	Number Samples	Mean	Minimum	Maximum
pH		SI	12	6.3	6.1	6.6
Alkalinity		mg/l	12	5.3	2.5	7.0
Hardness		mg/l	12	16	12	22
Total Dissolved Solids	(TDS)	mg/l	12	47	33	60
Biochemical Oxygen Demand	(BOD_5)	mg/l	11	1.6	0.9	3.9
Total Organic Carbon	(TOC)	mg/l	12	6.8	4.2	10.5
Total Phosphorus	(TP)	mg/l	12	0.066	0.028	0.100
Orthophosphate	(OPO_4)	mg/l	12	0.03	0.01	0.09
Total Nitrogen	(TN)	mg/l	2	1.22	0.94	1.49
Nitrate	(NO_3)	mg/l	12	0.298	0.111	0.480
Total Kjeldahl Nitrogen	(TKN)	mg/l	12	0.9	0.2	3.6
Ammonia	(NH_3)	mg/l	12	< 0.3	0.1	0.6
Chloride	(Cl)	mg/l	12	8.7	5.7	17
Fluoride	(F)	mg/l	12	< 0.15	< 0.10	0.27
Arsenic	(As)	mg/l	12	< 0.0021	< 0.0005	0.0039
Barium	(Ba)	mg/l	12	< 0.13	< 0.05	0.20
Calcium	(Ca)	mg/l	12	2.14	1.55	2.65
Cadmium	(Cd)	mg/l	12	< 0.005	< 0.002	0.005
Chromium	(Cr)	mg/l	12	< 0.016	< 0.005	0.050
Copper	(Cu)	mg/l	12	< 0.009	< 0.005	0.010
Iron	(Fe)	mg/l	12	2.07	1.10	3.18
Lead	(Pb)	mg/l	12	< 0.04	< 0.02	0.05
Magnesium	(Mg)	mg/l	12	1.18	0.76	1.40
Manganese	(Mn)	mg/l	12	0.066	0.035	0.094
Mercury	(Hg)	mg/l	12	< 0.0005	< 0.0005	< 0.0005
Selenium	(Se)	mg/l	12	< 0.0021	< 0.0005	0.0030
Silver	(Ag)	mg/l	12	< 0.006	< 0.002	0.010
Sodium	(Na)	mg/l	12	5.0	3.9	9.2
Zinc	(Zn)	mg/l	12	0.010	0.005	0.018

Source: Crump Creek Reservoir Project Development Report, Black and Veatch, Inc., 1989.

TABLE 4-10

MATADEQUIN CREEK WATER QUALITY

Parameter		Units	Number Samples	Mean	Minimum	Maximum
pH		SI	11	6.4	5.4	7.2
Alkalinity		mg/l	9	10	8	13
Hardness		mg/l	7	28	20	44
Total Dissolved Solids	(TDS)	mg/l	9	48	35	59
Turbidity		JTU	5	6.9	4.1	12
Specific Conductance		µS/cm	9	54	46	58
Dissolved Oxygen	(DO)	mg/l	10	8.9	6.5	12.7
Fecal Coliform		/100 mL	6	107	< 100	500
Biochemical Oxygen Demand	(BOD_5)	mg/l	9	1.9	1	4
Total Organic Carbon	(TOC)	mg/l	8	4.8	2.2	6.9
Total Phosphorus	(TP)	mg/l	8	< 0.1	< 0.1	0.14
Orthophosphate	(OPO_4)	mg/l	4	< 0.04	< 0.04	0.05
Nitrate	(NO_3)	mg/l	9	0.15	0.02	0.41
Total Kjeldahl Nitrogen	(TKN)	mg/l	9	0.5	0.3	0.6
Ammonia	(NH_3)	mg/l	9	< 0.04	< 0.04	0.07
Chloride	(Cl)	mg/l	7	5	4	6
Fluoride	(F)	mg/l	7	< 0.1	< 0.05	0.25
Arsenic	(As)	mg/l	9	< 0.01	< 0.01	< 0.01
Cadmium	(Cd)	mg/l	9	< 0.01	< 0.01	< 0.01
Chromium	(Cr)	mg/l	7	< 0.01	< 0.01	< 0.01
Copper	(Cu)	mg/l	7	< 0.01	< 0.01	< 0.01
Iron	(Fe)	mg/l	7	2.2	1.1	3.1
Lead	(Pb)	mg/l	7	< 0.01	< 0.01	< 0.01
Manganese	(Mn)	mg/l	7	0.062	0.041	0.090
Nickel	(Ni)	mg/l	7	< 0.01	< 0.01	< 0.01
Zinc	(Zn)	mg/l	7	< 0.01	< 0.01	0.011

Source: USEPA STORET data retrieval in Janua., 1993 for period August 1990 - November 1992.

Reservoir

Two tributaries of Black Creek, the Southern Branch Black Creek and the eastern branch of Black Creek, drain a combined watershed of 5.47 square miles above the two proposed dam sites.

Black Creek flows in a northerly direction into the Pamunkey River. The hydrologic system of the drainage area primarily consists of non-tidal, perennial, and intermittent streams. While drainage from the Southern Branch Black Creek is interrupted by a minor impoundment, Crumps Millpond, flow from the remainder of the proposed Black Creek Reservoir drainage area is unobstructed by manmade impoundments.

For this analysis it is assumed that all streams up to the proposed normal pool elevation of 100 feet msl would be affected. A total of 13.7 river miles of perennial and intermittent streams are located within the proposed reservoir pool area up to elevation 100 feet msl. Data concerning the stream system within the drainage area are presented in Table 4-11.

To estimate existing combined streamflow at the proposed dam sites, the streamflow record from Totopotomoy Creek near Studley (10/77 to 9/90) was adjusted to the contributing reservoir drainage area of 5.47 square miles. Average combined streamflow at the proposed dam sites is estimated to be 3.8 mgd.

Pipeline

The construction of 19.6 miles of pipeline would be required for this alternative component. The pipeline would cross 34 stream/wetland areas. One major crossing of an arm of Little Creek Reservoir would also be required. This alternative would also involve a raw water discharge into a perennial segment of the headwaters of Diascund Creek. Existing average streamflow was estimated based on the same streamflow record listed previously in the description of Ware Creek Reservoir streamflows (Section 4.2.1), and was adjusted to the drainage area at the point of discharge. Based on an estimated contributing drainage area of 1.6 square miles at Diascund Creek Outfall Site 1, average streamflow at this point is estimated at 1.0 mgd.

Field studies were conducted in July 1992 and January 1993 to obtain stream cross-sectional measurements at the proposed raw water discharge location on Diascund Creek. To identify the potential hydrologic impacts of the proposed raw water discharge to Diascund Creek, Manning's Equation for Open Channel-Uniform Flow was used to approximate the depth of flow which could result from a raw water discharge in the vicinity of Inspection Sites 1 and 2.

At Outfall Site 1 on Diascund Creek, estimated average discharge would be 1.0 mgd based on a 1.6-square mile drainage area. It is assumed that the maximum discharge would be the maximum pipeline capacity (40 mgd) plus the estimated average discharge at the site. Therefore, maximum discharge at Outfall Site 1 during pumpover operations is assumed to be 41 mgd. Diascund Creek Outfall Site 1, based on Manning's Equation, has an estimated channel capacity of at least 53 mgd. Therefore, the existing channel should be capable of accommodating maximum flows during pumpover operations.

TABLE 4-11

BLACK CREEK RESERVOIR STREAM ORDER ANALYSIS

Stream Order [1]	River Miles		Total
	Perennial [2]	Intermittent [3]	
First	0.34	7.04	7.38
Second	4.39	0.54	4.93
Third	1.43	0.00	1.43
		Total	13.74

1 Smallest tributaries are classified as "order 1". The point at which two first order streams join the channel is the beginning of a second order segment, and so on.

2 A perennial stream maintains water in its channel throughout the year.

3 An intermittent stream flows only in direct response to precipitation. It may be dry for a large part of the year, ordinarily more than three months.

Groundwater Resources

The geologic and hydrogeologic setting for this reservoir alternative is the Virginia Coastal Plain Physiographic Province. This location, is therefore, very similar to that already described for the Ware Creek Reservoir alternative component. At the proposed location of the two-dam reservoir alternative, the Columbia Aquifer is reportedly thin to absent. The Yorktown Aquifer and overlying Yorktown confining unit, are therefore, the primary surficial hydrogeologic units at the proposed project site. The general characteristics of this unit are described in Section 4.2.1.

Soil and Mineral Resources

Intake

The affected environment for the Pamunkey River intake, located at the Northbury site, is discussed in Section 4.2.1.

Reservoir

Generally, the soils found in the proposed Black Creek Reservoir area are considered of the Coastal Plains Uplands, Side Slopes, and Upland Flood Plains category (Hodges et al., 1989). There are two soil groupings that would be affected by construction of the proposed Black Creek Reservoir, Caroline-Emporia and Nevarc-Remlik-Johnston. Approximately 17 acres of these soils are considered prime agricultural soils.

Construction of the Black Creek Reservoir dam would disturb 48.5 acres of soil. The dam footprint would cover approximately 23.4 acres, while the emergency spillway would cover approximately 8 acres. Portions of the dam embankment and access roads would account for the remaining 17.1 acres of disturbed soil.

There are no known mineral recovery facilities that would be affected by the construction of the proposed reservoir (VDMR 1976; Sweet and Wilkes, 1990).

Pipeline

Construction of the 19.6 miles or raw water pipelines associated with this alternative would cause the disturbance of approximately 119 acres of soils. Associated with the pipeline are two raw water outfall locations. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Johnston Mucky Loam soil is present at this site (Hodges et al., 1989) which is included in the hydric soils list of Virginia (USDA, 1985). These soils are nearly level, very poorly drained, and have generally formed over layers of shell. They are usually found on flood plains and along major drainageways. The second outfall location would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610. The affected soil is similar in type to the soils found at the first outfall location. Table 4-12 lists the type of soils affected by the pipeline and outfall structures.

TABLE 4-12

BLACK CREEK RESERVOIR ALTERNATIVE

SOILS WITHIN THE PIPELINE ROUTE

Map * Symbol	Soil Name	Description
1A	Altavista	Fine sandy loam, 0-2 % slopes. Very deep, nearly level, moderately well drained
2A	Altavista-Dogue complex	0-2% slopes. Very deep, nearly level, moderately well drained
3A	Augusta	Fine sandy-loam, 0-2% slopes. Very deep, nearly level, poorly drained
5A	Bojac	Loamy-sand, 0-2% slope. Very deep,nearly level, well drained
6B	Caroline	Loam, 2-6% slope. Very deep, gently sloping, well drained
7B	Caroline-Emporia complex	2-6% slope. Very deep, gently sloping, well drained. On broad upland ridges
7C	Caroline-Emporia complex	6-10% slope. Very deep, gently sloping, well drained. On broad upland ridges
9A	Conetoe	Loamy sand., 0-4% slopes. Very deep, nearly level, well drained. On low river terraces
10C	Craven	Loam, 6-10% slopes. Very deep, strongly sloping, moderately well drained
11B	Craven-Caroline complex	2-6% slopes. Very deep, gently sloping. On narrow ridgetops and side slopes
13A	Dogue	Fine sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained
15B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently slpoing, well drained
16A	Johnston	Mucky-loam, 0-2% slopes. Very deep, nearly level, very poorly drained
18B	Kempsville	Gravelly fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
19C	Kempsville-Emporia complex	6-10% slopes. Very deep, strongly sloping, well drained. On upland ridges
21A	Lanexa	Mucky-silty clay, 0-1% slope, frequently flooded. Deep, nearly level, poorly drained
23A	Munden	Sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained. On ridges
26D	Nevarc-Remlic complex	6-15 % slope. Very deep, moderately steep. On side slopes along rivers
26E	Nevarc-Remlic complex	15-25% slopes. Very deep, steep. On sides of slopes along rivers and creeks
26F	Nevarc-Remlic complex	25-60% slopes. Very deep, very steep. On sides of slopes along rivers & creeks
28B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
30B	Pamunkey	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, and well drained
31A	Roanoke	Silt-loam, 0-2% slopes. Very deep, nearly level, and poorly drained
33A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
34B	Slagle-Emporia complex	0-2% slope. Very deep, gently sloping. On upland ridges and depressions
37A	Tarboro	Loamy sand, 0-4% slope. Very deep, nearly level to gentle slope & excessively drained
41B	Udorthents	Loamy, gentle slope. Consists of pits providing foundation materials & areas of landfills

Map ** Symbol	Soil Name	Description
10B	Craven	2-6% slopes. Very deep, gently sloping, moderately well drained
11C	Craven	6-10% slopes. Very deep, strongly sloping, moderately well drained
14B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently slpoing, well drained
15E	Emporia	15-25% slopes. Very deep, well drained.
15F	Emporia	25-50% slopes. Very deep, well drained.
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
25B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
27	Peawick	0-3% slope. Deep and moderately well drained.
29A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
29B	Slagle	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, & moderately well drained
31B	Suffolk	Fine sandy-loam, 2-6% slopes. Deep, well drained.
34B	Uchee	Loamy fine-sand, 2-6% slopes. Deep, well drained.

* Source used for the identification of soil types was the Soil Survey of New Kent County, Virginia (Hodges et al, 1989)

** Source used for the identification of soil types was the Soil Survey of James City and York Counties, and the City of Williamsburg, Virginia (Hodges et al, 1985)

Air Quality

The intake, reservoir and most of the pipeline would be located in New Kent County and the balance of the pipeline would be built in James City County. The air quality in New Kent County is considered satisfactory while James City County is not in attainment of the ozone ambient air quality standard. There is residential development near the proposed reservoir area which might be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded.

4.2.3 King William Reservoir with Pumpover from Mattaponi River

Four dam configurations are being presented with the King William Reservoir with pumpover from the Mattaponi River alternative: KWR I, KWR II, KWR III, and KWR IV. The intake site and the majority of the pipeline route for all four dam configurations are the same; only the dam location and reservoir pool elevation vary. The normal pool elevation for the KWR I project configuration is 90 feet msl, and the normal pool elevation for all other project configurations is 96 feet msl. Unless otherwise specified, physical resources are the same for all dam configurations of the King William Reservoir alternative. The river water pipeline between the river pumping station and the reservoir, and the portion of the pipeline route from the directional drill under the Pamunkey River to Diascund Reservoir, then from Diascund Reservoir to Little Creek Reservoir, remains as proposed in the DEIS for all configurations. The entire pipeline for KWR I remains a gravity pipeline with the route as proposed in the DEIS. KWR II, III, and IV will be pumped pipelines with new portions of pipeline routes identified from each proposed pump station to the Pamunkey River directional drill location. In addition, the outfall location into Diascund Reservoir for KWR II, III, and IV has been extended downstream of that proposed in the DEIS for KWR I.

Substrate

Intake

Lanexa Mucky Silty Clay appears to be the parent soil of the affected river substrate in the vicinity of the proposed pump station.

Reservoir

Soils located within the proposed pool area of King William Reservoir are the parent material for the substrate that would be affected by construction of King William Reservoir. Generally, the substrates in this area originate from soils which are categorized as Coastal Plain Uplands, Side Slopes, and Upland Flood soils (Hodges et al., 1985) The major grouping is Nevarc-Remlik-Johnston.

Pipeline

The area of substrate disturbance at each minor stream/wetland crossing was assumed to be 2,500 square feet (pipeline ROW width (50 feet) multiplied by the length of the crossing). There are two raw water outfall locations associated with this alternative that are expected to affect aquatic ecosystem substrate. The first outfall would be located 1.3 river miles upstream of the normal pool area of Diascund Creek Reservoir on Beaverdam Creek for the KWR I project configuration, and 0.8 river miles upstream of the reservoir for all other project configurations. Substrate at this outfall location originates from Johnston Mucky Loam soil. The second raw water outfall location would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route

610. The affected substrate is the same as that found at the first outfall location. Substrate types at the proposed crossings and outfall locations include: Altavista and Slagle Fine Sandy Loams, Johnston Mucky Loam, Matten Muck, Munden Sandy Loam, Roanoke Silt Loam, Tetotum soils, Tomotely Loam, Daleville soils, and soils of the Nevarc-Remlik and Bibb-Kinston complexes. Johnston Mucky Loam, Matten Muck, Roanoke Silt Loam, Tomotely Loam and Daleville soils are included in the hydric soils list of Virginia (USDA, 1985).

Water Quality

Intake

All surface waters within the Mattaponi River basin have been designated as "effluent limited" by the SWCB (SWCB, 1992). Well downstream of Scotland Landing, in the estuarine portion of the river from Clifton to West Point, the Mattaponi River is designated as "nutrient enriched."

There are currently no SWCB-designated "major" municipal or industrial discharges in the Mattaponi River basin. In addition there are no point sources in the SWCB-designated "Mattaponi River-Walkerton Waterbody" which Scotland Landing falls within. Southern International Company operated a wood preserving facility in King and Queen County which had a permitted stormwater discharge to Dickeys Swamp at U.S. Route 360. This waterbody is a tributary of Garnetts Creek which flows into the Mattaponi River across from Scotland Landing. The owner of this facility declared bankruptcy and the facility is now inactive. The USEPA has since been in charge of a site cleanup since some containers leaked onto a concrete bermed area. This site cleanup has been completed and the facility is now idle. The discharge permit was reissued in 1995 and is valid for an additional 5 years. As of October 1996, the facility had remained inactive (D. Barnes, VDEQ, personal communication, 1996).

The SWCB maintains a water quality monitoring station on the Mattaponi River at the Walkerton Bridge (State Route 629), approximately 5 river miles upstream of Scotland Landing. According to the ***Virginia Water Quality Assessment 1990 - 305(b) Report to EPA and Congress*** (SWCB, 1990), there were no violations of water quality standards at this station. In addition, no point sources were known to affect this station. There were also no violations of the water quality standards reported for the Mattaponi River-Walkerton Waterbody in the ***Virginia Water Quality Assessment for 1992 - 305(b) Report to EPA and Congress*** (SWCB, 1992).

Available water quality data were compiled for the Mattaponi River at Scotland Landing (River Mile 24.2), Mantua Ferry (River Mile 24.5), and Walkerton (River Mile 29.1). Water quality for these three stations are summarized in Tables 4-13 through 4-15. These data were collected between Years 1972 and 1991.

Reservoir

Estimates of the water quality for Cohoke Creek in this report are based on water quality information from Crump Creek and Matadequin Creek. Crump Creek is a tributary of the Pamunkey River located in central Hanover County east of U.S. Route 301 and northeast of the City of Richmond. Matadequin Creek is also a tributary of the Pamunkey River and, near its mouth, is located on the New Kent County - Hanover County line. Matadequin Creek flows into the Pamunkey River approximately 0.2 river miles upstream of Northbury. Water quality data for Crump Creek and Matadequin Creek were used as surrogates for Cohoke Creek water quality conditions because all

TABLE 4-13

MATTAPONI RIVER WATER QUALITY AT SCOTLAND LANDING

Parameter	Units	Mean	Std. Dev.	Min.	Max.	Number Samples
Temperature	C	25.1	3.8	13.9	30.0	35
pH	SI	6.53	0.35	5.6	7.5	34
Dissolved Oxygen	mg/l	5.96	0.91	4.9	8.8	35
BOD_5	mg/l	1.27	0.67	0.3	2.0	7
Fecal Coliforms	/100 ml	283	996	< 100	6000	35
Alkalinity	mg/l	9.0	0.0	9.0	9.0	1
Ammonia	mg/l	BDL	-	BDL	BDL	21
Nitrate	mg/l	0.143	0.077	0.030	0.320	21
Total Kjeldahl Nitrogen	mg/l	0.365	0.109	0.200	0.500	20
Total Phosphorus	mg/l	0.114	0.065	<0.10	0.40	21
Chloride	mg/l	21.9	57.2	2	300	29
Arsenic	μg/l	BDL	-	BDL	BDL	3
Cadmium	μg/l	BDL	-	BDL	BDL	7
Chromium	μg/l	BDL	-	BDL	BDL	11
Copper	μg/l	11.8	6.0	< 10	30	11
Lead	μg/l	BDL	-	BDL	BDL	10
Mercury	μg/l	0.52	0.06	<0.5	0.7	11
Nickel	μg/l	BDL	-	BDL	BDL	3
Zinc	μg/l	23.6	38.8	< 10	190	25

Source: USEPA STORET data retrieval in May 1989 for period June 1972-October 1975.

Notes: BDL = Below Detection Limit

TABLE 4-14

MATTAPONI RIVER WATER QUALITY AT MANTUA FERRY

Parameter	Units	Level
Temperature	C	15
pH	SI	5.9
Turbidity	NTU	11.0
Total Organic Carbon	mg/l	7.5
Specific Conductance	μmhos/cm	68
Total Dissolved Solids	mg/l	51
Alkalinity	mg/l	6.0
Hardness	mg/l	15.3
Chloride	mg/l	7.5
Sodium	mg/l	9.4
Aluminum	μg/l	70
Chromium	μg/l	BDL
Copper	μg/l	BDL
Iron	μg/l	770
Lead	μg/l	BDL
Manganese	μg/l	30
Zinc	μg/l	46

Source: B. F. Goodrich laboratory analysis of sample collected by Malcolm Pirnie on January 24, 1989.

Note: BDL = Below Detection Limit.

TABLE 4-15

MATTAPONI RIVER WATER QUALITY AT WALKERTON

Parameter	Units	Number Samples	Mean
Temperature	(C)	139	19
pH	(SI)	114	6.7
Salinity	(g/l)	293	0.0017
Dissolved Oxygen	(mg/l)	139	7.5
Chlorophyll a	(μg/l)	42	5
Total Organic Carbon	(mg/l)	113	8.3
Total Kjeldahl Nitrogen	(mg/l)	118	0.58
Ammonia	(mg/l)	119	0.07

Source: Tributary Water Quality 1984-1987 Data Addendum - York River (SWCB, 1989) and more recent database updates.

three creeks have similar watershed areas, topography (morphology), and land use within the watershed areas. This information is used only as a best estimate of existing water quality for Cohoke Creek and is not intended to represent the actual water quality. Water quality data for Crump Creek and Matadequin Creek are summarized in Tables 4-9 and 4-10, respectively.

Available water quality data were compiled for Cohoke Creek over a one year time period. Samples were collected at the Route 626 Bridge on the creek between June 1995 and June 1996. Based on a review of the limited sampling results of Cohoke Creek listed in Table 4-15A, the data suggest that the water quality at Crump Creek and Matadequin Creek is representative of Cohoke Creek. The Cohoke Creek minimum value of 0.7 mg/l for the dissolved oxygen parameter, and maximum value of 0.13 mg/l for the orthophosphate, may reflect either the site specific conditions of the sampling location, or inefficient sampling techniques. The lower dissolved oxygen reading could be attributed to the seasonal anaerobic conditions associated with swamps, while the higher orthophosphate concentration could have resulted from high fertilizer use in the adjacent agricultural areas. The higher total organic carbon concentrations in Cohoke Creek could be explained by the high humic and fulvic acid concentrations typically found in swamp environments.

Within the Cohoke Creek watershed there is minimal existing or planned development. There are some concerns regarding groundwater quality and surface water runoff quality since portions of the King William County Landfill are located within the reservoir drainage area. This 85-acre landfill parcel is located above the proposed normal pool elevation (90 feet msl for KWR I; 96 feet msl for KWR II, III, and IV), along the south side of State Route 30, near the intersection of State Routes 30 and 640. Municipal solid waste (MSW) was deposited in the King William County Landfill from 1988 to 1994. In addition, Chesapeake Corporation disposed of a small quantity of pulp waste in the landfill. This type of waste is not known to pose any greater threat to the public health and environment than MSW when disposed of in a properly designed MSW facility. Closure construction began in the spring of 1994 and was completed in April 1995.

Pipeline

Under this alternative, Mattaponi River withdrawals would be pumped to King William Reservoir for intermediate storage. From King William Reservoir, raw water withdrawals would be conveyed by a gravity pipeline for the KWR I configuration, and pumped for the other project configurations, to the Diascund Creek Reservoir basin, for eventual transmission to Newport News Waterworks' terminal reservoirs. The construction of 17.0, 17.4, 18.2, and 18.7 miles of pipeline for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively, would involve 65, 60, 58, and 60 stream/wetland area crossings, respectively. In addition, the pipeline would cross the Pamunkey River and an arm of Little Creek Reservoir. The route for KWR I remains to the east of Cohoke Millpond prior to crossing the Pamunkey River, whereas the other configurations would follow a more direct path to the west of the Cohoke Creek and Cohoke Millpond.

The proposed discharge location in the Diascund Creek Reservoir basin would be near the headwaters of Beaverdam Creek. Existing average streamflow at this outfall site is estimated at 3.5 mgd for the KWR I configuration, and 4.1 mgd for all other project configurations. The maximum flow rate from the pipeline to Beaverdam Creek would be 40 mgd for the gravity pipeline associated with the KWR I configuration, and 50 mgd for the configurations that will use a reservoir pump station (KWR II, III, and IV). Water quality for Beaverdam Creek is routinely measured by the USGS at Station 02042736, which is at the State Route 632 crossing north of Interstate 64. This monitoring station is approximately 0.6 and 1.1 miles upstream from the proposed discharge location for the

TABLE 4-15A

COHOKE CREEK WATER QUALITY AT ROUTE 626 CROSSING

Parameter		Units	Number Samples	Mean	Minimum	Maximum
pH		SI	5	6.48	6.12	6.71
Alkalinity		mg/l	4	36	26	48
Hardness		mg/l	5	56	36	68
Turbidity		JTU	5	13.6	4.5	22
Specific Conductance		µS/cm	5	107	92	124
Dissolved Oxygen	(DO)	mg/l	5	6.2	0.7	9.5
Fecal Coliform		/100 mL	4	72.8	20 (<100)	110
Biochemical Oxygen Demand	(BOD_5)	mg/l	4	2.4	2	3
Total Organic Carbon	(TOC)	mg/l	5	55.6	36	68
Total Phosphorus	(TP)	mg/l	5	<0.1	< 0.1	0.16
Orthophosphate	(OPO_4)	mg/l	5	0.064	< 0.04	0.13
Nitrate	(NO_3)	mg/l	5	0.04	0.04	0.04
Total Kjeldahl Nitrogen	(TKN)	mg/l	5	0.5	0.2	0.7
Ammonia	(NH_3)	mg/l	5	0.04	0.04	0.04
Chloride	(Cl)	mg/l	4	6.2	5	7

Source: USEPA STORET data for period June 1995 - June 1996.

KWR I configuration, and remaining configurations, respectively. Water quality data for the station are summarized in Table 4-2.

Hydrology

Intake

The proposed intake site on the Mattaponi River at Scotland Landing would be located in King William County, approximately 24.2 river miles upstream of the mouth of the Mattaponi River. Tidal freshwater conditions exist at the proposed intake location. The estimated mean tidal range is 3.56 feet at Scotland Landing (Basco, 1996).

Contributing drainage area at Scotland Landing is approximately 781 square miles. The proposed 75-mgd maximum withdrawal capacity represents 15.2 percent of the estimated average freshwater discharge at Scotland Landing (494 mgd). More detailed streamflow characteristics of the Mattaponi River at the proposed intake site are presented in Table 3-B.

Reservoir

Cohoke Creek drains a watershed of 13.17, 11.45, 10.33, and 8.92 square miles above the proposed King William Reservoir dam site configurations KWR I, KWR II, KWR III, and KWR IV, respectively. The entire Cohoke Creek watershed has an estimated drainage area of 17.0 square miles. Cohoke Creek flows in a southeasterly direction into Cohoke Millpond, which is an existing impoundment downstream of the proposed dam site, and tributary to the Pamunkey River. The upper end of Cohoke Millpond and the Cohoke Millpond Dam itself are located approximately 0.4, 1.0, 1.9, and 2.1 river miles and 1.8, 2.4, 3.3, and 3.5 river miles, respectively, downstream of the proposed King William Reservoir dam site configurations KWR I, KWR II, KWR III, and KWR IV.

The hydrologic system of the proposed King William Reservoir drainage area primarily consists of non-tidal, perennial and intermittent streams. Flow from the King William Reservoir drainage area is, for the most part, unobstructed by manmade impoundments. However, in the central portion of the proposed reservoir site, the main channel of Cohoke Creek passes through a triple 10-foot by 10-foot box culvert underneath State Route 626. In addition, just upstream of the Route 626 crossing are the remains of the Valley Millpond Dam. Virginia Department of Transportation as-built plan and profile sheets for Route 626 (1959) show that the top of this old earthen dam had an average elevation of 40 feet msl when the area was surveyed in 1957. Immediately upstream of the remains of the old dam and the Route 626 embankment is a wide emergent wetland area which was presumably once an open water habitat known as Valley Millpond in 1919. The normal pool elevation of Valley Millpond was 37 feet msl as shown on the 1919 USGS topographic map.

For this analysis it is assumed that all streams up to the proposed normal pool elevation of 90 feet msl for the KWR I configuration, and 96 feet msl for all other configurations, would be affected. A total of 28.3, 26.5, 24, and 20.3 river miles of perennial and intermittent streams are located within the proposed reservoir pool area for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively. Data concerning the stream system within the drainage area are presented in Table 4-17.

To estimate existing streamflow at the proposed dam site, streamflow records from Piscataway Creek near Tappahannock (7/51 to 9/90) and Totopotomoy Creek near Studley (10/77 to 9/90) were adjusted to the contributing reservoir drainage area for the respective configurations. Average

TABLE 4-17

KING WILLIAM RESERVOIR STREAM ORDER ANALYSIS

Reservoir Configuration	Stream Order [1]	River Miles		Total
		Perennial [2]	Intermittent [3]	
KWR I	First	3.07	15.32	18.39
	Second	3.94	0.76	4.70
	Third	5.16	0.00	5.16
			Total	28.25
KWR II	First	3.07	15.28	18.35
	Second	3.18	0.38	3.56
	Third	4.59	0.00	4.59
			Total	26.50
KWR III	First	3.07	13.95	17.02
	Second	3.18	0.38	3.56
	Third	3.83	0.00	3.83
			Total	24.41
KWR IV	First	3.07	11.48	14.55
	Second	2.61	0.38	2.99
	Third	3.45	0.00	3.45
			Total	20.99

1 Smallest tributaries are classified as "order 1". The point at which two first order streams join the channel is the beginning of a second order segment, and so on.

2 A perennial stream maintains water in its channel throughout the year.

3 An intermittent stream flows only in direct response to precipitation. It may be dry for a large part of the year, ordinarily more than three months.

streamflow at the proposed dam site is estimated to be 9.3, 8.0, 7.3, and 6.2 mgd for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively.

Pipeline

The construction of 17.0, 17.4, 18.2, and 18.7 miles of pipeline for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively, would be required for this alternative component. The ~~pipeline would cross~~ 65, 60, 58, and 60 stream/wetland areas for the KWR I, II, III, and IV configurations, respectively. Two major stream crossings would also be required, and would include the Pamunkey River and an arm of Little Creek Reservoir.

This alternative component would also involve a raw water discharge into a perennial segment of the headwaters of Beaverdam Creek, which is a major tributary of Diascund Creek Reservoir. Existing average streamflow at this location was estimated based on the same streamflow record listed previously in the description of Ware Creek Reservoir streamflows (Section 4.2.1), and was adjusted to the drainage area at the point of discharge. Based on an estimated contributing drainage area of 5.4 and 6.4 square miles at the discharge location on Beaverdam Creek for the KWR I and all other configurations, respectively, average streamflow rates at these points are estimated to be 3.5 and 4.1 mgd.

Field studies were conducted in July 1992 and January 1993 to obtain stream cross-sectional measurements at the raw water discharge location on Beaverdam Creek. The proposed discharge location is approximately 0.75 river miles upstream of Interstate 64 and 1.3 river miles upstream of the normal pool area of Diascund Creek Reservoir for the KWR I configuration. The discharge location has been moved farther downstream to a site 0.3 miles upstream of Interstate 64, and 0.8 river miles upstream of the normal pool area of Diascund Creek Reservoir for the remaining configurations. Field studies of the downstream discharge location were conducted in September 1996.

To identify the potential hydrologic impacts of the proposed raw water discharge, Manning's Equation for Open Channel-Uniform Flow was used to approximate the depth of flow which could result from the discharge at each location.

At the proposed KWR-I outfall site, the estimated average annual stream discharge is 3.5 mgd based on a 5.4-square mile drainage area. It is assumed that the maximum discharge would be the maximum pipeline capacity (40 mgd), plus the estimated average discharge at the site. Therefore, maximum discharge at the outfall site during reservoir withdrawal operations is assumed to be 43.5 mgd. Based on Manning's Equation, the Beaverdam Creek outfall site has an estimated channel capacity of 43 mgd. Therefore, the existing channel should be capable of accommodating maximum flows during King William Reservoir withdrawal operations.

Daily flows at a USGS gaging station on Beaverdam Swamp near Ark in Gloucester County, Virginia were adjusted to acquire an estimate of the daily flows at the downstream discharge point on Beaverdam Creek. The flows were adjusted in proportion to the respective drainage areas. The drainage area at the USGS gaging station on Beaverdam Swamp is 6.6 square miles. Beaverdam Creek has a drainage area of 6.4 square miles at the pipeline discharge site associated with the KWR II, KWR III, and KWR IV configurations. Adjusting the daily flows recorded from October 1949 to September 1987 at the Beaverdam Swamp gage to the Beaverdam Creek drainage area results in an estimated average daily streamflow of 4.5 mgd. The maximum pipeline discharge rate for this site is 50 mgd.

To assess the erosion potential to the stream from the downstream pipeline discharge, a profile and cross-section survey was conducted from the discharge site to the open water of Diascund Creek Reservoir. Cross-sections were taken approximately every 500 feet along the stream. For a flow of 54.5 mgd (50 mgd peak pipeline discharge plus current average daily flow), the maximum flow velocity calculated at any section was 1.3 feet per second (fps). This velocity is generally non-erosive for all soil types. The bed and banks of Beaverdam Creek in this area are generally composed of stiff clay type soils. The Virginia Erosion and Sediment Control Handbook recommends a permissible velocity of 5.0 fps for excavated channels in stiff clay soils. The relatively low flow velocity is due partially to the relatively flat channel bottom slope from the pipeline discharge location to the reservoir.

The Beaverdam Creek channel bottom profile from State Route 249 to Diascund Creek Reservoir is illustrated in Figure 4-1A. The downstream pipeline discharge is located at an elevation (27.1 feet msl) that is between the Diascund Creek Reservoir normal pool (26.0 feet msl) and the Diascund Creek Reservoir elevation during a 100-year flood event (30.2 feet msl). This downstream discharge channel bottom location is only 1.1 feet above the normal pool elevation of the reservoir. At the point where the creek enters the open water of the reservoir, the main channel bottom is at elevation 22 feet msl. The resulting average channel bottom slope between the discharge point and the reservoir is approximately 0.1 percent, or 0.1 foot per 100 horizontal feet.

Groundwater Resources

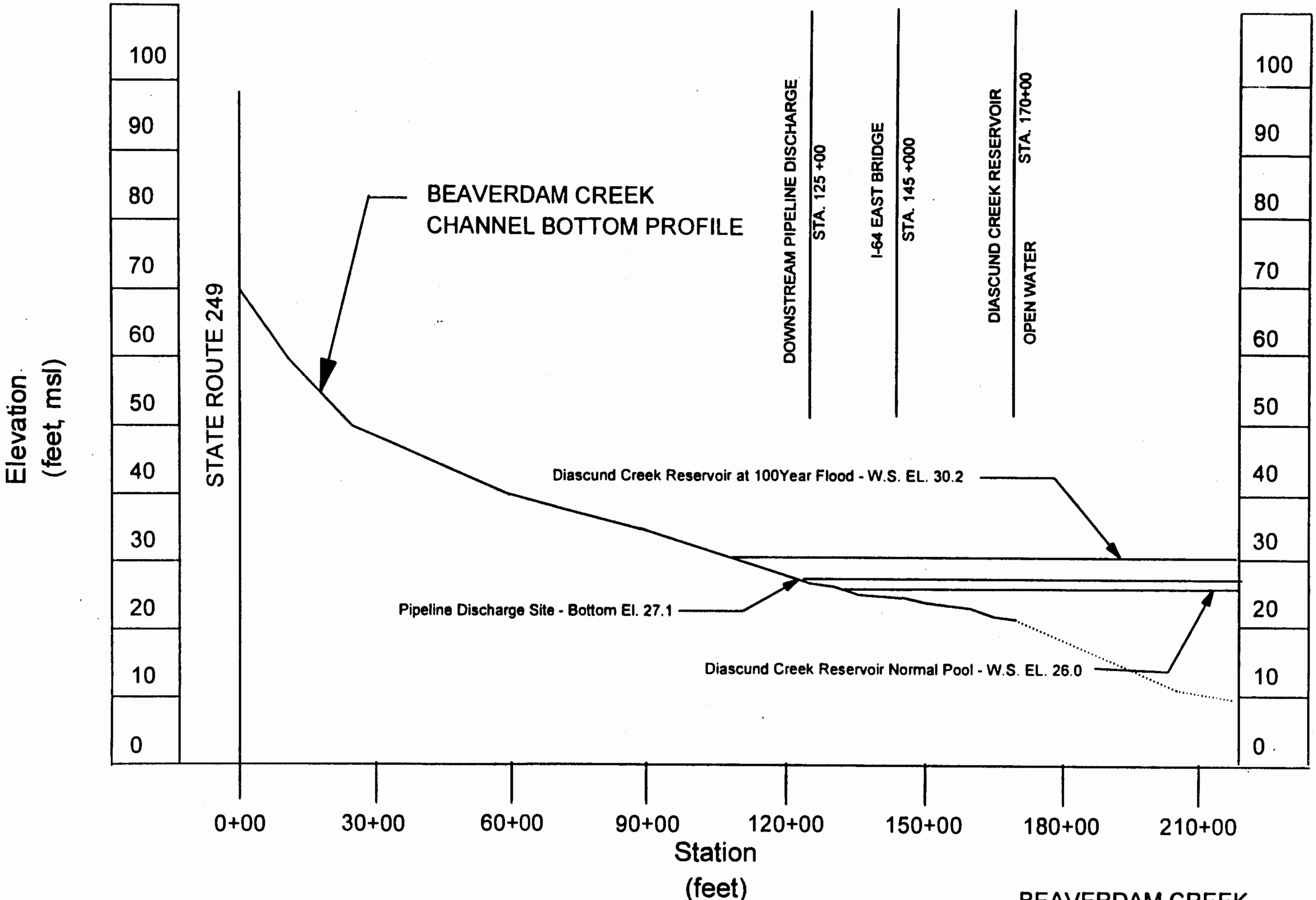
The general hydrogeologic setting applicable to this alternative is presented in Section 4.2.1.

Soil borings conducted by Mueser Rutledge Consulting Engineers (MRCE) in 1989 and Malcolm Pirnie in 1991, indicate that approximately 20 to 50 feet of the Columbia Aquifer is present overlying the Yorktown Formation in the vicinity of the proposed reservoir. The existing water table elevation ranges from approximately 50 to 95 feet msl across the watershed and adjacent uplands (MRCE, 1989). The permeability of the Columbia Aquifer in this area is reported as 1×10^{-2} cm/sec, and represents a substantial source of leakage (in the form of underseepage) from the reservoir. Beneath the sands of the Columbia Aquifer, Yorktown sediments have a reported 2×10^{-2} cm/sec permeability consisting of fine sand and occasional shells. The overlying Yorktown confining unit, consisting of a stiff green-gray silty clay, was encountered in only two of five borings, and therefore, is considered to be intermittent in this area. SWCB data files show that the unconsolidated water-table aquifers are an important source of domestic groundwater in the Middle Peninsula (Siydula et al., 1977). In addition, these aquifers when combined with the shallow Yorktown Aquifer system supply potable water for agriculture and other users in the area.

Soil and Mineral Resources

Intake

In the vicinity of the proposed Mattaponi River intake site at Scotland Landing, the major soil series present are Tetotum, Bojac, and Tarboro. Tetotum soil is very deep, nearly level, and moderately well drained. This soil is found on low terraces along the river. Bojac soil is very deep, nearly level, and well drained. It is on low stream terraces along the Mattaponi River. Tarboro soil is very deep, nearly level to gently sloping, and somewhat excessively drained. It is found mostly on low stream terraces along rivers and creeks. There are no important mineral resource recovery facilities located on or near the proposed intake facility site (VDMR, 1976; Sweet and Wilkes, 1990).



Source: ASC Topographic Mapping (1994)
USGS Walkers Quadrangle Map
Field Survey by Draper, Aden Assoc., Inc. (September, 1996)

BEAVERDAM CREEK
CHANNEL BOTTOM PROFILE
SCALE: HORIZ. 1"=3000'
VERT. 1"=20'

Figure 4-1A

11/26/96

Reservoir

Soils located within the proposed pool area of King William Reservoir constitute the affected environment. Nevarc-Remlik-Johnston appears to be the major soil association. Approximately 342, 298, 277, and 228 acres of these soils for the KWR-I, KWR-II, KWR-III, and KWR-IV configurations are considered prime agricultural soils. The area currently used for crop cultivation is negligible.

There are no mineral recovery facilities located in the vicinity of the proposed pool area of King William Reservoir. However, during 1975, sand and gravel were produced near Aylett, Virginia by the Fox Gravel Company for concrete and masonry purposes, highway construction and maintenance, and other use. This mining operation is located approximately 16 river miles upstream from the proposed Scotland Landing intake site. Presently, Aylett Sand and Gravel Corporation mines sand and gravel in Aylett (VDMR, 1976; Sweet and Wilkes, 1990).

Construction of the King William Reservoir dam, emergency spillway, reservoir pump station, access road, and associated structures would disturb 59, 52, 53, and 43 acres of soil for the KWR I, II, III, and IV project configurations, respectively. The dam footprint would cover approximately 18.5, 18.0, 17.7, and 14.2 acres for the KWR I, II, III, and IV project configurations, respectively. The emergency spillway would cover approximately 11, 10, 8, and 7 acres for the KWR I, II, III, and IV project configurations, respectively. The reservoir pumping station affiliated with the KWR II, III, and IV project configurations would disturb 3 acres of soil.

Pipeline

SCS soil survey maps were used in conjunction with USGS topographic maps to determine the types of soils that would be affected by construction of approximately 17.0, 17.4, 18.2, and 18.7 miles of raw water pipeline associated with the KWR-I, KWR-II, KWR-III, and KWR-IV configurations for this alternative.

There are two potential raw water outfall locations associated with the pipeline from King William Reservoir to Beaverdam Creek. These Beaverdam Creek outfall sites are located 1.3 and 0.8 river miles upstream of the normal pool area of Diascund Creek Reservoir for the KWR-I and all other configurations, respectively. The soil type at these locations is Johnston Mucky Loam. This soil is very deep, nearly level, and very poorly drained. It is on floodplains and along major drainageways throughout the survey area.

An outfall would also be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610. Soil types at this location are similar to those found at the first outfall location. Table 4-18 lists the types of soils that would be affected by the construction of the pipeline and the pipeline outfall structures.

Air Quality

The intake, reservoir and portions of the pipeline would be located in King William County with the balance of the pipeline being built in New Kent and James City Counties. King William and New Kent Counties have been classified as attainment (or unclassifiable) with acceptable levels of all criteria air pollutants. James City County has been classified as non-attainment for ozone and attainment for all other criteria air pollutants. There is little residential development near the proposed reservoir area which might be sensitive to construction activities. However, there are recreational uses

TABLE 4-18

KING WILLIAM RESERVOIR ALTERNATIVE

SOILS WITHIN THE PIPELINE ROUTE

Map * Symbol	Soil Name	Description
1A	Altavista	Fine sandy loam, 0-2 % slopes. Very deep, nearly level, moderately well drained
3A	Augusta	Fine sandy-loam, 0-2% slopes. Very deep, nearly level, poorly drained
7B	Caroline-Emporia complex	2-6% slope. Very deep, gently sloping, well drained on broad upland ridges
9A	Conetoe	Loamy sand, 0-4% slopes. Very deep, nearly level, well drained. On low river terraces
13A	Dogue	Fine sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained
16A	Johnston	Mucky-loam, 0-2% slopes. Very deep, nearly level, very poorly drained
22A	Matten	Muck, 0-1% slope. Deep, nearly level, and poorly drained. In freshwater swamps
23A	Munden	Sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained. On ridges
26D	Nevarc-Remlic complex	6-15 % slope. Very deep, moderately steep. On side slopes along rivers
26E	Nevarc-Remlic complex	15-25% slopes. Very deep, steep. On sides of slopes along rivers and creeks
26F	Nevarc-Remlic complex	25-60% slopes. Very deep, very steep. On sides of slopes along rivers & creeks
30B	Pamunkey	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, and well drained
35A	State	Very fine sandy-loam., 0-2% slope. Very deep, nearly level, well drained
38A	Tetotum	0-2% slopes. Very deep, nearly level, and moderately well drained
39A	Tomotely	Loam, 0-2% slope. Very deep, nearly level, poorly drained. On broad flats
41B	Udorthents	Loamy, gentle slope. Consists of pits providing foundation materials & areas of landfills

Map ** Symbol	Soil Name	Description
4D	Remlic-Suffolk complex	6-15% slope
4F	Remlic-Suffolk complex	15-50% slope
8A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
8B	Slagle	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, & moderately well drained
10A	Suffolk	Fine-sandy loam, 0-2% slope. Deep, gently sloping and well drained
10B	Suffolk	Fine-sandy loam, 2-6% slope. Deep, gently sloping and well drained
11A	Conetoe	Loamy sand, 0-4% slopes. Very deep, nearly level, and well drained
13B	Wickham	0-2% slope
14B	Bojac	Loamy sand, 2-6% slope. Very deep, nearly level, and well drained
15B	Kempsville	0-2% slope
21B	Kenansville	Loamy-fine sand, 0-4% slope. Deep, gently sloping, and well drained. On upland ridges
34A	Emporia	Fine-sandy loam, 0-2% slope. Very deep, gently sloping, well drained
38A	Craven	Loam, 0-2% slope. Very deep, gently sloping, moderately well drained
38B	Craven	Loam, 2-6% slope. Very deep, gently sloping, moderately well drained
61A	Roanoke	Silt-loam, 0-2% slope. Very deep, nearly level, and poorly drained
65	Daleville	0-2% slope
132A	Eunola	0-2% slope
145	Tomotely	Loam, 0-2% slope. Very deep, nearly level, poorly drained. On broad flats
149	Seabrook	Loamy sand, 0-2% slope. Very deep, nearly level, and moderately well drained

Map *** Symbol	Soil Name	Description
10B	Craven	2-6% slopes. Very deep, gently sloping, moderately well drained
11C	Craven	6-10% slopes. Very deep, strongly sloping, moderately well drained
14B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently sipoing, well drained
15E	Emporia	15-25% slopes. Very deep, well drained.
15F	Emporia	25-50% slopes. Very deep, well drained.
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
25B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
27	Peawick	0-3% slope. Deep and moderately well drained.
29A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
29B	Slagle	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, & moderately well drained
31B	Suffolk	Fine sandy-loam, 2-6% slopes. Deep, well drained.
34B	Uchee	Loamy fine-sand, 2-6% slopes. Deep, well drained.

* Source used for the identification of soil types was the Soil Survey of New Kent County, Virginia (Hodges et al, 1989)

** Source used for the identification of soil types was the Soil Survey of King William County, Virginia (Hodges et al, 1985)

*** Source used for the identification of soil types was the Soil Survey of James City and York Counties, and the City of Williamsburg, Virginia (Hodges et al, 1985) close down stream, in Cohoke Millpond, which could be sensitive to air quality impacts if fugitive dust emissions was not adequately controlled. No indication of a nuisance dust problem in the project development area has been recorded.

4.2.4 Fresh Groundwater Development

<u>Substrate</u>

Well Sites

Because all of the well sites associated with this alternative are located in upland areas, there would be no affect on aquatic ecosystem substrates.

Pipelines

Each well associated with this alternative has a corresponding pipeline which would transport water to an existing reservoir. These pipelines would not directly affect any aquatic ecosystem substrate.

The construction of the outfall structure associated with Well DC-1 would impact substrate originating from the Nevarc-Remlik complex. This soil type is very deep, with steep slopes of 15 to 25 percent.

The construction of the DC-2 well outfall structure would impact substrate originating from the Nevarc-Remlik complex. This soil type is similar to that located at the DC-1 location, distinguished only by the greater slopes of 25 to 60 percent.

The affected substrate located at the proposed DC-3 outfall location is the same as that found at the proposed DC-2 outfall location.

At the proposed DC-4 outfall location the affected substrate originates from the Emporia Complex soil. This soil type consists of Emporia soils and similar soils that are well drained and deposited over fossil shells. Slopes range from 15 to 25 percent.

The construction of the proposed outfall structures associated with Wells LC-1 and LC-3 would impact substrate originating from the Udorthents series of soils. These soils consist of deep, well drained and moderately well drained loamy soils. Slopes range from 2 to 30 percent.

The construction of the proposed outfall structures associated with Wells LC-2 and LC-4 would impact substrate originating from the Emporia complex. These soils are moderately well drained and are found deposited over fossil shells. Slopes range from 15 to 50 percent.

<u>Water Quality</u>

Based on results from a Test Well Program conducted for the City of Newport News Waterworks in 1988, approximately four deep production wells would be required in each of two well fields (Geraghty & Miller, 1988). The wells would be screened in the Middle Potomac aquifer at approximate depths of between 515 and 740 feet below msl.

Some groundwater quality data for the Potomac aquifers are available for both the Diascund Creek and Little Creek areas. Water quality data from the Diascund test well and two USGS monitoring wells adjacent to Little Creek Reservoir were used to represent groundwater quality characteristics for this alternative. Groundwater quality data for these wells are summarized in Table 4-19.

Phosphate concentration was not measured in the Diascund well and ranged from 0.03 to 0.06 mg/l in the Little Creek wells. Phosphorus concentration for the Little Creek discharge is not expected to be a problem. There appears, however, to be an increasing trend in groundwater phosphorus concentrations to the west, toward Diascund Creek. In the Delmarva Well, west of the Diascund well, phosphorus concentration averaged 0.29 mg/l. If the phosphorus concentration in the Diascund well is similar, the phosphorus loading could be considerable. The sodium concentration, like the chloride concentration, is also high in the groundwater. In the Diascund well, sodium concentration averages 273 mg/l and at Little Creek, sodium ranges from 450 mg/l in the deeper well to 100 mg/l in the shallower well.

Existing surface water conditions for Diascund Creek Reservoir are described in Section 4.2.1. Surface water quality data for Little Creek Reservoir are summarized in Table 4-20.

Hydrology

This alternative component would involve fresh groundwater withdrawals made from new well fields in western James City County and/or New Kent County. Up to 10 mgd of new permitted groundwater withdrawal capacity would be used to augment Diascund Creek and Little Creek reservoirs when Newport News Waterworks system reservoir volume is below 75 percent of total capacity. A discussion of the affected hydrologic regime for the Fresh Groundwater Withdrawals alternative is presented below in the description of Groundwater Resources.

Groundwater Resources

Setting

Fresh groundwater withdrawals have been targeted specifically for the Middle Potomac Aquifer. Due to the potential for impacts (via leakage) to the multi-aquifer system, the affected environment is not limited only to the Middle Potomac. A description of the general hydrogeologic setting of the Virginia Coastal Plain Province is included in Section 4.2.1. Table 4-21 summarizes the basic characteristics of the aquifers in the York-James Peninsula that would be affected.

Soil and Mineral Resources

Well Sites

Each individual well near Little Creek Reservoir would be located in an upland area. The first well, designated as LC-1, would be installed in Craven Uchee complex soils. These soils consist of moderately well drained Craven soils and well drained Uchee soils. Areas of this complex are on side slopes and narrow ridge tips. Well LC-2 would be installed in Emporia complex soils. This complex consists of areas of deep, very steep, well drained Emporia soils, and areas of similar soils that formed over layers of fossil shells. Well LC-3 would be installed in the Udorthents Loamy soil unit. This unit consists of deep, well drained, and moderately well drained loamy soil material in areas where the soils have been disturbed during past excavation and grading activities. Well LC-4 would be installed in soils similar to Well LC-1.

TABLE 4-19

DIASCUND CREEK AND LITTLE CREEK GROUNDWATER QUALITY

		Diascund Creek Test Well				James City County Wells	
Parameter	Units	Number Samples	Mean	Minimum	Maximum	56h25	56h26
pH		5	8.1	8.0	8.1	7.8	7.9
Conductivity	μMHOs/cm	ND	ND	ND	ND	2200	540
Total Dissolved Solids	mg/l	5	690	676	702	1190	310
Alkalinity	mg/l	ND	ND	ND	ND	484	262
Hardness	mg/l	ND	ND	ND	ND	18	54
Chloride	mg/l	5	81	74	84	340	6
Turbidity	NTU	5	0.13	0.08	0.24	ND	ND
Sulfate	mg/l	5	22	2.3	28	61	11
Nitrate	mg/l	5	0.25	0.18	0.50	< 0.1	< 0.1
Ammonia	mg/l	ND	ND	ND	ND	0.09	0.04
Phosphorus	mg/l	ND	ND	ND	ND	0.03	0.06
Fluoride	mg/l	5	2.7	2.5	2.7	0.3	1.1
Calcium	mg/l	ND	ND	ND	ND	5.1	18
Iron	mg/l	5	0.26	0.23	0.29	1	0.78
Magnesium	mg/l	ND	ND	ND	ND	1.2	2.3
Manganese	mg/l	5	0.03	0.01	0.07	0.03	0.06
Sodium	mg/l	5	273	215	289	450	100
Zinc	mg/l	5	0.075	0.061	0.087	0.02	< 3.0

Sources: Geraghty & Miller (1988) for Diascund Creek Test Well.
Laczniak and Meng (1988) for James City County Wells.

Notes: ND = No Data

TABLE 4-20

LITTLE CREEK RESERVOIR WATER QUALITY

Parameter	Units	3 to 10 foot Depth				30 to 40 foot Depth			
		Number Samples	Mean	Min.	Max.	Number Samples	Mean	Min.	Max.
Conductivity	μMHOs/cmm	58	107	78	140	58	122	81	211
pH	SI	58	7.1	6.4	8.1	57	6.8	6.3	7.4
Temperature	C	58	18	2	31	58	10	2.5	17
Dissolved Oxygen	mg/l	58	9.2	6.3	13.4	58	4.8	0	13.2
Dissolved Oxygen (Sat.)	%	58	95	68	120	58	40	0	100
Alkalinity	mg/l	37	21	15	28	23	23	14	45
Sulfate	mg/l	6	6.6	5.5	7.0	6	5.7	<1	7.5
Chlorides	mg/l	37	12	8.4	15	37	13	7.8	31
Nitrate	mg/l	60	0.022	<0.005	0.089	60	0.045	<0.005	0.329
Ammonia	mg/l	59	0.042	<0.002	0.188	60	0.332	<0.002	1.9
Total Kjeldahl Nitrogen	mg/l	60	0.6	<0.2	1.4	60	0.9	0.3	3.1
Total Phosphorus	mg/l	60	0.015	<0.004	0.107	60	0.015	0.004	0.105
Iron (Total)	μg/l	37	388	80	1700	37	4240	200	28000
Manganese (Total)	μg/l	37	70	<10	390	37	539	20	1600
Total Organic Carbon	mg/l	30	6.9	4.8	11	23	6.7	5.2	9.4
Chlorophyll a	μg/l	18	10	3.3	21.4	18	7.5	1.2	18
Pheophytin a	μg/l	18	5	0	21	18	5.6	0.1	25

Sources: Prugh et al., 1988, 1989, 1990, 1991, and 1992.

USGS Station 0204275430 - Little Creek Reservoir.

TABLE 4-21

HYDROGEOLOGIC DESCRIPTIONS, CHARACTERISTICS, AND WELL YIELDS OF AQUIFERS IN THE YORK-JAMES PENINSULA

Aquifer Name and Description	Well Yield (gal/min)		Hydrologic Characteristics
	Common Range	May Exceed	
Columbia Aquifer: Sand and gravel, commonly clayey; interbedded with silt and clay. Fluvial to marine in origin, disposition resulted in terrace-type deposits from varying Pleistocene sea levels.	3-30	40	Generally unconfined, semi-confined locally. Most productive in eastern area, very thin to missing in central and western areas. Water is very hard calcium-bicarbonate type. Highly susceptible to contamination from surface pollutants. Elevated concentrations of iron and nitrate in some areas. Possibility of salty water in coastal regions.
Yorktown-Eastover Aquifer: Sand, commonly shelly; interbedded with silt, clay, shell beds, and gravel. Shallow, embayed marine in origin, deposition resulted in interfingering near-shore deposits from marine transgressions.	5-80	200	Multiaquifer unit. Mostly confined, unconfined updip in outcrop areas. Thickness dependent on altitude of land surface. Highest yields in eastern area, thin to missing in western area. Water is hard to very hard sodium calcium sodium bicarbonate type and generally suitable for most uses. Aquifer not present in western area.
Chickahominy-Piney Point Aquifer: Sand, moderately glauconitic, shelly; interbedded with silt, clay, and thin, indurated shell beds. Shallow, inner marine shelf in origin, deposition result of marine transgression.	10-110	200	Important aquifer in central area; yields moderate to abundant supplies to domestic, small industrial, and municipal wells. Water is soft to hard, calcium sodium bicarbonate type and generally suitable for most uses. Aquifer not present in western area.
Aquia Aquifer: Sand, glauconitic, shelly; interbedded with thin, indurated shell beds and silty clay intervals. Shallow, inner to middle marine shelf in origin, deposition result of marine transgression.	15-210	350	Important aquifer in central area; yields moderate supplies to domestic, small industrial, and municipal wells. Water is soft sodium bicarbonate type, with elevated iron, sulfide, and hardness locally. Aquifer not present in eastern area.

TABLE 4-21
(Continued)

HYDROGEOLOGIC DESCRIPTIONS, CHARACTERISTICS, AND WELL YIELDS OF AQUIFERS IN THE YORK-JAMES PENINSULA

Aquifer Name and Description	Well Yield (gal/min)		Hydrologic Characteristics
	Common Range	May Exceed	
Upper Potomac Aquifer: Sand, very fine to medium, micaceous, lignitic, and clayey; interbedded with silty clays; confined, restricted to central and eastern areas. Shallow, estuarine and marginal marine in origin, sediments result of first major marine inundation of Cretaceous deltas.	20-400	1,000	Multiaquifer unit. Restricted to subsurface, yields largest supply of water in study area. Water is soft sodium chloride bicarbonate type with elevated chlorides in eastern area.
Middle Potomac Aquifer: Sand, fine to coarse, occasional gravels; interbedded with silty clays; generally confined, unconfined in outcrop areas of northwestern Coastal Plain and major stream valleys near Fall Line. Fluvial in origin, sediments result of deltaic deposition.	20-160	700	Multiaquifer unit. Yields second largest supply of water in study area. Water is moderately hard, sodium chloride bicarbonate type, with elevated chlorides in eastern area.
Lower Potomac Aquifer: Sand, medium to very coarse, and gravels, clayey; generally confined, unconfined only in northwestern area of Coastal Plain. Fluvial in origin, sediments result of deltaic deposition.	100-800	1,500	Multiaquifer unit. Yields third largest supply of water. Water is soft to very hard, and of a sodium bicarbonate to sodium chloride type, with elevated chlorides and dissolved solids in eastern area. Thickest of all aquifers.

[gal/min is gallons per minute]

Source: Laczniak and Meng, 1988.

The wells surrounding Diascund Creek Reservoir would be installed in upland areas. The first well, designated as DC-1, would be installed in Craven Loam. This soil is very deep, strongly sloping, and moderately well drained. It is found on narrow to medium-sized upland ridges and side slopes. Well DC-2 would be installed in Craven-Caroline complex. This complex consists of very deep, gently sloping soils on narrow ridgetops and side slopes. Well DC-3 would be installed in Nevarc-Remlik complex. This complex consists of very deep, very steep soils on side slopes along rivers, creeks, and drainageways. This complex consists of about 40 percent moderately well drained Nevarc soil, 35 percent well drained Remlik soil, and 25 percent included soils. Well DC-4 would be installed in Emporia complex soils. This complex consists of areas of deep, steep, well drained Emporia soils, and areas of similar soils that formed over layers of fossil shells.

Pipeline

Each fresh groundwater well would require a pipeline to convey the pumped groundwater from the well to its respective reservoir. Construction of each pipeline would require a 40-foot maximum ROW width extending from the well site and traveling the shortest distance to the discharge site on the respective reservoir.

Air Quality

The fresh groundwater alternative would involve land clearing, excavation, and construction to install eight wells and construct short pipelines. The proposed pipelines and most of the fresh groundwater wells would lie in James City County with some wells in New Kent County. There is residential development near the proposed pipeline route which might be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded.

4.2.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Substrate

Intake

The four wells included in this alternative are each located in upland areas, therefore, no effects on aquatic ecosystem substrates are anticipated.

Pipeline

The concentrate discharge pipeline from the Copeland Industrial Park groundwater well (Site 1) would not cross any streams. However, the outfall structure and associated riprap would disturb approximately 1,000 square feet of aquatic ecosystem substrate approximately 200 feet south of the entrance to Salters Creek, a tributary to Hampton Roads harbor.

The concentrate discharge pipeline from the Upper York County groundwater well (Site 2) would cross one perennial and one intermittent stream. The outfall structure and associated riprap would disturb approximately 1,000 square feet of aquatic ecosystem substrate on Queens Creek, a tributary to the York River.

The concentrate discharge pipeline from the Harwood's Mill groundwater well (Site 3) would cross the upper portion of the Poquoson River, immediately downstream of Harwood's Mill Reservoir. The remainder of the pipeline would cross one perennial and one intermittent stream. The outfall of the pipeline would disturb approximately 1,000 square feet of aquatic substrate on the Poquoson River, at Howards Landing.

The concentrate discharge pipeline from the Lee Hall groundwater well (Site 4) would not cross any streams along its route to Skiffe's Creek. The outfall structure and associated riprap would disturb approximately 1,000 square feet of substrate on Skiffe's Creek.

Water Quality

Blended groundwater from the Middle Potomac and Lower Potomac aquifers would be used to supply the RO treatment facilities to take advantage of the favorable water quality of the Middle Potomac and the increased yield available from the Lower Potomac. Water quality data for both of the aquifers are presented in ***Groundwater Resources of the York-James Peninsula of Virginia*** (Laczniak and Meng, 1988). Existing deep wells on the Lower Peninsula include a 910-foot deep well in the Copeland Park area which penetrates approximately 130 feet of the Middle Potomac aquifer (59D-20), a USGS observation well cluster near Newport News Park which penetrates all the Potomac aquifers to a depth of 1,425 feet below sea level (58F 50-55), a NASA Research Center well drilled to 2,053 feet below sea level which encountered all the Potomac aquifers (59E 5), and a test well for the U.S. Army at the Big Bethel WTP drilled to approximately 1,000 feet below the ground surface. Water quality data available from four of these wells are presented in Table 4-22.

Based on the limited water quality data available from the USGS and SWCB for these well locations, a blended raw water quality ranging from 2,000 to 4,000 mg/l TDS could be expected using the Middle Potomac and Lower Potomac aquifers. It should be noted that a single water sample taken from the Middle Potomac aquifer at the Big Bethel WTP site reported 4,787 mg/l of chloride. Feed water with this quality could not be successfully treated with a conventional low-pressure membrane system designed for brackish water. This highlights the fact that blended water quality at each site would depend on the site-specific water quality and yield of each aquifer.

Under this alternative, it was assumed that five, 2-mgd wells would be used to supply up to 10 mgd of brackish groundwater. The proposed locations for these wells are as follows:

■ Site 1 (Copeland Park)	One well	2 mgd
■ Site 2 (Upper York County)	One well	2 mgd
■ Site 3 (Harwood's Mill)	One well	2 mgd
■ Site 4 (Lee Hall)	Two wells	4 mgd
Total	**Five wells**	**10 mgd**

Assuming recoveries of 80 percent, the RO process would produce 400,000 gallons per day of reject concentrate at each of the 2-mgd raw water sites and 800,000 gallons per day at the 4-mgd raw water site. Outfalls would be directed to brackish or saline surface waters and permitted as regulated discharges. The concentrate outfall locations would be as follows:

■ Site 1 (Copeland Park)	Hampton Roads south of the mouth of Salters Creek
■ Site 2 (Upper York County)	South bank of Queens Creek
■ Site 3 (Harwood's Mill)	West bank of the Poquoson River

TABLE 4-22

**POTOMAC AQUIFER WATER QUALITY
FOR BRACKISH GROUNDWATER WITHDRAWALS**

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.5	7.0	8.0	4
Total Dissolved Solids	g/l	3.94	1.39	7.96	4
Alkalinity	mg/l	346	225	422	4
Nitrate	mg/l	< 0.1	< 0.1	< 0.1	4
Ammonia	mg/l	1.04	0.42	2.7	4
Phosphorus	mg/l	< 0.04	< 0.01	0.1	4
Silica	mg/l	22	15	32	4
Total Organic Carbon	mg/l	0.7	0.3	1.3	4
Chloride	mg/l	2,085	540	4,400	4
Sulfate	mg/l	158	64	350	4
Fluoride	mg/l	1.0	0.2	2	4
Boron	mg/l	1.7	1.5	1.8	4
Calcium	mg/l	38	6.1	82	4
Magnesium	mg/l	22	2.4	59	4
Sodium	mg/l	1,465	520	3,000	4
Potassium	mg/l	28	13	62	4
Iron	mg/l	4.1	0.69	8.7	4
Manganese	mg/l	0.12	0.03	0.22	4
Zinc	mg/l	0.3	0.01	1.0	4

Sources: USGS groundwater Observation Well 58F-50 (unpublished data received from SWCB for sample collected on July 16, 1986.

USGS groundwater Observation Wells 58F-51, 58F-52, and 59E-6 (Laczniak and Meng, 1988).

- Site 4 (Lee Hall) South bank of Skiffe's Creek

Surface water quality data near each of these proposed outfall locations are available from Chesapeake Bay Program Monitoring Stations. Water quality data are summarized in Tables 4-23 and 4-24. Three of the discharge locations; the mouth of the Poquoson River, Hampton Roads, and the mouth of Queens Creek; have relatively high salinities and would be classified as polyhaline, with salinities typically ranging between 18 ppt to 28 ppt. The other discharge location, at the mouth of Skiffe's Creek would be classified as mesohaline to oligohaline, with salinities typically ranging between 3 ppt and 10 ppt.

Hydrology

Wells

This alternative component would involve deep brackish groundwater withdrawals made from wells developed in the City of Newport News and on Newport News Waterworks property located in York County. Up to 10 mgd of new permitted groundwater withdrawal capacity would be used to supply raw water to four reverse osmosis (RO) treatment facilities.

A discussion of the affected hydrologic regime and potential hydrologic impacts associated with these deep brackish groundwater withdrawals is presented below in the description of Groundwater Resources.

Pipeline

Approximately 13.4 miles of new concentrate discharge pipeline would be required for this alternative component. Two perennial and two intermittent stream crossings would be required along the pipeline routes. These minor stream crossings would be accomplished via conventional cut and fill techniques. For Site 3, the concentrate discharge pipeline would also cross the Poquoson River. This could be accomplished by suspending the pipeline across the existing U.S. Route 17 overpass pipeline crossing structure. The concentrate discharge pipelines would terminate at outfall sites located on four tidal water bodies previously listed.

The estimated maximum rate of concentrate discharge into the receiving water bodies is 0.8 mgd for the Site 1 (Lee Hall) discharge into Skiffe's Creek, and 0.4 mgd for each of the remaining three sites.

Groundwater Resources

Setting

Withdrawals are proposed from the high yielding brackish region of the Middle and Lower Potomac Aquifers that are present beneath the City of Newport News and property in York County owned by Newport News Waterworks. Anticipated depths for the proposed five-well system range from 800 to 1,200 feet with well depths increasing to the east. Due to the lack of data from the deeper aquifers in the eastern third of the city, a test well would be needed to document the vertical distribution of water quality and to confirm the yield of the aquifer(s). The horizontal distribution of brackish water in the Middle and Lower Potomac Aquifers on the James-York Peninsula has not been studied in detail. The SWCB concluded in 1981 that "...the Lower Cretaceous aquifer is capable of producing large quantities of brackish groundwater for desalting purposes or for other uses where saltiness is not objectionable." (Siydula et al., 1981). Use of these brackish aquifers has not been

TABLE 4-23

JAMES RIVER WATER QUALITY
AT PROPOSED CONCENTRATE DISCHARGE LOCATIONS

James River Station LE 5.1
Near Skiffe's Creek

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.2	3.1	8.8	69
Salinity	g/l	5.8	0.05	16	179
Nitrate	mg/l	0.29	0.05	0.80	83
Ammonia	mg/l	0.09	0.05	0.50	82
Phosphate	mg/l	0.08	0.02	0.4	83
Silica	mg/l	4.5	1.2	13	81
Total Organic Carbon	mg/l	6.1	2.0	12	83

James River Station LE 5.4
In Hampton Roads Harbor

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.93	4.82	9.49	77
Salinity	g/l	22.3	12.5	30.2	332
Nitrate	mg/l	0.08	0.01	0.36	82
Ammonia	mg/l	0.06	0.05	0.2	77
Phosphate	mg/l	0.06	0.03	0.16	82
Silica	mg/l	1.3	0.0	5.2	80
Total Organic Carbon	mg/l	6	2	15	82

Source: Tributary Water Quality 1984-1986 Data Addendum - James River (SWCB, 1987).

TABLE 4-24

YORK RIVER WATER QUALITY
AT PROPOSED CONCENTRATE DISCHARGE LOCATIONS

York River Station LE 4.2
Near Queens Creek

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.7	6.3	8.9	106
Salinity	g/l	20	7.7	26	391
Nitrate	mg/l	0.1	0.1	0.1	119
Ammonia	mg/l	0.1	0.0	0.1	86
Phosphate	mg/l	0.1	0.0	0.5	120
Silica	mg/l	2.7	0.0	24	118
Total Organic Carbon	mg/l	6	2	16	115

Source: Tributary water quality 1984-1987 Data Addendum - York River (SWCB, 1989).

substantially expanded in the region since 1981, indicating the current availability of this resource.

Based on the limited water quality data available from the USGS and SWCB for well locations on the Peninsula, a blended raw water quality ranging from 2,000 to 4,000 mg/l TDS could be expected using the Middle Potomac and Lower Potomac aquifers. It should be noted that a single water sample taken from the Middle Potomac aquifer at the Big Bethel WTP site reported 4,787 mg/l of chloride.

Soil and Mineral Resources

This alternative would involve the construction of approximately 13.4 miles of concentrate pipeline. Soils within the estimated 65 acres of pipeline ROW would be disturbed during pipeline construction.

Air Quality

The Groundwater Desalination alternative would involve installation of five groundwater wells and excavation and construction activities to construct four concentrate discharge pipelines. Two sets of facilities would be located in the City of Newport News and the other two sets of facilities would be in York County. The City of Newport News and York County are located in an ozone non-attainment area. Therefore, this entire alternative falls in an ozone non-attainment area. Additionally, the proposed concentrate discharge pipelines would be constructed in medium to high density residential areas which should be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded, however.

4.2.6 Additional Conservation Measures and Use Restrictions

Substrate

No aquatic ecosystem substrate would be affected by this alternative.

Water Quality

Implementation of this alternative is not expected to affect existing water quality conditions.

Hydrology

The hydrology of water resources in the project areas is described in Sections 4.2.1through 4.2.5.

Groundwater Resources

The setting for evaluating effects of this alternative on the groundwater resources of the region is described in Sections 4.2.1 through 4.2.5.

Soils and Mineral Resources

This alternative would not have any effect on soils or mineral resources.

Air Quality

The implementation of this alternative would not adversely effect ambient air quality.

4.2.7 No Action

Substrate

If no action was taken, there would be no aquatic ecosystem substrate would be affected.

Water Quality

The existing water quality conditions in the project region are described in Sections 4.2.1 through 4.2.5.

Hydrology

If the No Action alternative were taken, existing Lower Peninsula water supply sources would be relied on more and more heavily to meet increasing demand. The potential impacts of this reliance are addressed in Section 5.2.7.

Groundwater Resources

The groundwater resources setting for evaluating this alternative is described in Sections 4.2.1 through 4.2.5.

Soil and Mineral Resources

This alternative would not affect soils or mineral resources.

Air Quality

If no action was taken, these would be no adverse affect on ambient air quality.

4.3 BIOLOGICAL RESOURCES

This section provides a general description of the biological environment at proposed project sites for each of the seven alternatives evaluated. Biological resource categories evaluated are described below.

Endangered, Threatened, or Sensitive Species

This section provides a listing of all state- or federally-listed endangered or threatened species, or sensitive species (candidates for state or federal listing), which could be affected by implementation of the alternatives. The endangered, threatened, and sensitive species impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses the potential impacts on biological characteristics of the aquatic ecosystem (40 CFR § 230.30).

Fish and Invertebrates

This section lists the fish and invertebrates and other aquatic organisms in the food web that may be affected by the implementation of the alternatives. Aquatic organisms in the food web include fin fish, crustaceans, mollusks, insects, annelids, planktonic organisms, and plants and animals on which they feed and depend on for their needs. All forms and life stages are included in this category. The fish and invertebrates impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on biological characteristics of the aquatic ecosystem (40 CFR § 230.31).

Other Wildlife

This section identifies wildlife which may be affected by implementation of the alternatives which are not addressed in the Endangered, Threatened, and Sensitive Species category or the Fish and Invertebrates category. Game and non-game species are identified. The other wildlife category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on biological characteristics of the aquatic ecosystem (40 CFR § 230.32).

Sanctuaries and Refuges

This section identifies any sanctuaries and refuges which could be affected by the implementation of the evaluated alternatives. For purposes of this analysis, sanctuaries and refuges are defined as areas designated under federal, state, or local authority to be managed principally for the preservation and use of fish and wildlife resources. The sanctuaries and refuges impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on special aquatic sites (40 CFR § 230.40).

Wetlands and Vegetated Shallows

Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Where wetlands are adjacent to open water, they generally constitute the transition to upland (40 CFR § 230.41). Vegetated shallows are permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation.

In this section, wetlands and vegetated shallows are identified and categorized in the vicinity of the various alternative components, based on analysis of existing literature, aerial photography, wetland inventories, field visits, and the results of a wetland evaluation study. Data are presented describing the type, composition and ecological value of the resource. The wetlands and vegetated shallows category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on special aquatic sites. These sites include wetlands (40 CFR § 230.41) and vegetated shallows (40 CFR § 230.43).

Mud Flats

In this section, mud flats are identified in the vicinity of the various alternative components. Mud flats are broad, flat areas along the coast, in coastal rivers to the head of tidal influence, and in inland lakes, ponds, and riverine systems. Tidal mud flats are typically exposed at low tides and inundated at high tides with water at or near the surface of the substrate (40 CFR § 230.42, 1980).

The mud flats impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on special aquatic sites (40 CFR § 230.42).

4.3.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Endangered, Threatened, or Sensitive Species

Intake

In the 1984 ***Feasibility Report and Final Environmental Impact Statement, Water Supply Study - Hampton Roads, Virginia***, the USCOE evaluated an alternative which would involve a pumpover from the Pamunkey River at the Northbury intake site. With the exception of transient individuals, the study documented that there were no known federal endangered or threatened species in the vicinity of the proposed intake site (USCOE, 1984).

Project areas for this alternative were reviewed by the Virginia Department of Conservation and Recreation (VDCR) Division of Natural Heritage, the Virginia Department of Game and Inland Fisheries (VDGIF), and the Virginia Department of Agriculture and Consumer Services (VDACS), to identify any known natural heritage resources or endangered, threatened or sensitive species in these areas. The VDCR provided a list of natural heritage resources of the tidal Pamunkey River. Five of the nine species listed are either endangered, threatened, or candidate species at the federal and/or state levels (see Table 4-25).The agencies concluded that there are no known natural heritage resources or endangered or threatened animal, plant, or insect species in the immediate vicinity of the proposed intake site at Northbury (T. J. O'Connell, VDCR, personal communication, 1992; H. E. Kitchel, VDGIF, personal communication, 1992; J. R. Tate, VDACS, personal communication, 1992).

The Sensitive Joint-vetch (*Aeschynomene virginica*) is an annual legume which has been identified by the VDCR as a natural heritage resource of the tidal Pamunkey River in King William and New Kent counties (J. R. Tate, VDACS, personal communication, 1993). The closest known population of this species occurs approximately 5 miles downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

Until recently, the species was proposed for listing as a federal threatened species and was a candidate for listing by the State. However, in June 1992, the species became a federally listed threatened species and thus, will now receive protection by the Federal and State Governments. On January 11, 1993, a Notice of Intended Regulatory Action by the VDACS was published in ***The Virginia Register***. This proposed regulatory action would list Sensitive Joint-vetch as a state endangered species. As of November 1996, no final regulatory action had been taken (J. R. Tate, VDACS, personal communication, 1996).

The Virginia Institute of Marine Science (VIMS) conducted a study of the Sensitive Joint-vetch (also referred to as the Northern Joint-vetch) in the vicinity of the proposed intake site on the Pamunkey River. The study is documented in ***Identification of Historic Locations of Aeschynomene virginica in the Tidal Freshwater Zone of the Pamunkey River, Virginia*** (Perry, 1993) which is included as an appendix to Report E, ***Biological Assessment for Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is incorporated herein by reference and is an appendix to this document. The study consisted of a review of historical data on the species for the area of the Pamunkey River from Sweet Hall Marsh upstream to the U.S. 360 bridge crossing of the river. The proposed intake site is included in this area.

TABLE 4-25

ENDANGERED, THREATENED, AND CANDIDATE SPECIES OF THE TIDAL PAMUNKEY RIVER

Scientific Name	Common Name	Federal Status	State Status
Aeschynomene virginica	Sensitive Joint-vetch	LT	PE
Bacopa stragula	Mat-forming Water-hyssop	NL	LE
Chamaecrista fasciculata var. macrosperma	Prairie Senna	SC	NL
Haliaeetus leucocephalus	Bald Eagle	LT	LE
Lasmigona subvirdis	Atlantic Heelsplitter	SC	NL

Federal Legal Status

- LE - Listed endangered
- LT - Listed threatened
- SC - Species of concern
- NL - No listing available

State Legal Status

- LE - Listed endangered
- PE - Proposed endangered
- NL - No listing available

Sources: VDCR, 1992; VDACS, 1993; VDCR, 1996.

The VIMS study identified the Sensitive Joint-vetch as having been recorded at three sites along the Pamunkey River from Sweet Hall Marsh (Pamunkey River mile 12.9) to Whitehouse (Pamunkey River mile 32.4). The species' historical range is, therefore, at least 19.5 river miles on the Pamunkey River. The locations of the three recorded populations are described in the VIMS report included in Report E. Each of the three sites supported viable populations as of the summer of 1991 (Perry, 1993). None of the known Sensitive Joint-vetch populations are located in the immediate vicinity of the proposed intake site at Northbury. The Northbury intake site is outside of the species' historical range on the Pamunkey River and is located in a deep water channel of the river with no potential habitat documented along either bank in the immediate vicinity.

The VDACS indicated that there are numerous populations of the state endangered plant Mat-forming Water-hyssop located in the tidal region of the Pamunkey River which are of concern (J. R. Tate, VDACS, personal communication, 1992). The Mat-forming Water-hyssop is a state-listed endangered species which has no federal status. On January 11, 1993, a Notice of Intended Regulatory Action by the VDACS was published in ***The Virginia Register***. This proposed regulatory action would remove Mat-forming Water-hyssop from the Virginia endangered or threatened species list. As of November 1996, no final regulatory action had been taken (J. R. Tate, VDACS, personal communication, 1996).

Mat-forming Water-hyssop is a perennial herb which was identified by the VDACS as occurring in the vicinity of the project area and is listed by the VDCR as a natural heritage resource of the tidal Pamunkey River. It has been found in King and Queen, King William, and New Kent counties. The closest known population of this species occurs approximately 5 miles downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

The Bald Eagle (*Haliaeetus leucocephalus*), which is a federally-listed threatened and state-listed endangered species, was identified by the VDCR and the VDGIF as occurring within the project area, and is included on the VDCR list of natural heritage resources of the tidal Pamunkey River. Several known Bald Eagle nesting areas are found along the Pamunkey River, two of which are located within 3 miles of Northbury. The closest site, Montague Creek, is approximately 2 river miles downstream, while the Macon Creek nesting site is approximately 3 river miles downstream (H. E. Kitchel, VDGIF, personal communication, 1992). Malcolm Pirnie biologists observed a Bald Eagle in flight approximately 2 river miles downstream of Northbury in May 1990 (Malcolm Pirnie, 1990).

The Prairie Senna (*Chamaecrista fasciculata* var *macrosperma*) and the Atlantic Heelsplitter (*Lasmigona subvirdis*) are two federal species of concern and are included on the VDCR list of resources of the tidal Pamunkey River. The Prairie Senna is a plant which has been found in King William and New Kent counties. The Atlantic Heelsplitter is a freshwater mussel which prefers small streams, quiet pools or eddies with gravel and sand bottoms.

Reservoir

Bald Eagle

The Bald Eagle is currently listed as a threatened species on the federal list and an endangered species on the Virginia list.

The USCOE's ***Feasibility Report and Final Environmental Impact Statement, Water Supply Study - Hampton Roads, Virginia*** (USCOE, 1984), identified the Bald Eagle as potentially being present in the Ware Creek system. The USCOE's FEIS for James City County's Ware Creek Reservoir project (USCOE, 1987) also stated that Bald Eagles have been sighted in the project area, but no active nests within the project area had been found as of 1983. According to VDGIF records, the closest Bald Eagle nest as of 1992 is approximately 1 mile north of the project area (VDGIF, 1992). No critical habitat has been designated by the USFWS for the Bald Eagle (50 CFR 17.11).

Small Whorled Pogonia

The Small Whorled Pogonia (*Isotria medeoloides*) is a member of the orchid family and is a federally-listed threatened and state-listed endangered species. In the USCOE's 1984 evaluation of the Ware Creek Reservoir as a component of a regional water supply alternative, the Small Whorled Pogonia was identified as occurring in James City County. No critical habitat has been designated by the USFWS for the Small Whorled Pogonia (50 CFR 17.12).

A botanical survey of the Ware Creek watershed for Small Whorled Pogonia in October 1983 did not reveal any individuals of the species (Scanlan, 1983). However, the month of June is considered to be the most appropriate time to conduct a field survey for this plant in this region (D.M.E. Ware, The College of William of Mary, personal communication, March 1993). Later in the year, extant specimens may not be found due to factors such as herbivory by deer and other animals and desiccation through weathering in hot weather months.

Additional limited field studies were conducted in the Ware Creek Reservoir watershed as part of the ***National Areas Inventory of the Lower Peninsula of Virginia: City of Williamsburg, James City County, York County*** (Clampitt, 1991). Participants in this study spent a total of 8 hours in the Ware Creek watershed searching for Small Whorled Pogonia and three other plant species, 4 hours each on August 17, 1989, and July 24, 1990, with two participants on each visit. Limited areas along Ware Creek and Bird Swamp were inspected. No Small Whorled Pogonia were found. The field surveyors prepared a site survey summary indicating that more exploration should be performed farther upstream in the Ware Creek watershed and farther downstream in the Bird Swamp watershed (D.M.E. Ware, The College of William & Mary, personal communication, July 1993).

In 1993, the USFWS recommended conducting additional surveys for Small Whorled Pogonia at the site of the proposed Ware Creek Reservoir, due to the existence of potential habitat at the reservoir site and the less than ideal timing of the previous study (K. L. Mayne, USFWS, personal communication, 1993). USFWS' recommended methodology and the methodology selected for the survey are described in detail in Report E.

Potential habitat for Small Whorled Pogonia within the proposed Ware Creek Reservoir area was identified in May 1993 by Dr. Donna Ware of The College of William & Mary, based on topographic mapping and color-infrared aerial photography of the area. A total of 56 potential locations were identified, and the total area of prime habitat was estimated to be 90 acres.

Malcolm Pirnie biologists reviewed ***A Survey of the Ware Creek Watershed for Small Whorled Pogonia*** (Scanlan, 1983) to determine which areas were examined during the 1983 survey. Only 7 of the 56 sites identified by Dr. Ware as prime habitat had been examined previously. Only one of those sites was identified in the 1983 survey as not having the potential for prime habitat. That site was, therefore, removed from the search area. Because the 1983 survey was conducted in October, and the best time to identify the species in the field is June, it is unlikely that the plant would have been noted, if present. Therefore, the six remaining areas surveyed in 1983 were included in the search area, along with the other 49 potential habitat areas identified by Dr. Ware.

Due to lack of access to the Ware Creek site, field surveys were delayed until May 1994. During that survey, two specimens of Small Whorled Pogonia were identified within the proposed Ware Creek Reservoir pool area, which would be flooded by the proposed reservoir project. The two specimens were found on a southwest facing slope in the remaining ruts of a logging road or skidder trail. The area appears to have been logged about 10 years ago. The field studies are documented in Report E.

Sensitive Joint-vetch

In June 1992, the Sensitive Joint-vetch (*Aeschynomene virginica*) (also known as Northern Joint-vetch) became a federally listed threatened species. On January 11, 1993, Virginia Department of Agriculture and Consumer Services (VDACS) formally proposed to list the Sensitive Joint-vetch as a state endangered species. As of November 1996, no final regulatory action had been taken (J. R. Tate, VDACS, personal communication, 1996).

Sensitive Joint-vetch is an annual legume which occurs in high-diversity, slightly brackish tidal marshes of river shores and river banks in a zone generally dominated by annual species (Ware, 1991b). It is found in areas with an average salinity of 0.5 ppt (tidal freshwater-oligohaline transition zone), and it is usually not found in waters with substantially lower or higher salinities (J. E. Perry, VIMS, personal communication, 1992). No critical habitat has been designated by the USFWS for the Sensitive Joint-vetch (50 CFR 17.12).

The USFWS has indicated that Sensitive Joint-vetch may exist in tidal wetlands within the Ware Creek watershed (K. L. Mayne, USFWS, personal communication, 1993). VIMS conducted a study of the potential occurrence of Sensitive Joint-vetch in the tidal wetlands of Ware Creek. This study is documented in ***Investigation of Potential Distribution of Aeschynomene virginica in the Tidal Wetlands of Ware Creek, Virginia*** (Perry, 1993c) (Appendix 9 of Report E).

Methods used in the VIMS study included a review of historical data on the species and a field survey of the project area by boat. The study area included tidal emergent wetlands on both sides of Ware Creek, from its confluence with the York River upstream to the portion of Ware Creek where emergent wetlands end and forested wetlands dominate. Habitats which appeared similar to those that support populations of the species were further investigated by walking the habitat area and inspecting for Sensitive Joint-vetch. While many examples of the species' habitat were found in Ware Creek, no populations of Sensitive Joint-vetch were discovered in the study area (Perry, 1993c).

Other species

A 1992 database review by the VDACS indicated that no other state-listed threatened or endangered plant or insect species are known to occur in the immediate vicinity of the proposed dam site and downstream areas. (J. R. Tate, VDACS, personal communication, 1992). Limited field studies conducted by Malcolm Pirnie field biologists in October 1992 also did not reveal the presence of any threatened or endangered species in the vicinity of the proposed dam site.

Pipeline

The USCOE feasibility report evaluated an alternative which would involve a pumpover from the Pamunkey River at the Northbury intake site and a transmission pipeline to the headwaters of Diascund Creek. This route encompasses a portion of the pipeline route for the Ware Creek alternative evaluated herein. At the time of the study, it was documented that there were no known federal endangered or threatened species located in the vicinity of the project area with the exception of transient individuals (USCOE, 1984).

The VDCR indicated that the pipeline route from the proposed intake site at Northbury to Ware Creek Reservoir would come in close contact to an active Bald Eagle nest. Recent review by the VDGIF has indicated that the pipeline to the reservoir would come within 0.5 miles of this nest (VDGIF, 1996). No additional species were identified by the VDGIF as being known to occur in proximity to the proposed pipeline (H. E. Kitchel, VDGIF, personal communication, 1992).

The VDACS identified no state-listed threatened or endangered plant or insect species known to occur in sites associated with pipeline routes for this alternative component (J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Intake

Fish collection records for the vicinity of the intake are summarized and included in Table 4-26.

A literature search was conducted to determine which species of anadromous fish have historically used the Pamunkey River as a spawning or nursery area and to identify those species which are likely to still use the river. The following five species of anadromous fish have been documented as using the Chesapeake Bay and its tributaries for spawning and nursery grounds:

- Striped Bass (*Morone saxatilis*)
- American Shad (*Alosa sapidissima*)
- Hickory Shad (*Alosa mediocris*)
- Alewife (*Alosa pseudoharengus*)
- Blueback Herring (*Alosa aestivalis*)

Invertebrate species which may occur in the tidal freshwater region of the Pamunkey River are typical of those occurring in the tidal freshwater portions of the Chesapeake Bay and its tributaries. A listing of these species is included in Table 4-27. The proposed intake site is 3.7 miles downstream of the nearest leased oyster bed (VMRC, 1992).

Reservoir

Existing water bodies within the reservoir impact area include Ware Creek, intermittent and perennial streams associated with Bird Swamp, France Swamp, and Cow Swamp, and Richardson's Millpond.

Fish collections in Ware Creek and France Swamp have been conducted between 1980 and 1993 and are summarized in Tables 4-28 and 4-29. These records were provided by the VDGIF.

An environmental assessment of aquatic resources in Ware Creek was conducted in 1981 (Buchart-Horn, 1981). This assessment indicated that a diverse freshwater fish population exists

TABLE 4-26

FISH SPECIES OF THE PAMUNKEY RIVER (1949 - 1978)

Scientific Name	Common Name	1949	1950	1954	1955	1958	1967	1969	1971	1973	1978
Acipenser oxyrhynchus	Atlantic Sturgeon	■									
Alosa aestivalis	Blueback Herring	■							■		■
Alosa mediocris	Hickory Shad										■
Alosa pseudoharengus	Alewife							■	■	■	■
Alosa sapidissima	American Shad								■		■
Amia calva	Bowfin	■							■		
Anguilla rostrata	American Eel	■		■					■	■	
Aphredoderus sayanus	Pirateperch								■		
Brevoortia tyrannus	Atlantic Menhaden										■
Centrarchus macropterus	Flier	■									
Clinostomus funduloides	Rosyside Dace								■		
Cyprinus carpio	Common Carp								■		
Dorosoma cepedianum	Gizzard Shad	■						■	■		
Enneacanthus gloriosus	Bluespotted Sunfish	■							■		
Erimyzon oblongus	Creek Chubsucker							■			
Esox niger	Chain Pickerel	■									
Etheostoma olmstedi	Tessellated Darter	■		■	■		■			■	■
Fundulus diaphanus	Banded Killifish	■		■	■		■		■		
Fundulus heteroclitus	Mummichog									■	
Gambusia affinis	Mosquitofish	■							■	■	
Hybognathus regius	Eastern Silvery Minnow	■		■	■		■			■	■
Ictalurus catus	White Catfish	■		■	■		■		■		■
Ictalurus natilis	Yellow Bullhead								■		

TABLE 4-26

FISH SPECIES OF THE PAMUNKEY RIVER (1949 - 1978)

Scientific Name	Common Name	1949	1950	1954	1955	1958	1967	1969	1971	1973	1978
Ictalurus nebulosus	Brown Bullhead								■		
Ictalurus punctatus	Channel Catfish	■		■	■		■		■	■	■
Lepisosteus osseus	Longnose Gar	■		■					■		■
Lepomis auritus	Redbreast Sunfish	■		■	■		■		■	■	
Lepomis gibbosus	Pumpkinseed	■		■	■		■		■	■	
Lepomis macrochirus	Bluegill	■							■	■	
Menidia beryllina	Inland Silverside	■								■	
Micropterus salmoides	Largemouth Bass	■					■		■	■	
Morone americana	White Perch	■		■	■				■	■	■
Morone saxatilis	Striped Bass	■		■	■				■		■
Moxostoma macrolepidotum	Shorthead Redhorse	■		■	■			■	■		■
Notemigonus crysoleucas	Golden Shiner	■		■			■		■		■
Notropus amoenus	Comely Shiner								■		
Notropus analostanus	Satinfin Shiner	■		■	■				■	■	■
Notropus hudsonius	Spottail Shiner	■		■	■	■	■		■	■	■
Noturus gyrinus	Tadpole Madtom	■		■							■
Perca flavescens	Yellow Perch	■		■	■		■	■		■	
Petromyzon marinus	Sea Lamprey		■								
Pomoxis nigromaculatus	Black Crappie	■								■	
Semotilus corporalis	Fallfish	■									
Strongylura manna	Atlantic Needlefish	■									
Trinectes maculatus	Hogchoker	■									

Sources: H.E. Kitchel, VDGIF, personal communications, August 9, 1989 and August 11, 1992.
■ Indicates observation of fish species in particular year.

TABLE 4-27

TYPICAL INVERTEBRATES OF THE CHESAPEAKE BAY AND ITS TRIBUTARIES, TIDAL FRESHWATER ZONE

Scientific Name	Common Name
Anodonta sp.	Freshwater Mussels
Callinectes sapidus	Blue Crab
Cambarus diogens	Burrowing Crayfish
Cordylophora caspia	Freshwater Hydroid
Ferrissia spp.	Coolie Hat Snail
Gammarus sp.	Scuds
Goniobasis virginica	Hornshell Snail
Hydrobia spp.	Seaweed Snails
Lampsilis spp.	Freshwater Mussels
Leptodora kindtii	Giant Water Flea
Lironeca ovalis	Fish Gilled Isopod
Musculium spp.	Long-siphoned Fingernail Clams
Mytilopsis leucophaeata	Platform Mussel
Olencira praegustator	Fish-mouth Isopod
Orconectes limosus	Coastal Plains River Crayfish
Pectinatella sp.	Freshwater Bryozoan
Physa gyrina	Pouch Snail
Pisidium spp.	Pill Clam
Rangia cuneata	Brackish Water Clam
Sphaerium spp.	Short-siphoned Fingernail Clam

From: Lippson, A. J., and R. L. Lippson, 1984. Life in the Chesapeake Bay, The John Hopkins University Press, Baltimore, Maryland.

TABLE 4-28

FISH SPECIES OF WARE CREEK (1980-1993)

Scientific Name	Common Name	1980	1981	1982	1992	1993
Acantharcus pomotis	Mud Sunfish	■				
Amia calva	Bowfin				■	
Anchoa mitchilli	Bay Anchory				■	
Anguilla rostrata	American Eel	■	■	■	■	
Aphredoderus sayanus	Pirate Perch	■	■	■	■	
Cyprinodon variegatus	Sheepshead Minnow			■		
Cyprinus carpio	Common Carp			■	■	■
Dorosoma cepedianum	Gizzard Shad			■	■	■
Enneacanthus gloriosus	Bluespotted Sunfish	■	■	■		■
Erimyzon oblongus	Creek Chubsucker	■	■		■	
Etheostoma olmstedi	Tessellated Darter		■			
Fundulus diaphanus	Banded Killifish				■	■
Fundulus heteroclitus	Mummichog			■	■	■
Gambusia affinis	Mosquitofish	■	■	■	■	
Gobiosoma bosci	Naked Goby			■		
Ictalurus catus	White Catfish		■	■	■	
Ictalurus natalis	Yellow Bullhead	■	■			
Ictalurus nebulosus	Brown Bullhead	■			■	■
Lepisosteus osseus	Longnose Gar			■	■	■
Lepomis auritus	Redbreast Sunfish	■				
Lepomis gibbosus	Pumpkinseed	■	■	■	■	
Lepomis gulosus	Warmouth			■	■	
Lepomis humilis	Orange Spotted Sunfish	■				
Lepomis macrochirus	Bluegill	■	■	■	■	■
Leostomus xanthurus	Spot			■	■	
Menidia beryllina	Inland Silverside			■	■	■
Micropogonias undulatus	Atlantic Croaker				■	■
Micropterus salmoides	Largemouth Bass	■		■	■	
Morone americana	White Perch	■		■	■	■
Monroe saxatilis	Striped Bass				■	■
Mugil cephalus	Striped Mullet				■	
Notemigonus crysoleucas	Golden Shiner			■	■	■
Perca flavescens	Yellow Perch	■			■	
Pomatomous saltatrix	Bluefish			■		

TABLE 4-28

FISH SPECIES OF WARE CREEK (1980-1993)

Scientific Name	Common Name	1980	1981	1982	1992	1993
Pomoxis nigromaculatus	Black Crappie				■	
Strongylura marina	Atlantic Needlefish			■		
Umbra pygmaea	Eastern Mudminnow				■	

Sources: Buchart-Horn, 1981; James R. Reed & Associates, 1982; H.E. Kitchel, VDGIF, personal communication, August 11,1992; Dowling, 1993; and D. C. Dowling, VDGIF, personal communication, June 23, 1993.

■ Indicates observation of fish species in particular year.

TABLE 4-29

FISH SPECIES OF FRANCE SWAMP (1980 - 1992)

Scientific Name	Common Name	1980	1981	1992
Acantharcus pomotis	Mud Sunfish	■		
Anchoa mitchilli	Bay Anchory			■
Anguilla rostrata	American Eel	■	■	■
Aphredoderus sayanus	Pirate Perch	■	■	■
Dorosoma cepedianum	Gizzard Shad			■
Enneacanthus gloriosus	Bluespotted Sunfish	■	■	■
Erimyzon oblongus	Creek Chubsucker	■	■	■
Esox americanus	Redfin Pickerel	■		■
Etheostoma nigrum	Johnny Darter	■		
Etheostoma olmstedi	Tessellated Darter	■	■	■
Fundulus diaphanus	Banded Killifish			■
Fundulus heteroclitus	Mummichog			■
Gambusia affinis	Mosquitofish	■		■
Ictalurus catus	White Catfish	■		■
Ictalurus natalis	Yellow Bullhead	■		■
Ictalurus nebulosus	Brown Bullhead	■		■
Leostomus xanthurus	Spot			■
Lepisosteus osseus	Longnose Gar			■
Lepomis gibbosus	Pumpkinseed	■	■	■
Lepomis macrochirus	Bluegill	■		■
Menidia beryllina	Inland Silverside			■
Micropogonias undulatus	Atlantic Croaker			■
Micropterus salmoides	Largemouth Bass			■
Morone americana	White Perch	■		■
Morone saxatilis	Striped Bass			■
Mugil cephalus	Striped Mullet			■
Notemigonus crysoleucas	Golden Shiner	■		■
Perca flavescens	Yellow Perch			■

TABLE 4-29

FISH SPECIES OF FRANCE SWAMP (1980 - 1992)

Scientific Name	Common Name	1980	1981	1992
Pomoxis nigromaculatus	Black Crappie			■
Trinectes maculatus	Hogchoker			■
Umbra pygmaea	Eastern Mudminnow			■

Sources: Buchart-Horn, 1981; H. E. Kitchel, VDGIF, personal communication, August 11, 1992; and Dowling, 1993.

■ Indicates observation of fish species in particular year.

within Ware Creek's upper tidal portion and its major tributary France Swamp. Freshwater sections of Ware Creek are dominated by game species such as Largemouth Bass and Sunfish. Oligohaline and mesohaline sections of Ware Creek contain estuarine fish fauna. The most abundant game fish species in these areas is the White Perch.

Available information concerning the presence of anadromous fish in Ware Creek was reviewed for this regional study. VIMS has indicated that Ware Creek may be too far downstream on the York River to attract large spawning runs of herring (J. G. Loesch, VIMS, personal communication, 1992).

A 5½-month study was conducted by James R. Reed & Associates (1982) to determine whether Ware Creek and its tributaries are used as spawning or nursery areas by anadromous fish, specifically Striped Bass, American Shad, Alewife, and Blueback Herring. These species are known to occur in the York River.

The James R. Reed & Associates (1982) study suggested that the nursery value of Ware Creek appears to be more important than its spawning value for anadromous fish and that no major spawning occurs there. The slow current velocities and soft substrate characteristics of Ware Creek were not deemed conducive to egg and larval survival. Of the species studied, Alewife and Blueback Herring were considered most likely to spawn in Ware Creek. Striped Bass and American Shad were not considered likely to use Ware Creek for spawning since the slow moving current and soft substrate of Ware Creek is not the preferred habitat for these species. However, Striped Bass sport fishing occurs at the mouth of Ware Creek (James R. Reed & Associates, 1982).

The U.S. National Marine Fisheries Service (NMFS) considers Ware Creek to be "...a suitable but unutilized site for andromous spawning (*Alosa spp.*)..." (E. W. Christoffers, NMFS, personal communication, 1986). However, the NMFS and USCOE have also stated that when high freshwater discharges during spawning season coincide with years of high anadromous fish populations, Ware Creek may be used as a spawning area for alosid species such as Alewife and Blueback Herring (E. W. Christoffers, NMFS, personal communication, 1986; USCOE, 1987). For several years, populations of these species have been at historic lows and recent sampling efforts have failed to reveal the species' presence in Ware Creek (VDGIF, 1992). Ware Creek is actively used for spawning and as nursery by semi-anadromous White Perch (E. W. Christoffers, NMFS, personal communication, 1986).

The VDGIF conducted fish sampling at the proposed Ware Creek Reservoir site in the summer and fall of 1992. As part of this sampling effort, VDGIF biologists observed Striped Bass in Ware Creek and France Swamp, upstream of the proposed Ware Creek dam site (Dowling, 1993). Fish sampling was conducted again in May 1993 by the VDGIF. The results of this study indicated that Ware Creek, at and above the dam site, was being used by juvenile Atlantic Croaker, White Perch, and Striped Bass. Based on these surveys, the VDGIF concluded that "...Ware Creek, above the proposed dam site, serves as a diverse and important transition zone between brackish and freshwater fish communities that warrants protection" (D. C. Dowling, personal communication, 1993).

Benthic invertebrates were collected at several sites in Ware Creek and France Swamp in November 1980 and April 1981 by James R. Reed & Associates (Buchart-Horn, 1981). A complete listing of the observed species is included in Table 4-30.

TABLE 4-30

INVERTEBRATE SPECIES OF WARE CREEK AND FRANCE SWAMP (1980 - 1981)

Class or Order	Common Name	Species
Hirudinea	Leeches	*Glossophnid spp.* *Helobdella elongata* *Myzobdella lugubris*
Isopoda	Aquatic Sow Bugs	*Cyathura polita* *Edotea triloba*
Amphipoda	Scuds, Sideswimmers & Shrimps	*Corophium lacustre* *Grammarus spp.* *Hyalella azteca* *Leptochirus plumulosus* *Orchestia grillus*
Decapoda	Freshwater Crayfish	*Callinectes spp.* *Crayfish* *Palaemonetes spp.*
Megaloptera	Hellgrammites, Dobsonfies & Fishflies	*Sialis spp.*
Trichoptera	Caddisflies	*Brachycentrus spp.* *Dolophilodes spp.* *Hydropsyche spp.*
Tricladia	Triclad Flatworms	*Dugesia spp.*
Nemertean	Nemertine Worms	

TABLE 4-30

INVERTEBRATE SPECIES OF WARE CREEK AND FRANCE SWAMP (1980 - 1981)

Class or Order	Common Name	Species
Gastropoda	Snails & Slugs	*Amnicola spp.* *Campeloma spp.* *Ferrissia spp.* *Gillia spp.* *Gyraulus spp.* *Lymnea spp.* *Melampis spp.* *Physa spp.*
Bivalvia	Clams & Mussels	*Elliptio campanulata* *Musculium spp.* *Pisidium spp.*
Polychaeta	Sea Worms	*Hypaniola grayi* *Laeonereis culveri*
Oligochaeta	Aquatic Earthworms	*Limnodrilus spp.* *Lumbricilus spp.* *Nais spp.* *Peloscolex multiseptosus*
Hemiptera	Water Bugs	*Belostoma spp.* *Pelocoris spp.*
Coleoptera	Water Beetles	*Berosus spp.* *Bidessus spp.*
Ephemeroptera	Mayflies	*Baetisea spp.*

TABLE 4-30

INVERTEBRATE SPECIES OF WARE CREEK AND FRANCE SWAMP (1980 - 1981)

Class or Order	Common Name	Species
Odonata	Damselflies & Dragonflies	
		Agrion spp.
		Archilestes spp.
		Dorocordulia spp.
		Erythemis spp.
		Gomphus spp.
		Marcromia spp.
		Octogomphus spp.
		Perithemus spp.
		Plathemis spp.
		Tetragoneuria spp.
		Triacanthagyna spp.
Diptera	True Flies	
(family) Ceratopogonidae	Biting Midges	*Palpomyia spp.*
(family) Chironomidae	True Midges	*Chironomus spp.*
		Coelotanypus spp.
		Cricotopus spp.
		Cryptochironomus spp.
		Dicrotendipes spp.
		Polypedilum spp.
		Proclauidus spp.
(family) Dolichopodidae	Dolichopotid Flies	*Unknown*
(family) Simuliidae	Blackfiles	*Simulium spp.*
(family) Tipulidae	Craneflies	*Tipula spp.*

Source: Buchart-Horn, 1981.

Pipeline

Construction of new pipeline associated with this alternative would require minor crossings of 5 perennial and 16 intermittent streams. Fish species expected to occur in these streams are similar to those found in France Swamp (see Table 4-29).

Invertebrate species found within intermittent and perennial streams crossed by the pipeline are expected to be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

<u>Other Wildlife</u>

Intake

Field studies conducted by Malcolm Pirnie during the spring of 1990 determined that the proposed Northbury intake site is relatively isolated and that the predominant vegetation cover types are agricultural fields and forests. An analysis of color-infrared aerial photography of the proposed intake site was conducted and vegetation community types were classified according to Anderson et al. (1976). Community types were identified as follows:

- Mixed Forest
- Deciduous Forest
- Pine Plantation and Coniferous Forest
- Old Field/Agricultural
- Palustrine Forested Broad-Leaved Deciduous
- Scrub-Shrub
- Emergent/Open Water

The predominate forest type at the proposed intake location is deciduous. To determine the potential wildlife species occurring at the intake site location, the VDGIF was contacted. A search of the Biota of Virginia (BOVA) database was conducted, and a listing of species anticipated to occur in riparian habitats of the Pamunkey River was generated. Based on this information and a literature review, typical wildlife species of each community type were identified. Listings of typical wildlife species according to vegetation community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this report. The predominant vegetation cover types at the proposed intake site are deciduous forest and agricultural fields.

Species noted by Malcolm Pirnie scientists in the vicinity of the intake include Bald Eagle, Eastern Kingbird, Great Blue Heron, Green Heron, Indigo Bunting, Mallard, Osprey, Pileated Woodpecker, Red-tailed Hawk, Sanderling, Turkey Vulture, and Beaver (Malcolm Pirnie, 1990).

Reservoir

Based on review of color-infrared aerial photography of the proposed Ware Creek Reservoir watershed, vegetation community types were classified according to Anderson et al. (1976).

TABLE 4-31

TYPICAL FRESHWATER INVERTEBRATES OF THE LOWER VIRGINIA PENINSULA

Scientific Name	Common Name
Alasmidonta undulata	Triangle Floater Mussel
Anodonta cataracta	Eastern Floater
Anodonta grandis	Giant Floater Mussel
Cambarus bartonii	Crayfish
Cambarus diogenes	Crayfish
Cambarus robustus	Crayfish
Elliptio angustata	Carolina Lance Mussel
Elliptio complanata	Eastern Elliptio
Elliptio congaraea	Carolina Slabshell Mussel
Elliptio lanceolata	Yellow Lance Mussel
Fallicambarus uhleri	Crayfish
Ligumia nasuta	Eastern Pond Mussel
Orconectes limosus	Crayfish
Strophitus undulatus	Squawroot Mussel

Source: H. E. Kitchel, VDGIF, personal communication, August 11, 1992.

According to Anderson's methodology and field inspection, vegetation community types in the watershed area were estimated to consist of 1,384 acres of coniferous forest, 222 acres of deciduous forest, 5,959 acres of mixed forest, 590 acres of wetlands and open water, and 2,346 acres of agricultural, residential, open field, and shrub communities. The remaining 640 acres of the watershed consist of roads, light commercial areas, and industrial areas which would not be heavily utilized by wildlife. Based on information provided from the VDGIF's BOVA database and a literature review, wildlife species anticipated to occur in the project vicinity were identified. These species are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this document.

Based on review of color-infrared aerial photography and field inspections, it was estimated that the reservoir pool area consists of 582 acres of mixed forested land, 19 acres of coniferous forested land, 24 acres of deciduous forest, 590 acres of wetlands and open water, and 4 acres of agricultural, residential, and open field communities. The remaining area consists of roads, which have very limited habitat value. The primary cover type of the reservoir pool area is forested land which comprises approximately 625 acres of the proposed 1,238 acre pool area.

Field investigations were conducted by the USFWS on March 17, 1981 and April 8, 1981 to determine wildlife composition in the reservoir area. Foxes are the major predatory mammal associated with the forested regions of the watershed. Omnivorous mammals typical of this community type include the Opossum and the Raccoon. White-tailed Deer are also common throughout forested habitats. Smaller mammals noted within the project area include the Gray Squirrel, White-footed Mouse, Meadow Vole, Cotton Mouse, Marsh Rice Rat, and Muskrat. Forest edge habitat is utilized by White-tailed Deer, Striped Skunk, and many old field small mammals including the Wood Mouse, Cottontail Rabbit, and Meadow Vole (Buchart-Horn, 1981). Mammals associated with aquatic habitats in the project vicinity include Mink, Beaver, Muskrat, and River Otter (USCOE, 1984).

Based on previous studies, the Red-eyed Vireo is the most common bird in the deciduous forested area (Buchart-Horn, 1981). Common warblers include the Prothonotary Warbler, Black and White Warbler, Pine Warbler, and Yellow-throated Warbler. Other characteristic bird species include the Ovenbird, Woodthrush, Carolina Chickadee, Tufted Titmouse, and various woodpeckers.

Large areas of mature forest provide necessary habitat for predators such as hawks and owls. Species noted include the Great Horned Owl, Screech Owl, and Barred Owl (Buchart-Horn, 1981). The Red-tailed Hawk has also been frequently noted in this area. The Black Vulture and Turkey Vulture are abundant in the project area. The presence of large oaks and occasional hickories in the Ware Creek watershed provides suitable habitat for Turkey.

Forest edge habitat is important for a variety of bird species. Field Sparrows and Song Sparrows are common permanent residents in forest edge communities. The Mockingbird, Robin, Indigo Bunting, Chipping Sparrow, and Cardinal also utilize these areas for nesting. The Common Yellowthroat, Eastern Bluebird, Yellow Breasted Chat, and the Yellow Rumped Warbler have also been noted in the area. Predatory birds such as the Red-tailed and Red-shouldered Hawks utilize the forest edge and agricultural/old-field areas to prey on small mammals (Buchart-Horn, 1981).

Ware Creek is an extremely productive ecosystem utilized by species such as Wood Duck, Black Duck, Blue-winged Teal, and Great Egret. Wood Ducks find nesting trees in the forested areas and a stable source of food in wetland (especially herbaceous) vegetation and benthic invertebrates. These Wood Ducks also congregate in large communal roosts in Ware Creek wetlands in the fall.

Black Duck, a species which has undergone a dramatic decline in population in recent years, are attracted to the Ware Creek aquatic system by the ample foods of the freshwater marshes (including Wild Rice) and areas of shallow water which provide important wintering habitat for migratory species (USCOE, 1984). Bald Eagle have also been noted in the area, and the potential also exists for nesting of this species in the proposed impact area (USCOE, 1984).

An additional identified resource is a Great Blue Heron (*Ardea herodias*) rookery located on both sides of France Swamp, north of the intersection of U.S. Route 60 and Interstate 64. This rookery contained 98 nests during a 1990 survey (D. Bradshaw, VDGIF, personal communication, 1993). The Great Blue Heron is ranked by the State as being rare to uncommon, but not threatened or endangered. It is currently protected under the Migratory Bird Treaty Act (T. O'Connell, VDCR, personal communication, 1992). This species, considered to be a species of special concern by the USFWS, thrives in natural habitats, preferentially nesting in riparian swamps such as the rookery in France Swamp (USEPA, 1992).

Common amphibians and reptiles found in the forested community include the Green Frog, Spotted Salamander, Marbled Salamander, Slimy Salamander, Red-backed Salamander, Grey Treefrog, Northern Black Racer, Black Rat Snake, Eastern Hognose Snake, Eastern Kingsnake, Southern Copperhead, Broad-headed Skink, Ground Skink, Five-lined Skink, and Southern Five-lined Skink.

The American and Fowler's Toads are common around cultivated fields. Freshwater creeks and ponds in the project area also support amphibians and reptiles such as the Bullfrog, Leopard Frog, Pickerel Frog, and Red-spotted Newt. Snakes noted in wetland and open water habitats of the project area include the Northern Water Snake, Brown Water Snake, Red-bellied Water Snake, and the Eastern Cottonmouth. Snapping Turtles have also been noted in this community type (Buchart-Horn, 1981).

The USCOE, USFWS, USEPA, VDGIF, and James City County conducted a Habitat Evaluation Procedures (HEP) analysis for the Ware Creek Reservoir project as proposed by James City County. Fish and wildlife habitat values for each important cover type in the drainage area were studied. Upland and wetland habitats within the drainage area were analyzed for the study.

HEP analyses use species-specific Habitat Suitability Index (HSI) models to quantitatively assess habitat quality for particular species based upon selected habitat characteristics. These models yield habitat suitability index values (HSIs) that vary from 0.0 for unsuitable habitat to 1.0 for optimal habitat for the modeled species. HSIs are multiplied by acreage to determine habitat units (HUs).

Nine species were evaluated for the HEP study. The lists of cover types and representative species were combined to yield evaluation elements. Subsequently, baseline calculations of HSIs and HUs were completed. Results of the study are summarized in Table 4-31A. The baseline calculations show that uplands and forested, herbaceous and open water wetlands at the Ware Creek site provide 20,744 habitat units for the species evaluated.

Pipeline

Assuming a pipeline right-of-way width of 50 feet, the new pipeline would disturb approximately 159 acres of land. Existing vegetation community types along the pipeline route were identified through review of USGS topographic mapping and color-infrared aerial photography. Based on a review of these resources, the 26.3 miles of new pipeline would impact primarily mixed forested and agricultural land. Typical wildlife species of these community types

TABLE 4-31A

**BASELINE CALCULATIONS OF HABITAT SUITABILITY INDICES (HSIs) AND HABITAT UNITS (HUs)
WARE CREEK RESERVOIR**

Evaluation Element	HSI	HU
Pileated Woodpecker		
Upland mixed pine-hardwood forest	0.35	1369.72
Upland mixed pine-hardwood forest/low density residential	0	0
Upland hardwood forest	0.64	3717.38
Upland hardwood forest/low density residential	0	0
Forested Wetland	0.79	217.80
Gray Squirrel		
Upland mixed pine-hardwood forest	0.34	1330.59
Upland mixed pine-hardwood forest/low density residential	0	0
Upland hardwood forest	0.55	3194.62
Upland hardwood forest/low density residential	0	0
Forested Wetland	0.49	135.09
Woodcock		
Upland mixed pine-hardwood forest	1.0	3913.5
Upland mixed pine-hardwood forest/low density residential	0	0
Upland hardwood forest	0.98	5692.23
Upland hardwood forest/low density residential	0	0
Forested Wetland	0.32	88.22
Scrub-shrub Wetland	0.38	27.89

TABLE 4-31A

BASELINE CALCULATIONS OF HABITAT SUITABILITY INDICES (HSIs) AND HABITAT UNITS (HUs)
WARE CREEK RESERVOIR

Wood Duck (brood habitat)		
Forested Wetland	0.28	77.20
Scrub-shrub Wetland	0.71	52.11
Herbaceous Wetland	0.68	134.71
Beaver		
Forested Wetland	0.55	151.64
Scrub-shrub Wetland	0.95	69.73
Herbaceous Wetland	0.85	168.39
Lacustrine Open Water Wetland	0.87	57.86
Yellow Warbler		
Scrub-shrub Wetland	0.87	63.86
Red-Winged Blackbird		
Herbaceous Wetland	0.26	165.49
Largemouth Bass		
Lacustrine Open Water Wetland	0.77	51.20
Spot (juvenile)		
Estuarine Open Water	0.97	64.99
Total		**20,744.22**

Source: Final Environmental Impact Statement, James City County's Water Supply Reservoir on Ware Creek (USCOE, 1987) are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this document.

Sanctuaries and Refuges

No existing designated sanctuaries or refuges are located within the vicinity of the proposed intake, Ware Creek Reservoir watershed, or pipeline routes associated with this alternative (VDCR, 1989; Delorme Mapping Company, 1989; RRPDC, 1991; JCC, 1991).

Wetlands and Vegetated Shallows

Intake

Tidal freshwater marshes and swamps are found along the Pamunkey River from Hill Marsh (near Romancoke) upstream to Hanover County (Doumlele, 1979). In a classification system based on salinity, these areas lie between the oligohaline (average annual salinity between 0.5 and 5.0 ppt) and non-tidal freshwater wetland zones. The lack of dominance by estuarine marsh grasses (*Spartina spp.*) distinguishes tidal freshwater marshes from oligohaline and higher salinity marshes. Tidal freshwater marshes are characterized by a large, diverse assemblage of broad-leaved plants, grasses, rushes, shrubs, and herbaceous vegetation (Odum et al., 1984).

Tidal marsh inventories of King William County and New Kent County were reviewed and the Northbury intake site was inspected in order to characterize tidal marshes along the Pamunkey in the vicinity of the site. These tidal freshwater marshes are typically dominated by Arrow Arum (*Peltandra virginica*), Pickerelweed (*Pontederia cordata*), Spatterdock (*Nuphar luteum*), Wild Rice (*Zizania aquatica*), and Rice Cutgrass (*Leerzia oryzoides*). In areas where salinities periodically extend into oligohaline ranges (0.5 to 5.0 ppt), species such as Big Cordgrass, Common Three-square (*Scirpus americanus*), Narrow-leaved Cattail (*Typha angustifolia*), smartweeds (*Polygonum spp.*), Arrow Arum, Wild Rice and Water Hemp (*Amaranthus cannabinus*) become the most prevalent community components (Silberhorn and Zacherle, 1987; Odum et al., 1984).

Tidal freshwater swamps are also common along the Pamunkey and are often closely associated with the tidal freshwater marshes. Occurring primarily landward of the marsh, these forested areas are dominated by trees such as Red Maple (*Acer rubrum*), Black Gum (*Nyssa sylvatica*), and ash (*Fraxinus sp.*). In addition, tidal swamps typically support a diverse understory of emergent herbs and shrubs (Silberhorn and Zacherle, 1987; Odum et al., 1984). The Northbury intake site was inspected by Malcolm Pirnie biologists in May 1990. The majority of the site consists of upland agricultural and forested land. A small pond (LOWZ) is found approximately 500 feet east of the pump station site and about 100 feet south of the Pamunkey River. A narrow fringe of wetland vegetation is located on the south shore of the Pamunkey.

A palustrine forested wetland (PF01R) is found directly across from the intake site, on the King William County side of the Pamunkey River. This tidal freshwater swamp is dominated by trees such as River Birch (*Betula nigra*), Sycamore (*Platanus occidentalis*), Red Maple, Sweet Gum (*Liquidambar styraciflua*), and Black Gum. The swamp gradually becomes marshland at points 500 feet upstream and 1,000 feet downstream from the intake site. The upstream marsh consists mainly of Wild Rice, Rice Cutgrass, Spatterdock, Pickerelweed, and Arrow Arum; the downstream marsh is dominated by Arrow Arum, Pickerelweed, Marsh Hibiscus, Spatterdock, Wild Rice, Water Willow (*Decodon verticillatus*), and Spotted Jewelweed (*Impatiens capensis*) (Silberhorn and Zacherle, 1987).

Reservoir

Wetlands at the proposed Ware Creek Reservoir site have been identified and delineated using the criteria described in the ***Corps of Engineers Wetlands Delineation Manual*** (USCOE, 1987). The methodology used to delineate wetlands included a combination of in-house and routine on-site methods for estimating wetland impacts. Wetland classification, diversity analysis, and functional assessment studies were also conducted. Detailed descriptions of the methodology and results of these studies are presented in Report F, ***Wetland Assessment for Reservoir Alternatives*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document; and ***Wetland Evaluation of Proposed Ware Creek, Black Creek, and King William Reservoir Sites*** (Malcolm Pirnie, 1993, Appendix II-1 of Report D (Volume II)).

Preliminary wetland acreage estimates were developed from available map sources, including:

MAP SOURCE	ACRES OF WETLANDS
USFWS NWI Maps	507
SCS Soils Maps	501
Ware Creek EIS (USCOE) [1]	425
USFWS (1985) [2]	583
James City County [3]	653

Notes:

1 USCOE, 1987.

2 U.S. Department of the Interior (1985); 539 acres vegetated; add 44 open water to result in 583 acres.

3 James City County Comprehensive Plan and Zoning Maps adopted 1991. Maps depict only James City County area of 591 acres. New Kent County portion adds 62 acres based on the Ware Creek Final EIS (USCOE, 1987).

Because review of these individual sources did not result in similar wetland acreage estimates, a separate wetland identification was performed using aerial photograph interpretation with field verification. Mapping of the area was conducted using the following sources:

- USGS Topographic Maps - Toano Quadrangle (Scale 1 inch = 2,000 feet)
- USFWS NWI Maps - Toano Quadrangle (Scale 1 inch = 2,000 feet)
- SCS Soils Maps - James City County and New Kent County.
- Ware Creek EIS - Wetland Delineation (USCOE, 1987)

- Aerial Photography - 1982 NHAP (Scale 1 inch = 1,250 feet; Date Flown; March, 7, 1982)

- James City County Mapping - Zoning maps adopted 1992 (Wetlands and 2-foot contours)

- VIMS Tidal Wetland Inventory, 1980

A detailed wetland delineation was conducted in the fall of 1993. The final wetland determination consisted of detailed field mapping of all the wetlands within the reservoir impoundment area using the routine on-site inspection methodology from the ***Corps of Engineers Wetlands Delineation Manual*** (USCOE, 1987). The methodology for the field mapping was developed and agreed upon by the USCOE, representatives of the RRWSG, and representatives of James City County. Field investigations were conducted by teams consisting of two or three wetland professionals with at least one representative of the RRWSG and James City County on each team.

Field investigations of the Ware Creek Reservoir site and preparation of wetland field maps were conducted between October 27 and November 10, 1993. The methodology for the field mapping entailed taking field measurements of wetland dimensions and marking the wetland/upland border on topographic maps (1 inch = 100 feet). Wetland dimensions were measured with hip chains or by pacing, and wetland/upland mosaic areas were assigned a wetland percentage based on transects or visual estimation agreed upon by all team members. Wetland acreage was calculated by planimetering the final field maps. A total of 590 acres of wetlands were delineated at the site below 35 feet msl (normal pool elevation).

Wetland types for the Ware Creek Reservoir site were presented in the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek*** (USCOE, 1987) and are listed in Table 4-32. A wetland classification map based on the RRWSG's delineation is included in Report F. This classification was developed by an interagency team with aerial photograph interpretation and field inspections using the USGS topographic map as a base (scale 1 inch = 2,000 feet).

Wetlands in the tidal portion of Ware Creek near its confluence with the York River are dominated by Salt-marsh Cordgrass. Herbaceous wetlands grade from a mixture of Big Cordgrass, Saltmarsh Cordgrass, and bulrushes (*Scirpus spp.*) in the oligohaline mid-sections, to a mixture of Wild Rice, cattails (*Typha spp.*), Pickerelweed, Arrow Arum, and bulrushes in the tidal freshwater areas. In the non-tidal freshwater emergent areas, cattails, bur-reeds (*Sparganium spp.*), Rice Cutgrass, and smartweeds are common (USCOE, 1987).

Typical tree species found in forested wetlands in the Ware Creek area include Red Maple, Black Gum, Green Ash *(Fraxinus pennsylvanica)*, Sycamore, and Sweetgum. Shrubs and understory species include Black Willow *(Salix nigra)*, Alder (*Alnus sp.*), Northern Spicebush (Lindera benzoin), Poison Ivy *(Toxicodendron radicans)*, Lizard's Tail *(Saururus cernuus)*, blueberries *(Vaccinium spp.)*, sedges *(Carex spp.)* and various ferns (USCOE, 1987).

Scrub-shrub wetlands at the site are commonly vegetated with Alder, Black Willow, Buttonbush *(Cephalanthus occidentalis)*, and Red Maple and Sweetgum saplings. Typical understory vegetation includes bur-reeds, cattails, and Rice Cutgrass (USCOE, 1987).

TABLE 4-32

WETLAND TYPES FOUND IN THE WARE CREEK RESERVOIR IMPOUNDMENT AREA

Abbreviation	Description
PFO1A	Palustine, forested, broad-leaved deciduous, temporarily flooded
PFO1C	Palustine, forested, broad-leaved deciduous, seasonally flooded
PFO1E	Palustine, forested, broad-leaved deciduous, seasonlly saturated
PFO1F	Palustine, forested, broad-leaved deciduous, semipermanently flooded
PFO1R	Palustine, forested, broad-leaved deciduous, seasonlly tidal
PFO1Cb	Palustine, forested, broad-leaved deciduous, seasonally flooded, beaver
PFO1Eb	Palustine, forested, broad-leaved deciduous, seasonlly saturated, beaver
PFO1Fb	Palustine, forested, broad-leaved deciduous, semipermanently flooded, beaver
PFO5Eb	Palustine, forested, dead, seasonlly saturated, beaver
PFO5Fb	Palustine, forested, dead, semipermanently flooded, beaver
PEM1C	Palustrine, emergent, persistent, seasonally flooded
PEM1E	Palustrine, emergent, persistent, seasonlly saturated
PEM1Eb	Palustrine, emergent, persistent, seasonlly saturated, beaver
PEM1Fb	Palustrine, emergent, persistent, semipermanently flooded, beaver
PSS1C	Palustrine, scrub/shrub, broad-leaved deciduous, seasonally flooded
PSS1E	Palustrine, scrub/shrub, broad-leaved deciduous, seasonally saturated
PSS1R	Palustrine, scrub/shrub, broad-leaved deciduous, seasonally tidal
PSS1Eb	Palustrine, scrub/shrub, broad-leaved deciduous, seasonally saturated, beaver
PSS1F	Palustrine, scrub/shrub, broad-leaved deciduous, semipermanently flooded, beaver
POWHh	Palustrine, open water, permanently flooded, impounded
POWZh	Palustrine, open water, intermittently exposed, impounded
L1OWHh	Lacustrine, limnetic, open water, permanent, impounded
E1OWL	Estuarine, subtidal, open water, subtidal
E2EM1P	Estuarine, intertidal, emergent, persistent, irregularly tidal
PFO1/EM1C	These remaining wetland types depict situations in which two distinct subsystems or classes occur within a single ecological system. For instance, PFO1/EM1C refers to a wetland in tthe palustrine ecological system, which is dominated by broad-leaved deciduous trees and has a subdominant, but not insignificant, wetland class comprised of persistent emergent vegetation. The water regime for the wetland in this case is seasonlly flooded. In all of these cases the dominant subsystem or class is shown first,and the subdominant one is shown following a slash (/).
PFO1/EM1Eb	
PFO1/SS1Eb	
PFO5/1Fb	
PFO5/EM1Eb	
PFO5/EM1Fb	
PFO5/EM1R	
PFO5/SS1Fb	
PFO5/OWFb	
PEM1/FO5Fb	
PEM1/SS1C	
PEM1/SS1E	
PEM1/SS1Eb	
PEM1/OWFb	
PSSI/EM1Eb	
PSSI/EM1Fb	
PSSI/EM1R	
PSSI/OWFb	
E2EM1/2P	

Source: Final Environmental Impact Statement - James City County's Proposed Dam and Water Supply Reservoir on Ware Creek (USCOE, 1987).

Note: Nomenclature and abbreviations used are from Classification of Wetlands and Deepwater Habitats in the United States (Cowardin, et al., 1979).

The Ware Creek FEIS does not include wetland acreage for each of the detailed wetland types[1], but it does present a breakdown of wetland acreage by wetland class. Using this breakdown, a Brillouin Index was calculated to describe the wetland diversity within the Ware Creek Reservoir impoundment area. The wetland diversity was then compared to wetland diversity at the Black Creek and King William Reservoir sites. The Brillouin Index traditionally is used to measure species diversity, including species richness (the number of species) and species evenness (the relative abundance of individuals among the species) (Murdoch et al., 1972). By substituting wetland types for species and acres for individuals, the Brillouin Index can also be used to measure landscape diversity. The Brillouin Index calculates a relationship between the total number of wetland acres in the project area and the number of acres in each wetland cover type. When wetland acres for an examined area are distributed among many wetland classes, diversity is high. However, when a large percentage of wetland acres are concentrated in few wetland classes, diversity is low. The Brillouin Index was selected from the many diversity indexes because it is designed for situations where data has been collected for the entire area in question. Table 4-32A presents the wetland acreage included in the Ware Creek FEIS by wetland class and the calculated Brillouin Index. A full description of the wetland diversity analysis is included in Report F.

In April 1993, a wetland evaluation was completed for tidal and non-tidal wetlands within the area of the proposed Ware Creek Reservoir impoundment. The USCOE's Wetland Evaluation Technique (WET) was utilized to assess the functions and values of the wetlands at Ware Creek (Adamus et al., 1987; Adamus et al., 1991). WET is a broad brush approach to wetland evaluation, based on information about predictors of wetland functions that can be gathered quickly. WET estimates the probability that particular functions would occur in a wetland area and provides insight into the importance of these functions. A detailed discussion of the methodology and results of this analysis is contained in Appendix II-1 of Report D, Volume II.

Separate evaluations were prepared for estuarine and palustrine systems within the impoundment area, using the wetland classifications provided in the Ware Creek Reservoir FEIS. For the purposes of this analysis, the site of the proposed impoundment was considered the assessment area (AA) and the impact area (IA). Therefore, this WET analysis provides an assessment of the palustrine and estuarine wetland complexes as a whole. Because the palustrine system consists of many different types of wetlands, the evaluation of any particular wetland site could be different from the overall results achieved in this analysis.

Tables 4-33 and 4-34 summarize the results of the WET analysis for the Ware Creek Reservoir palustrine and estuarine wetlands. According to this analysis, the palustrine system has a high probability of being effective in providing floodflow alteration, sediment stabilization, sediment/toxicant retention, and wildlife habitat. It has a moderate probability of providing production export functions, and a low probability of being effective in providing groundwater recharge, groundwater discharge, nutrient removal/transformation, and aquatic diversity/abundance.

On the whole, the estuarine wetland complex is rated lower than the palustrine system. The estuarine wetland complex within the impoundment area received high scores only for sediment stabilization and wildlife wintering habitat. It received moderate scores for nutrient removal/transformation, productivity export, wildlife breeding habitat, and aquatic diversity.

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1 "Detailed wetland types" refers to the wetland classification using the full Cowardin et al. classification including hydrologic modifiers.

TABLE 4-32A

NWI WETLAND DIVERSITY ANALYSIS
WARE CREEK RESERVOIR IMPOUNDMENT AREA

Wetland Class*	Acres
Palustrine Emergent	181
Palustrine Scrub/Shrub-Emergent	49
Palustrine Forested	152
Open Water**	40
Estuarine Water	3
Total	**425**
Diversity Index	
Brillouin Index	1.75

* Source: Final Environmental Impact Statement, James City County's Water Supply Reservoir on Ware Creek (USCOE, 1987).

** Open Water includes both palustrine and lacustrine open water.

TABLE 4-33

SUMMARY OF WET ANALYSIS RESULTS
WARE CREEK RESERVOIR ESTUARINE WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	M	L	*
Floodflow Alteration	M	L	L
Sediment Stabilization	L	H	*
Sediment/Toxicant Retention	M	L	H
Nutrient Removal/Transformation	M	M	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	M	*
Wildlife Diversity/Abundance (Migration)	*	L	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	L	M	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

TABLE 4-34

SUMMARY OF WET ANALYSIS RESULTS
WARE CREEK RESERVOIR PALUSTRINE WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	M	L	*
Floodflow Alteration	L	H	M
Sediment Stabilization	L	H	*
Sediment/Toxicant Retention	H	H	H
Nutrient Removal/Transformation	H	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	H	*
Wildlife Diversity/Abundance (Migration)	*	H	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	L	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

According to the results of this analysis, the estuarine wetland complex at Ware Creek Reservoir has a low probability of being effective in providing five functions: groundwater recharge, groundwater discharge, floodflow alteration, sediment/toxicant retention, and wildlife migration habitat.

The results of the WET analysis for the estuarine wetlands seem to conflict with existing field data and appear likely to underestimate the value of the wetlands. These wetlands are located in an oligohaline/tidal freshwater transition zone and provide many more ecosystem functions and benefits to fish and wildlife than oligohaline, mesohaline, or haline marshes. However, the WET program does not distinguish between the near-freshwater, oligohaline, mesohaline and haline classes of wetlands. Therefore, the near-freshwater wetlands found within the Ware Creek Reservoir impact area contain the combined value of tidal and non-tidal systems and should, perhaps, receive a higher rating.

The USCOE, USFWS, USEPA, VDGIF, and James City County conducted a Habitat Evaluation Procedures (HEP) analysis for the Ware Creek Reservoir project as proposed by James City County. Forested wetland, scrub-shrub wetland, herbaceous wetland, lacustrine open water, and estuarine open water were among the cover types analyzed for the study. Results of the study are summarized in Table 4-31A. The baseline calculations show that forested and herbaceous wetlands at the Ware Creek site provide moderate habitat values for the wetland indicator species evaluated.

There are approximately 480 acres of tidal wetlands along Ware Creek and its side channels downstream of the Ware Creek Reservoir dam site, according to the VIMS Tidal Marsh Inventories for James City County (Moore, 1980) and New Kent County (Doumlele, 1979) and the USFWS National Wetlands Inventory Map. Using the species indicators for salinity regimes included in the ***Ware Creek Reservoir Release Study*** (Hershner and Perry, 1987), the approximate acreage of tidal freshwater, oligohaline and mesohaline communities can be identified as follows:

TIDAL WETLANDS DOWNSTREAM OF WARE CREEK RESERVOIR	
Tidal Freshwater Wetlands	66 acres
Oligohaline Wetlands	99 acres
Mesohaline Wetlands	260 acres
Total Wetlands	480 acres

Pipeline

There are approximately 21 stream/wetland area crossings along the 26.3 miles of new pipeline. The majority of affected stream/wetland areas would be palustrine forested, broad-leaved deciduous wetlands. Typical tree species of these Virginia Coastal Plain palustrine systems include Sweetgum, River Birch, Black Gum, Red Maple, Green Ash, and Sycamore.

Mud Flats

No mud flats are located in the immediate vicinity of the Northbury intake site based on review of USGS topographic maps and USFWS NWI maps. The closest mud flat to the intake site is located 8,000 feet downstream. No mud flats exist upstream of the site.

No mud flats were identified within the proposed reservoir area or below the proposed dam site on Ware Creek. Also, no mud flats were identified along the pipeline route.

4.3.2 Black Creek Reservoir with Pumpover from the Pamunkey River

Endangered, Threatened, or Sensitive Species

Intake

Endangered, threatened and other sensitive species likely to be found in the vicinity of the proposed Northbury intake site on the Pamunkey River are described in Section 4.3.1.

Reservoir

In the evaluation of Black Creek Reservoir conducted as part of the USCOE's ***Feasibility Report and Final Environmental Impact Statement, Water Supply Study - Hampton Roads, Virginia***, with the exception of transient individuals, no known federal endangered or threatened species were found in the project area (USCOE, 1984).

Bald Eagle. The results of the 1994 and 1996 VDGIF aerial Bald Eagle surveys confirmed that while the Bald Eagle is known to exist in New Kent County, no active nests or concentration areas are located within several miles of the impoundment (D. Bradshaw, VDGIF, personal communication, 1994; VDGIF, 1996). No critical habitat has been designated for the Bald Eagle by USFWS (50 CFR 17.11).

Small Whorled Pogonia. The Small Whorled Pogonia is a member of the orchid family and is a federally-listed threatened and state-listed endangered species. The USFWS has indicated that a historic record for Small Whorled Pogonia is known for New Kent County and that appropriate habitat for this species may exist at the Black Creek Reservoir sites (K.L. Mayne, USFWS, personal communication, 1993). Due to the potential for occurrences of the species within the project area, the USFWS recommended conducting a survey of appropriate habitat within the proposed reservoir area. USFWS' recommended methodology and the methodology selected for the survey are described in detail in Report E. No critical habitat has been designated by the USFWS for the Small Whorled Pogonia (50 CFR 17.12).

Potential habitat for Small Whorled Pogonia within the proposed Black Creek Reservoir was identified in May 1993 by Dr. Donna Ware of The College of William & Mary, based on topographic mapping and color-infrared aerial photography of the area. A total of 35 potential locations were identified, and the total area of prime habitat was estimated to be 147 acres.

Malcolm Pirnie biologists and Small Whorled Pogonia experts conducted field surveys of the areas of potential habitat located within the proposed reservoir sites, in early July 1993 and again in early August 1994. No specimens of Small Whorled Pogonia were found within suitable habitat in the project area. The field studies are documented in Report E.

Sensitive Joint-vetch. Because there are no tidal wetlands within the Black Creek Reservoir area, there is no suitable habitat present to support this species and no search was undertaken.

Other species. A 1992 VDGIF review of the proposed reservoir site identified two other species of concern in the project vicinity: Mabee's Salamander (*Ambystoma mabeei*) and the Northern Diamondback Terrapin (*Malaclemys terrapin*) (VDGIF, 1992). Mabee's Salamander is a state-listed threatened species. While individuals have not been documented in the project area, suitable habitat for the species may be present. The Northern Diamondback Terrapin, which is a candidate for federal protection, is commonly found in brackish and saltwater estuaries and tidal marshes. Therefore, it is not likely to be impacted by the impoundment (S. Carter-Lovejoy, VDGIF, Personal Communication, 1992). No individuals of this species have been found in the project area.

The VDACS indicated that no other state-listed threatened or endangered plant or insect species are known to occur in the immediate area of the proposed Black Creek Reservoirs (J.R. Tate, VDACS, personal communication, 1992).

Pipeline

The USCOE (1984) evaluated a project involving a pumpover from the Pamunkey River at Northbury to Black Creek Reservoir and a pipeline to the headwaters of Diascund Creek. It was documented that at the time of the study there were no known federal endangered or threatened species in the vicinity of the pipeline route, with the exception of transient individuals.

VDGIF review of the pipeline route from the proposed intake site at Northbury to Black Creek Reservoir has identified an active Bald Eagle nest located within 0.5 miles of the proposed pipeline (VDGIF, 1996). No additional species were identified by the VDGIF as being known to occur in proximity to the proposed pipeline route (H. E. Kitchel, VDGIF, personal communication, 1992).

The VDACS identified no state-listed threatened or endangered plant or insect species associated within pipeline routes for this alternative component (J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Intake

Existing conditions at the proposed Northbury intake site are described in Section 4.3.1.

Reservoir

Both VDGIF and Malcolm Pirnie have conducted numerous fish surveys within the pool area and downstream reaches of the Black Creek Reservoir sites. VDGIF conducted surveys in 1983 and 1993, and Malcolm Pirnie conducted surveys in 1990, 1992, and 1994-1995. The combined results of those surveys are presented in Table 4-38A. The table was revised based on review by Dr. Robert Jenkins of Roanoke College (Jenkins, 1996). Species that are not likely to persist in Black Creek under normal conditions were eliminated from the table. A detailed discussion of the methodology and results of the surveys is presented in Report H, ***Fish Survey* for *Areas Affected by Proposed King William Reservoir and Black Creek Reservoir Impoundments*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document.

The fish survey results indicate that no listed or candidate threatened or endangered fish species inhabit Black Creek. However, the Least Brook Lamprey *(Lamptern aepyptera)*, which was found in the non-tidal portion of Black Creek, apparently has declined in Virginia and is considered threatened in North Carolina (Jenkins and Burkhead, 1993).

VDGIF has identified herring species as a primary focus of its concerns, due to the currently depressed condition of regional herring populations. Historical accounts indicate that river herring and shad have used the tidal and non-tidal portions of Black Creek for spawning habitat in the past. In its report on its 1993 Black Creek survey, VDGIF noted that it "would expect herring to [be] found in this creek if further collections had been made later in April" (VDGIF, 1993) (Appendix 4 of Report H).

A single female Blueback Herring containing eggs was collected in the tidal portion of Black Creek during one of the 1994-1995 Malcolm Pirnie fish surveys. Its presence indicates that river herring still utilize Black Creek for spawning but the extent of their activity in the non-tidal portions of Black Creek is unknown. In the non-tidal portions of Black Creek, numerous beaverdams exist which can have an additive impact on fish passage in that fewer and fewer fish are able to traverse each successive dam (Jenkins and Burkhead, 1993).

White Perch *(Morone americana)*, which are considered semi-anadromous (Jenkins and Burkhead, 1993), also have been found in the tidal portions of Black Creek. Like fully anadromous fish, White Perch move upstream to spawn in the spring; but instead of returning to the sea, they remain in mid-estuary zones.

Pipeline

Construction of the new pipeline associated with this alternative would require minor crossings of 10 perennial and 14 intermittent streams. Fish species expected to occur in these streams would be similar to those found in freshwater tributaries of the Chesapeake Bay (see Table 4-39). Invertebrate species found within intermittent and perennial streams crossed by the pipeline are expected to be typical of freshwater invertebrates of the Lower Peninsula (see Table 4-31).

One major crossing of an arm of Little Creek Reservoir would also be required for this alternative. Fish species present in Little Creek Reservoir are discussed in Section 4.3.4. Invertebrate species within the Little Creek Reservoir pool area are expected to be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

Table 4-38A

Combined Fish Survey Results
Black Creek Watershed

Location	Species		VDGIF	MPI	MPI	VDGIF	MPI
Location	Scientific Name	Common Name	1983 *	1990	1992	1993	1994-95
Non-Tidal Waters	*Ameiurus nebulosus*	Brown Bullhead					X
	Anguilla rostrata	American Eel	X	X	X		X
	Aphredoderus sayanus	Pirate Perch	X	X			
	Clinostomus funduloides	Rosyside Dace	X	X			
	Enneacanthus gloriosus	Bluespotted Sunfish	X	X			
	Erimyzon oblongus	Creek Chubsucker	X				X
	Esox americanus	Redfin Pickerel **	X	X	X **		
	Esox niger	Chained Pickerel					X
	Etheostoma olmstedi	Tessellated Darter	X	X			
	Gambusia holbrooki	Eastern Mosquitofish					X
	Hybognathus regius	Eastern Silvery Minnow	X				
	Lampetra aepyptera	Least Brook Lamprey	X				
	Lepomis auritus	Redbreast Sunfish			X		X
	Lepomis gibbosus	Pumpkinseed			X		X
	Lepomis gulosus	Warmouth			X		
	Lepomis macrochirus	Bluegill Sunfish	X				
	Micropterus dolomieui	Smallmouth Bass	X	X			
	Micropterus salmoides	Largemouth Bass			X		
	Nocomis leptocephalus	Bluehead Chub	X				
	Notemigonus crysoleucas	Golden Shiner	X				
	Notropis amoenus	Comely Shiner			X		
	Noturus gyrinus	Tadpole Madtom	X	X	X		
	Rhinichthys atratulus	Blacknose Dace			X		
	Semotilus corporalis	Fallfish	X				
	Semotilus atromaculatus	Creek Chub	X	X	X		
	Umbra pygmaea	Eastern Mudminnow	X	X	X		X
	Total Number of Species		26				

* - Sampling locations within Black Creek watershed were not specified in VDGIF records. Species assemblage indicates that sampling was conducted primarily in non-tidal waters.

** - Listed as Grass Pickerel in Draft EIS.

Table 4-38A

Combined Fish Survey Results
Black Creek Watershed
(Continued)

Location	Species: Scientific Name	Species: Common Name	VDGIF 1983 *	MPI 1990	MPI 1992	VDGIF 1993	MPI 1994-95
Tidal Waters	*Alosa aestivalis*	Blueback Herring					X
	Ameiurus natalis	Yellow Bullhead				X	
	Anguilla rostrata	American Eel				X	X
	Aphredoderus sayanus	Pirate Perch					X
	Dorosoma cepedianum	Gizzard Shad					X
	Enneacanthus gloriosus	Bluespotted Sunfish				X	X
	Erimyzon oblongus	Creek Chubsucker					X
	Etheostoma olmstedi	Tessellated Darter					X
	Fundulus diaphanus	Banded Killifish				X	X
	Fundulus heteroclitus	Mummichog					X
	Gambusia holbrooki	Eastern Mosquitofish					X
	Ictaluridae	Catfish					X
	Lepisosteus osseus	Longnose Gar					X
	Lepomis auritus	Redbreast Sunfish				X	X
	Lepomis gibbosus	Pumpkinseed				X	X
	Lepomis macrochirus	Bluegill Sunfish				X	X
	Micropterus salmoides	Largemouth Bass				X	X
	Morone americana	White Perch					X
	Perca flavescens	Yellow Perch				X	
	Trinectes maculatus	Hogchocker					X
	Total Number of Species	20					
Total Number of Species for Watershed		36					

* - Sampling locations within Black Creek watershed were not specified in VDGIF records. Species assemblage indicates that sampling was conducted primarily in non-tidal waters.

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Acipenseridae	**Sturgeons**
Acipenser brevirostrum	Shortnose Sturgeon
Acipenser oxyrhynchus	Atlantic Sturgeon
Family Anguillidae	**Freshwater Eels**
Anguilla rostrata	American Eel
Family Atherinidae	**Silversides**
Membras martinica	Rough Silverside
Menidia beryllina	Inland Silverside
Menidia menidia	Atlantic Silverside
Family Belonidae	**Needlefishes**
Strongylura marina	Atlantic Needlefish
Family Catostomidae	**Suckers**
Catostomus commersoni	White Sucker
Erimyzon oblongus	Creek Chubsucker
Family Centrachidae	**Sunfishes**
Lepomis gibbosus	Pumkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieui	Smallmouth Bass
Micropterus salmoides	Largemouth Bass
Pomoxis annularis	White Crappie
Pomoxis nigromaculatus	Black Crappie

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Clupeidae	**Herrings**
Alosa aestivalis	Blueback Herring
Alosa mediocris	Hickory Shad
Alosa pseudoharengus	Alewife
Alosa sapidissima	American Shad
Brevoortia tyrannus	Atlantic Menhaden
Dorosoma cepedianum	Gizzard Shad
Dorosoma petenense	Threadfin Shad
Family Cyprinidae	**Minnows and Carps**
Carassius auratus	Goldfish
Hybognathus nuchalis	Silvery Minnow
Notemigonus crysoleucas	Golden Shiner
Notropis analostanus	Satinfin Shiner
Notropis hudsonius	Spottail Shiner
Family Cyprinodontidae	**Killifishes**
Cyprinodon variegatus	Sheepshead Minnow
Fundudlus diaphanus	Banded Killifish
Fundulus heteroclitus	Munnichog
Fundulus majalis	Stripped Killifish
Lucania parva	Rainwater Killifish
Family Engraulidae	**Anchovies**
Anchoa mitchilli	Bay Anchovy

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Esocidae	**Pikes**
Esox americanus	Redfin Pickerel
Esox niger	Chain Pickerel
Family Gasterosteidae	**Sticklebacks**
Gasterosteus aculeatus	Threespine Stickleback
Family Ictaluridae	**Bullhead Catfishes**
Ictalurus catus	White Catfish
Ictalurus nebulosus	Brown Bullhead
Ictalurus punctatus	Channel Catfish
Family Lepisosteidae	**Gars**
Lepisosteus osseus	Longnose Gar
Family Percichthyidae	**Temperate Basses**
Morone americana	White Perch
Morone saxatilis	Striped Bass
Family Percidae	**Perches**
Etheostoma olmstedi	Tessellated Darter
Perca flavescens	Yellow Perch
Family Poeciliidae	**Livebearers**
Gambusia affinis	Mosquitofish
Family Sciaenidae	**Drums**
Leiostomus xanthurus	Spot
Micropogonias undulatus	Atlantic Croaker

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Soleidae	**Soles**
Trinectes maculatus	Hogchoker
Family Umbridae	**Mudminnows**
Umbra pygmaea	Eastern Mudminnow

Source: Lippson, A.J. and R.L. Lippson. 1984. Life in the Chesapeake Bay. The John Hopkins University Press, Baltimore, Maryland.

Other Wildlife

Intake

Existing conditions at the proposed Pamunkey River intake site are described in Section 4.3.1.

Reservoir

To compile a list of typical wildlife species expected at the reservoir sites, Malcolm Pirnie scientists conducted the biological analyses using a combination of classification of vegetative community types, examination of existing wildlife references, and on-site field inspections.

Existing community types ware classified as prescribed by Anderson et al. (1976) based on reviews of false color-infrared aerial photography of the proposed project sites. According to this analysis, the vegetation community types in the reservoir drainage area, including the pool area, were estimated to comprise 320 acres of coniferous forest; 77 acres of deciduous forest; and 2,375 acres of mixed coniferous/ deciduous forest[2]; 458 acres of agricultural, residential, and open field; and 289 acres of wetlands (including forested wetlands), and open water. The remaining area consists of roads, which have limited wildlife habitat value.

Vegetation communities in the reservoir pool area were estimated to be 15 acres of coniferous forest; 34 acres of deciduous forest; 497 acres of mixed coniferous/deciduous forest; 79 acres of agricultural, residential, and open field communities; and 285 acres of wetlands and open water.

A list of wildlife species from the Biota of Virginia database (BOVA) was obtained from VDGIF. The list included wildlife species known to occur in riparian habitats along the Chickahominy, Pamunkey, and Mattaponi Rivers and Ware Creek, Black Creek, and Diascund Creek (VDGIF, 1992). Additional published wildlife references were also reviewed to identify wildlife species typical for each identified community type.

Malcolm Pirnie biologists also conducted field studies at the Black Creek Reservoir site during May and June of 1990. Those field studies were based on the single-dam Black Creek Reservoir site being evaluated by the RRWSG at that time; but the biological analysis addresses the entire Black Creek watershed, so the findings regarding current (baseline) conditions should not be affected. Wildlife species typical of each community type are listed in Tables 4-39A through 4-39G.

VDGIF's records for the area downstream of the proposed impoundment identified several heron rookeries located along the Pamunkey River, approximately 0.5 miles downstream of the mouth of Black Creek (H. E. Kitchel, VDGIF, personal communication, 1992). The Great Blue Heron is ranked by the State as rare to uncommon and is considered a species of special concern by the USFWS. Therefore, it is federally protected from "takings" as defined in the Migratory Bird Treaty Act, 16 U.S.C. §§ 703-712.

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[2] Mixed coniferous/deciduous forest is defined as an area where both evergreen and deciduous trees are growing and neither predominates.

TABLE 4-39A

TYPICAL WILDLIFE SPECIES OF THE MIXED FOREST COMMUNITY

Scientific Name	Common Name
Amphibians	
Bufo americanus	American Toad
Bufo woodhousei fowleri	Fowlers Toad
Plethodon glutinosus	Slimy Salamander
Reptiles	
Agkistrodon contortrix	Copperhead
Carphophis amoenus	Worm Snake
Diadophis punctatus	Ringneck Snake
Terrapene carolina	Eastern Box Turtle
Virginia valeriae	Smooth Earth Snake
Birds	
Accipiter striatus	Sharp-shinned Hawk
Buteo lineatus	Red-shouldered Hawk
Buteo platypterus	Broad Winged Hawk
Carduelis pinus	Pine Siskin
Catharus guttatus	Hermit Thrush
Contopus virens	Eastern Pewee
Corvus brachyrhynchos	American Crow
Cyanocitta cristata	Blue Jay
Dendroica coronata	Yellow-rumped Warbler
Dryocopus pileatus	Pileated Woodpecker
Junco hyemalis	Northern Junco
Melanerpes carolinus	Red-bellied Sapsucker
Parus atricapillus	Black-capped Chickadee
Parus biocolor	Tufted Titmouse

TABLE 4-39A

TYPICAL WILDLIFE SPECIES OF THE MIXED FOREST COMMUNITY

Scientific Name	Common Name
Parus carolinensis	Carolina Chickadee
Picoides pubescens	Downy Woodpecker
Picoides villosus	Hairy Woodpecker
Sphyrapicus varius	Yellow-bellied Sapsucker
Troglodytes aedon	House Wren
Vireo gilvus	Warbling Vireo
Zenaida macroura	Mourning Dove
Zonotrichia albicollis	White-throated Sparrow
Mammals	
Didelphis virginiana	Virginia Opossum
Glaucomys volans	Southern Flying Squirrel
Odocoileus virginianus	White-Tailed Deer
Peromyscus maniculatus	Deer Mouse
Sciurus carolinensis	Gray Squirrel
Urocyon cinereoargenteus	Gray Fox
Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.	

TABLE 4-39B

TYPICAL WILDLIFE SPECIES OF THE DECIDUOUS FOREST AND COVE HARDWOOD COMMUNITY

Scientific Name	Common Name
Amphibians	
Ambystoma maculatum	Spotted Salamander
Ambystoma opacum	Marbled Salamander
Bufo americanus	American Toad
Bufo woodhousei fowleri	Fowler's Toad
Eurycea bislineata cirrigera	Southern Two-lined Salamander
Plethodon glutinosus	Slimy Salamander
Reptiles	
Agkistrodon contortrix mokason	Copperhead
Carphophis amoenus	Worm Snake
Diadophis punctatus	Ringneck Snake
Elaphe obsoleta	Rat Snake
Eumeces fasciatus	Five-lined Skink
Lampropeltis calligaster	Mole Kingsnake
Opheodrys aestivus	Rough Green Snake
Storeria dekayi	Northern Brown Snake
Storeria occipitomaculata	Redbelly Snake
Terrapene carolina	Eastern Box Turtle
Virginia valeriae	Smooth Earth Snake
Birds	
Accipiter striatus	Sharp-shinned Hawk
Buteo lineatus	Red-shouldered Hawk
Buteo platypterus	Broad-winged Hawk
Coccyzus americanus	Yellow-billed Cuckoo
Contopus virens	Eastern Pewee
Corvus brachyrhynchos	American Crow
Cyanocitta cristata	Blue Jay
Dryocopus pileatus	Pileated Woodpecker
Empidonax virescens	Acadian Flycatcher
Hylocichla mustelina	Wood Thrush
Melanerpes carolinus	Red-bellied Sapsucker

TABLE 4-39B

TYPICAL WILDLIFE SPECIES OF THE DECIDUOUS FOREST AND COVE HARDWOOD COMMUNITY

Scientific Name	Common Name
Parus atricapillus	Black-capped Chickadee
Parus bicolor	Tufted Titmouse
Parus carolinensis	Carolina Chickadee
Picoides pubescens	Downy Woodpecker
Picoides villosus	Hairy Woodpecker
Polioptila caerulea	Blue-gray Gnatcatcher
Seiurus aurocapillus	Ovenbird
Setophaga ruticilla	American Redstart
Sphyrapicus varius	Yellow-billed Cuckoo
Troglodytes aedon	House Wren
Vireo flavifrons	Yellow-throated Vireo
Vireo gilvus	Warbling Vireo
Zenaida macroura	Mourning Dove
Mammals	
Blarina brevicauda	Northern Short-tailed Shrew
Didelphis virginiana	Virginia Opossum
Glaucomys volans	Southern Flying Squirrel
Peromyscus leucopus	White-footed Mouse
Peromyscus maniculatus	Deer Mouse
Sciurus carolinensis	Gray Squirrel
Sorex hoyi	Pygmy Shrew
Tamias striatus	Eastern Chipmunk
Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.	

TABLE 4-39C

TYPICAL WILDLIFE SPECIES OF THE PINE PLANTATION AND CONIFEROUS FOREST COMMUNITY

Scientific Name	Common Name
Amphibians	
Bufo americanus	American Toad
Bufo woodhousei	Fowler's Toad
Hyla crucifer	Spring Peeper
Plethodon glutinosus	Slimy Salamander
Reptiles	
Agkistrodon contortrix	Copperhead
Carphophis amoenus	Worm Snake
Diadophis punctatus	Ringneck Snake
Sceloporus undulatus	Eastern Fence Lizard
Scincella lateralis	Ground Skink
Storeria occipitomaculata	Redbelly Snake
Terrapene carolina	Eastern Box Turtle
Virginia valeriae	Smooth Earth Snake
Birds	
Accipiter striatus	Sharp-shinned Hawk
Aimophila aestivalis	Bachman's Sparrow
Asio otus	Long-eared Owl
Bubo virginianus	Great Horned Owl
Buteo lineatus	Red-shouldered Hawk
Cardinalis cardinalis	Northern Cardinal
Carduelis pinus	Pine Siskin
Catharus guttatus	Hermit Thrush

TABLE 4-39C

TYPICAL WILDLIFE SPECIES OF THE PINE PLANTATION AND CONIFEROUS FOREST COMMUNITY

Scientific Name	Common Name
Certha familiaris	Brown Creeper
Chordeiles minor	Common Nighthawk
Coccyzus americanus	Yellow-billed Cuckoo
Contopus virens	Eastern Pewee
Corvus brachyrhynchos	American Crow
Cyanocitta cristata	Bluejay
Dendroica coronata	Yellow-rumped Warbler
Dendroica dominica	Yellow-throated Warbler
Dendroica pinus	Pine Warbler
Dryocopus pileatus	Pileated Woodpecker
Otus asio	Common Screechowl
Picoides villosus	Hairy Woodpecker
Polioptila caerulea	Blue-gray Gnatcatcher
Regulus calendula	Ruby-crowned Kinglet
Regulus satrapa	Golden-crowned Kinglet
Sitta carolinensis	White-breasted Nuthatch
Sphyrapicus varius	Yellow-bellied Sapsucker
Spizella passerina	Chipping Sparrow
Strix varia	Barred Owl
Troglodytes aedon	House Wren
Troglodytes troglodytes	Winter Wren

TABLE 4-39C

TYPICAL WILDLIFE SPECIES OF THE PINE PLANTATION AND CONIFEROUS FOREST COMMUNITY

Scientific Name	Common Name
Tyto alba	Barn Owl
Zenaida macroura	Mourning Dove
Zonotrichia albicollis	White-throated Sparrow
Mammals	
Didelphis virginiana	Virginia Opossum
Lasiurus cinereus	Hoary Bat
Peromyscus maniculatus	Deer Mouse
Urocyon cinereoargenteus	Gray Fox

Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.

TABLE 4-39D

TYPICAL WILDLIFE SPECIES OF THE OPEN FIELD/ AGRICULTURAL COMMUNITY

Scientific Name	Common Name
Amphibians	
Bufo americanus	American Toad
Bufo woodhousei	Fowlers Toad
Reptiles	
Coluber constrictor	Black Racer
Elaphe obsoleta	Black Rat Snake
Ophisaurus attenuatus	Slender Glass Lizard
Sceloporus undulatus	Eastern Fence Lizard
Thamnophis sirtalis	Eastern Garter Snake
Birds	
Carduelis tristis	American Goldfinch
Carpodacus mexicanus	House Finch
Circus cyaneus	Northern Harrier
Columba livia	Rock Dove
Corvus brachyrhynchos	American Crow
Falco sparverius	American Kestrel
Hirundo rustica	Barn Swallow
Mimus polyglottos	Northern Mockingbird
Molothrus ater	Brown-headed Cowbird
Otus asio	Common Screechowl
Passer domesticus	House Sparrow
Progne subis	Purple Martin
Sialia sialis	Eastern Bluebird
Spizella passerina	Chipping Sparrow
Spizella pusilla	Field Sparrow

TABLE 4-39D

TYPICAL WILDLIFE SPECIES OF THE OPEN FIELD/ AGRICULTURAL COMMUNITY

Scientific Name	Common Name
Sturnella magna	Eastern Meadowlark
Sturnus vulgaris	European Starling
Turdus migratorius	American Robin
Tyrannus tyrannus	Eastern Kingbird
Tyto alba	Barn Owl
Zenaida macroura	Mourning Dove
Mammals	
Condylura cristata	Star-nosed Mole
Cryptotis parva	Least Shrew
Didelphis virginiana	Virginia Opossum
Marmota monax	Woodchuck
Mephitis mephitis	Striped Skunk
Microtus pennsylvanicus	Meadow Vole
Microtus pinetorum	Woodland Vole
Mustela frenata	Long-tailed Weasel
Odocoileus virginianus	White-tailed Deer
Peromyscus leucopus	White-footed Mouse
Procyon lotor	Raccoon
Reithrodontomys humulis	Eastern Harvest Mouse
Scalopus aquaticus	Eastern Mole
Sorex longirostris	Southeastern Shrew
Sylvilagus floridanus	Eastern Cottontail
Vulpes vulpes	Red Fox
Zapus hudsonius	Meadow Jumping Mouse

Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.

TABLE 4-39E

TYPICAL WILDLIFE SPECIES OF THE PALUSTRINE FORESTED BROAD-LEAVED DECIDUOUS COMMUNITY

Scientific Name	Common Name
Amphibians	
Ambystoma maculatum	Spotted Salamander
Ambystoma opacum	Marbled Salamander
Bufo americanus	American Toad
Bufo woodhousei	Fowler's Toad
Desmognathus fuscus	Northern Dusky Salamander
Eurycea bislineata	Two-lined Salamander
Eurycea guttolineata	Three-lined Salamander
Hyla chrysoscelis	Green Frog
Hyla crucifer	Spring Peeper
Notophthalmus viridescens	Eastern Newt
Plethodon cinereus	Red-backed Salamander
Plethodon glutinosus	Slimy Salamander
Pseudotriton montanus	Mud Salamander
Pseudotriton ruber	Red Salamander
Rana palustris	Pickerel Frog
Rana sphenocephala	Southern Leopard Frog
Reptiles	
Agkistrodon piscivorus	Cottonmouth
Carphophis amoenus	Worm Snake
Diadophis punctatus	Ringneck Snake
Elaphe obsoleta	Rat Snake
Eumeces fasciatus	Five-lined Skink
Nerodia erythrogaster	Redbelly Water Snake
Scincella lateralis	Ground Skink
Terrapene carolina	Eastern Box Turtle
Thamnophis sirtalis	Eastern Garter Snake

TABLE 4-39E

TYPICAL WILDLIFE SPECIES OF THE PALUSTRINE FORESTED BROAD-LEAVED DECIDUOUS COMMUNITY

Scientific Name	Common Name
Birds	
Aix sponsa	Wood Duck
Anas platyrhynchos	Mallard
Euphagus carolinus	Rusty Blackbird
Geothlypis trichas	Common Yellowthroat
Meleagris gallopavo	Wild Turkey
Seiurus motacilla	Louisiana Waterthrush
Strix varia	Barred Owl
Mammals	
Didelphis virginiana	Virginia Opossum
Mustela vison	Mink
Odocoileus virginianus	White-tailed Deer
Peromyscus leucopus	White-footed Mouse
Procyon lotor	Raccoon
Sorex longirostris	Southeastern Shrew
Ursus americanus	Black Bear

Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.

TABLE 4-39F

TYPICAL WILDLIFE SPECIES OF THE SCRUB-SHRUB COMMUNITY

Scientific Name	Common Name
Amphibians	
Bufo americanus	American Toad
Bufo woodhousei	Fowler's Toad
Reptiles	
Sceloporus undulatus	Eastern Fence Lizard
Birds	
Accipiter striatus	Sharp-shinned Hawk
Cardinalis cardinalis	Northern Cardinal
Columba livia	Rock Dove
Dendroica coronata	Yellow-rumped Warbler
Dendroica discolor	Prairie Warbler
Dendroica petechia	Yellow Warbler
Dumetella carolinensis	Gray Catbird
Oporornis formosus	Kentucky Warbler
Thryothorus ludovicianus	Carolina Wren
Vireo griseus	White-eyed Vireo
Zenaida macroura	Mourning Dove
Zonotrichia albicollis	White-throated Sparrow
Mammals	
Didelphis virginiana	Virginia Opossum
Odocoileus virginianus	White-tailed Deer
Sylvilagus floridanus	Eastern Cottontail

Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.

TABLE 4-39G

TYPICAL WILDLIFE SPECIES OF THE EMERGENT/OPEN WATER COMMUNITY

Scientific Name	Common Name
Amphibians	
Acris crepitans	Northern Cricket Frog
Ambystoma maculatum	Spotted Salamander
Ambystoma opacum	Marbled Salamander
Amphiuma means	Two-toed Amphiuma
Bufo americanus	American Toad
Bufo woodhousei	Fowler's Toad
Hyla cinerea	Green Treefrog
Hyla crucifer	Spring Peeper
Notophthalmus viridescens	Eastern Newt
Rana clamitans	Green Frog
Rana sphenocephala	Southern Leopard Frog
Reptiles	
Clemmys guttata	Spotted Turtle
Kinosternon subrubrum	Eastern Mud Turtle
Sternotherus odoretus	Eastern Musk Turtle
Terrapene carolina	Eastern Box Turtle
Birds	
Aix sponsa	Wood Duck
Anas acutta	Common Pintail
Anas platyrhyncnos	Mallard
Anas rubripes	American Black Duck
Ardea herodias	Great Blue Heron
Branta canadensis	Canada Goose
Circus cyaneus	Northern Harrier
Melospiza georgiana	Swamp Sparrow

TABLE 4-39G

TYPICAL WILDLIFE SPECIES OF THE EMERGENT/OPEN WATER COMMUNITY

Scientific Name	Common Name
Mammals	
Castor canadenis	Beaver
Didelphis virginiana	Virginia Opossum
Odocoileus virginianus	White-tailed Deer
Oryzomys palustris	Marsh Rice Rat
Procyon lotor	Raccoon
Zapus hudsonius	Meadow Jumping Mouse
Sources: Martof et al., 1980; Peterson, 1980; Webster et al., 1985.	

In 1983, the USCOE and the USFWS conducted a HEP analysis (USFWS, 1983) to determine the value of the habitat proposed for impoundment with the single dam Black Creek Reservoir configuration evaluated in the Norfolk District USCOE's ***Water Supply Study, Hampton Roads, Virginia*** (USCOE, 1984). The value of the habitat was determined by measuring vegetative components for selected species and determining the appropriate habitat suitability index from species models to obtain habitat units (HU) for the evaluated species. Based on the twelve species analyzed, it was determined that there is a total of 13,439 HU available in the project site watershed. Results of the Black Creek HEP study are presented in Table 4-39H.

Pipeline

Assuming a right-of-way width of 50 feet, the new pipeline would disturb approximately 119 acres of land (excluding the Little Creek Reservoir crossing). Existing vegetation community types along the proposed pipeline route were identified through reviews of USGS topographic maps and color-infrared aerial photography.

One of the criteria used in siting the pipeline route was to utilize existing maintained rights-of-way, such as roads and power lines, and to avoid forested or wetland areas when feasible. Based on USGS topographic maps, of the total 19.6 miles of new pipeline required for the Black Creek Reservoir project, approximately 8.4 miles (43 percent) would be along or within existing rights-of-way, approximately 7.6 miles (39 percent) of the pipeline routes would be located in forest or wetland areas, and 3.6 miles (18 percent) would cross agricultural fields. Wildlife species typical of these community types are listed in Tables 4-39A through 4-39G. Of the 8.4 miles of pipeline within existing rights-of-way, approximately 4.3 miles of new pipeline between Diascund Reservoir and Little Creek Reservoir would be laid and maintained within an existing raw water pipeline right-of-way through James City County. Because rights-of-way are periodically mowed, vegetation is typical of early stages of succession or old field communities. An additional 4.1 miles of the Black Creek Reservoir pipeline route would follow existing road or utility corridors, thereby minimizing forest fragmentation.

Approximately 3,600 linear feet of pipeline between the two Black Creek Reservoir impoundments would be directionally drilled, avoiding any impacts to surface vegetation or wildlife habitat.

Sanctuaries and Refuges

No existing designated sanctuaries or refuges are located within the vicinity of the proposed intake at Northbury, the Black Creek Reservoir watershed, or pipeline routes for this alternative (VDCR, 1989; Delorme Mapping Company, 1989; RRPDC, 1991; JCC, 1991).

Wetlands and Vegetated Shallows

Intake

A description of the wetlands located adjacent to and downstream of the Northbury site is included in Section 4.3.1.

Reservoir

Wetlands at the proposed Black Creek Reservoir site have been identified and delineated using the criteria described in the ***Corps of Engineers Wetlands Delineation Manual*** (USCOE, 1987). The methodology used to delineate wetlands included a combination of in-house and

TABLE 4-39H

BASELINE CALCULATIONS OF HABITAT SUITABILITY INDICES (HSIs) AND HABITAT UNITS (HUs) BLACK CREEK RESERVOIR

Evaluation Element	HSI	HU
Gray Squirrel	0.60	1312.80
White-tailed Deer	0.80	2419.20
Beaver	1.00	950.00
White-footed Mouse	1.00	2850.00
Mourning Dove	0.80	156.00
Wood Duck	0.20	449.80
Barred Owl	1.00	2328.00
Red-tailed Hawk	0.40	901.60
Eastern Meadowlark	0.40	28.80
Pine Warbler	0.20	431.00
Veery	0.50	1394.50
Bullfrog	0.90	216.90
Total		**13,438.60**

Source: Draft Coordination Act Report, Southside/Northside Water Supply Study (USFWS, 1983) routine on-site methods for estimating wetland impacts. Wetland classification, diversity analysis, and functional assessment studies were also conducted. Detailed descriptions of the methodology and results of these studies are presented in Report F and in Appendix II-1 of Report D (Volume II).

Available information from existing map sources was first compiled to identity wetland acreage at the site. The following wetland acreages were obtained through interpretation of the listed map sources for the proposed Black Creek Reservoir site:

MAP SOURCE	ACRES OF WETLANDS
USFWS NWI Maps	158
SCS Soils Maps	246

Because these sources did not agree on wetland acreage, color-infrared aerial photographs were obtained. Detailed wetland mapping of the proposed reservoir area was conducted by compiling the following sources:

- USGS Topographic Maps - New Kent Quadrangle (Scale: 1 inch = 2,000 feet)
- USFWS NWI maps - New Kent Quadrangle (Scale: 1 inch = 2,000 feet)
- SCS Soils Maps - New Kent County
- Aerial Photography - 1984 NHAP (Scale 1 inch = 1,300 feet; Date flown: 4/24/84)
- Aerial Photography - 1989 NAPP (Scale 1 inch = 830 feet; Date flown: 3/11/89)

A preliminary wetland map was developed using the 1989 NAPP 1 inch = 830 feet aerial photographs as a base, and overlaying the USGS topographic map adjusted to the same scale. The 1989 photographs were used for Black Creek because the poor quality of the 1984 photographs made vegetation types difficult to discern. Once interpretation of the aerial photography was complete, field studies were initiated to correct the map based on actual field conditions.

The entire wetland boundary was inspected and the wetland line was adjusted in several places. This analysis estimated that 285 acres of wetlands would be impacted at the Black Creek Reservoir below the 100-foot msl elevation.

Final detailed field mapping of all the wetlands within the reservoir impoundment areas was planned using the routine on-site inspection methodology from the ***Corps of Engineers Wetlands Delineation Manual*** (USCOE, 1987). The methodology for the field mapping was developed and agreed upon by the USCOE, representatives from the RRWSG, and representatives from James City County.

Field mapping at the Black Creek Reservoir site was begun in August 1994. Soon thereafter, however, the New Kent County Board of Supervisors asked the RRWSG to terminate all studies related to the Black Creek Reservoir. Before field mapping was interrupted, approximately one-half of the Southern Branch Black Creek impoundment area had been completed. Therefore, the 1993 wetland estimate, based on aerial photograph interpretation and available field verification, is presented for comparison with the other reservoir sites.

Wetlands within the Black Creek Reservoir impoundment areas were classified according to the classification system developed by Cowardin et al. and published in ***Classification of Wetlands and Deepwater Habitats of the United States*** (Cowardin et al., 1979). For purposes of this analysis, two modifications were made to Cowardin's classification system. First, no distinction was made between dominant and subdominant subclasses (i.e., PFO1/EM1 was considered the same as PEM1/FO1). Second, hydrologic modifiers were limited to temporarily flooded, seasonally flooded, semi-permanently flooded, permanently flooded, and intermittently exposed/permanent.

Because detailed Black Creek field mapping could not be completed, wetland classifications are presented only for the Southern Branch of Black Creek where half of the field mapping was completed. Wetland classification was accomplished with field notes from the detailed wetland field mapping and aerial photograph interpretation. The field notes assisted the scientists in identifying the aerial photograph signatures for each wetland type. Table 4-40 presents the 28 wetland types identified in the Southern Branch of Black Creek impoundment area. A wetland classification map is included in Report F. The materials used in the wetland classification analysis include the following:

- 1 inch = 200 feet scale enlargements of 1 inch = 660 feet scale aerial photographs (ASC, 3/12/94)

- 1 inch = 200 feet scale reductions of 1 inch = 100 feet scale topographic maps (ASC, 3/12/94)

Typical species found in non-tidal forested wetlands at the site include Red Maple, Alder, Yellow Poplar *(Liriodendron tulipifera)*, River Birch, Black Willow, Arrowood *(Viburnum dentatum)*, and various sedges, cattails, rushes, and ferns. Typical species found in palustrine emergent wetlands at the Black Creek Reservoir site include sedges, Soft Rush *(Juncus effuses)*, Woolgrass Bulrush *(Scirpus cyperinus)*, Sensitive Fern *(Onoclea sensibilis)*, Cinnamon Fern *(Osmunda cinnamomea)*, and cattails. Non-tidal scrub-shrub wetlands represent an intermediate successional stage between emergent and forested systems and are very important to a wide variety of fish and wildlife species. Typical species in these scrub-shrub wetlands include Northern Spicebush, Alder, Buttonbush, Arrowood, and various young willows, maples, gums and ashes. Understory species include various sedges, ferns, grasses, rushes and cattails.

To better describe the wetland complexes of the Black Creek Reservoir sites, a diversity analysis was performed. In landscape level analyses, diversity can be broken down into two components: composition and configuration. Composition is a non-spatial feature related to the number of cover types and the proportion of the total area that each type represents (also known as evenness). Configuration relates to the shape of the landscape patches and the spatial arrangement of those patches. (A patch is a subunit of the landscape which is generally homogeneous in cover type for the scale at which the analysis is performed.) More complexity in patch shape within a landscape (i.e., areas with irregular edges) generally allows for more interaction between patches. Likewise, greater numbers of cover types immediately adjacent to one another generally increases the interaction between cover types, thereby increasing diversity.

Table 4-40
Wetland Types Found in the Black Creek Reservoir Southern Branch Impoundment Area

Class	Abbreviation	%	Subtotal	Wetland Description
Unvegetated U.S. Waters	Channel	6%		Small unvegetated stream channel
	POWZb	2%		Palustrine, open water, intermittently exposed, beaver
	POWZh	1%		Palustrine, open water, intermittently exposed, impounded
	PUBHh	13%	22%	Palustrine, unconsolidated bottom, permanently flooded, impounded
Palustrine Emergent	PEM1A	<1%		Palustrine, emergent, persistent, temporarily flooded
	PEM1C	4%		Palustrine, emergent, persistent, seasonally flooded
	PEM1F	8%		Palustrine, emergent, persistent, semipermanently flooded
	PEM1Fb	1%		Palustrine, emergent, persistent, semipermanently flooded, beaver
	PEM1Fh	1%		Palustrine, emergent, persistent, semipermanently flooded, impounded
	PEM2Fb	2%	16%	Palustrine, emergent, non-persistent, semipermanently flooded, beaver
Palustrine Forested	PFO1A	11%		Palustrine, forested, broad-leaved deciduous, temporarily flooded
	PFO1C	9%		Palustrine, forested, broad-leaved deciduous, seasonally flooded
	PFO1Ch	2%	22%	Palustrine, forested, broad-leaved deciduous, seasonally flooded, impounded
Palustrine Scrub-Shrub	PSS1A	<1%		Palustrine, scrub/shrub, broad-leaved deciduous, temporarily flooded
	PSS1C	2%		Palustrine, scrub/shrub, broad-leaved deciduous, seasonally flooded
	PSS1F	3%		Palustrine, scrub/shrub, broad-leaved deciduous, semipermanently flooded
	PSS1Fb	1%	6%	Palustrine, scrub/shrub, broad-leaved deciduous, semipermanently flooded, beaver
Palustrine Emergent/ Scrub-Shrub	PEM1/SS1C	2%		These remaining wetland types depict situations in which two distinct subsystems or classes occur within a single ecological system. For instance, PFO1/EM1C refers to a wetland in the palustrine ecological system, which is co-dominated by broad-leaved deciduous trees and persistent emergent vegetation. The water regime for the wetland in this case is seasonally flooded.
	PEM1/SS1F	2%		
	PEM1/SS1Fb	3%		
	PEM1/SS1Fh	<1%	7%	
Palustrine Forested/ Emergent	PFO1/EM1A	4%		
	PFO1/EM1C	7%		
	PFO1/EM1Fb	1%	12%	
Palustrine Forested/ Scrub-Shrub	PFO1/SS1C	8%	8%	
Palustrine Open Water/ Emergent	POW/EM1Fb	2%		
	POW/EM1Zb	1%		
	POW/EM2Zb	1%	4%	
Total		100%	100%	

Note Nomenclature and abbreviations used are from 'Classification of Wetlands and Deepwater Habitats in the United States' (Cowardin, et. al., 1979).

Diversity indices traditionally are used to measure species diversity, including species richness (the number of species) and species evenness (the relative abundance of individuals among the species). By substituting cover types for species and acres for individuals, the diversity index also can be used to measure landscape diversity.

Composition diversity was calculated for the Southern Branch of Black Creek impoundment area, using the wetland classes from detailed wetland classification. The Brillouin Index, Shannon's Index and Romme's Relative Evenness were calculated (Murdoch et al. 1972). The Brillouin Index was selected from the many diversity indices because it is designed for situations where data has been collected on the entire area in question, as was the case for the King William project and the Ware Creek alternative. The Brillouin Index calculates a relationship between the total number of wetland acres in the project area and the number of acres in each wetland cover type. When wetland acres for an examined area are distributed among many wetland classes, compositional diversity is high. However, when a large percentage of wetland acres are concentrated in few wetland classes, compositional diversity is low.

Shannon's Index is very similar to the Brillouin Index in that it incorporates the number of wetland classes, the total number of classes, and the evenness of acreage distribution. However, it is designed to measure the compositional diversity of a sample from a larger population, and therefore may be more appropriate in this case because the entire BCR impoundment area is not included. Romme's Relative Evenness addresses only the evenness of acreage distribution and normalizes for the number of wetland classes.

To measure configuration diversity, a Modified Fractal Dimension (Olsen et al., 1993) was used. Fractal dimensions are commonly used in landscape analyses to describe the complexity of patch shape and the associated patch interaction. The Modified Fractal Dimension calculates a relationship between the modified perimeter of a patch, the area of the patch, the number of adjacent cover types, and the total number of cover types in the project area.

Table 4-40B presents the diversity indices calculated for the Southern Branch of Black Creek impoundment area using the detailed wetland classification.

The results of the wetland diversity analysis indicate that the Southern Branch impoundment area includes a diverse wetland complex. In comparison to the King William Reservoir wetland complex, the Southern Branch impoundment area is more diverse in composition and similar in configuration. The higher compositional diversity in Black Creek is primarily due to the more even distribution of acreage among the number of wetland types over the total wetland area. Therefore, Romme's Relative Evenness is much higher for the Black Creek wetlands than for the King William wetlands. A full description of the wetland diversity analysis is presented in Report F.

In April 1993, a wetland evaluation was completed for non-tidal wetlands within the area of the proposed Black Creek Reservoir impoundments. The USCOE's Wetland Evaluation Technique (WET) was utilized to assess the functions and values of the wetlands at Black Creek (Adamus et al., 1987; Adamus et al., 1991). WET is a broad brush approach to wetland evaluation, based on information about predictors of wetland functions that can be gathered quickly. WET estimates the probability that particular functions will occur in a wetland area and provides insight into the importance of those functions. A detailed discussion of the methodology and results of this analysis is contained in Appendix II-1 of Report D (Volume II).

Table 4-40B

Wetland Diversity Analysis
Black Creek Reservoir
Southern Branch Impoundment Area

Diversity Index		Equation	Result
Composition	Shannon's Index (Base 2 log)	H = [log N - sum(n*log n)/N]	2.81
	Brillouin's Index (Base 2 log)	H = [log N! - sum(log n!)]/N	2.60*
	Romme's Relative Evenness	E = -100(ln(sum Pi^2))/ln(s)	88.50
Configuration	Modified Fractal Dimension	D = 2*ln((P+(2*(A-1)*C/(Ct-1))/4) / ln(A))	1.46

* For purposes of comparison to the wetlands at Ware Creek, the Brillouin Index calculated for the NWI wetland acreage for the Black Creek impoundment area was 1.94.

TABLE 4-41

SUMMARY OF WET ANALYSIS RESULTS
BLACK CREEK RESERVOIR WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	M	M	*
Floodflow Alteration	M	H	M
Sediment Stabilization	M	H	*
Sediment/Toxicant Retention	M	H	H
Nutrient Removal/Transformation	H	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	H	*
Wildlife Diversity/Abundance (Migration)	*	H	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	M	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

For purposes of this analysis, the impoundment was considered the assessment area (AA) and the impact area (IA). Therefore, this WET analysis provides an assessment of the palustrine wetland complex as a whole. Because the palustrine system consists of many different types of wetland, the evaluation of any particular wetland site could be different from the results achieved in this analysis.

At the time this analysis was performed, the only wetland acreage estimate available was based on NWI maps; therefore, the acreage of wetlands was considered to be 158 acres. As described previously, a more detailed delineation of the wetlands in the Black Creek impoundment area was conducted in August 1994. This delineation, based on aerial photography and available field-verified mapping, yielded 285 acres of potential wetland impacts. A detailed on-site delineation comparable to that conducted for the Ware Creek and King William Reservoir projects was not conducted. The WET analysis of the Black Creek Reservoir was updated to reflect this change in potential wetland impacts. Table 4-41 summarizes the results of the WET analysis for the Black Creek Reservoir palustrine wetlands.

The results of the WET analysis indicate that the palustrine system has a high probability of being effective in providing sediment stabilization, floodflow alteration, sediment/toxicant retention, and wildlife habitat. It has a moderate probability of providing groundwater discharge and production export functions. It received a low score for groundwater recharge, nutrient removal/transformation, and aquatic diversity/abundance.

The USFWS completed a ***Draft Coordination Act Report, Southside/Northside Water Supply Study*** which included a HEP analysis of the proposed Black Creek Reservoir (USFWS, 1983). The HEP study assessed various wildlife habitat values for each important cover type in the Black Creek drainage. Deciduous forested wetlands, herbaceous wetlands, herbaceous/shrub wetlands and lacustrine open water were among the cover types analyzed. Results of this HEP study are summarized in Table 4-39H. The baseline calculations show that the habitat provides moderate to high habitat values for the wetland indicator species evaluated.

According to the USFWS NWI maps, there are approximately 210 acres of wetlands between the Black Creek Reservoir impoundment areas and the Pamunkey River. Approximately 60 of the 210 acres lie between the impoundment areas and the mainstem of Black Creek. Most of the wetlands directly downstream of the impoundment areas are semipermanently or permanently flooded, primarily due to the presence of beaver dams.

Pipeline

Approximately 34 stream/wetland area crossings are involved along the 19.6 miles of new pipeline. This estimate was based on review of the following:

- USGS Topographic Maps, 1 inch = 2000 feet scale
- USFWS National Wetlands Inventory Maps, 1 inch = 2000 feet scale
- Aerial Photographs, National High Altitude Photography (NHAP), 1 inch = 1300 feet scale
- Aerial Photographs, National Aerial Photography Program (NAPP), 1989, 1 inch = 650 feet scale

TABLE 4-42A POTENTIAL STREAM/WETLAND IMPACTS FROM PIPELINE CONSTRUCTION BLACK CREEK RESERVOIR PROJECT*			
	Wetland Area		
Wetland Type	Black Creek Reservoir Pipeline (square feet)	Diascund to Little Creek Reservoir Pipeline Upgrade (square feet)	Total (square feet)
L1OWHh		25,000	25,000
PEM1E		25,000	25,000
PEM1Fb	10,000		10,000
PFO1A	62,000	26,250	88,250
PFO1C	18,750	25,000	43,750
PFO1Cb	20,000		20,000
PFO1Eh		12,500	12,500
PSS1C		12,500	12,500
PUBHh	12,000	27,500	39,500
Total (Sq.Ft.)	**122,750**	**153,750**	**276,500**
Total (Acres)	**2.82**	**3.53**	**6.35**

* Stream/wetland area and type estimated from small scale (i.e., 1"=2000') topographic maps and aerial photographs. Wetland area based on 50' pipeline corridor.

- Aerial Photography, Air Survey Corporation (ASC), 1994, 1 inch = 650 feet scale (reservoir impoundment areas only)

Table 4-42A summarizes the stream/wetland types and acreage which occur along the Black Creek Reservoir pipeline route, including the segment of pipeline between Diascund Reservoir and Little Creek Reservoir. Most of the affected stream/wetland areas would be palustrine forested, broad-leaved deciduous wetlands. Typical tree species of these Virginia Coastal Plain palustrine systems include Sweetgum, River Birch, Black Gum, Red Maple, Green Ash, and Sycamore.

The pipeline also would cross the open water of an arm of Little Creek Reservoir.

Mud Flats

No mud flats are located in the immediate vicinity of the Northbury intake site based on review of USGS topographic maps and USFWS NWI maps. The closest mud flat to the intake site is located 8,000 feet downstream and no mud flats exist upstream of the site.

No mud flats were identified within the proposed reservoir area. A mud flat exists on the Pamunkey River approximately 11,000 feet downstream of the dam on the eastern branch of Black Creek.

No mud flats were identified along the pipeline route.

4.3.3 King William Reservoir with Pumpover from the Mattaponi River

Four dam configurations are being presented with the King William Reservoir with pumpover from the Mattaponi River alternative: KWR-I, KWR-II, KWR-III, and KWR-IV. The intake site, pump station size, and a majority of the pipeline route for all four dam configurations are the same. The dam locations, pool elevations, and river withdrawal operating rules vary. The specific characteristics of each configuration are outlined in Section 3.4.15. Unless otherwise specified, biological resources are the same for all dam configurations of the King William Reservoir alternative.

Endangered, Threatened, or Sensitive Species

Intake

The VDCR provided a list of natural heritage resources of the tidal Mattaponi River. Five of the nine species listed by the VDCR are either endangered, threatened, or candidate species at the federal and/or state levels (see Table 4-43).

A large population of the Sensitive Joint-vetch consisting of five sub-populations is known along a 15-mile stretch of the Mattaponi River in King and Queen and King William counties (J. R. Tate, VDACS, personal communication, 1993). The species has been noted as far downstream as the Wakema/Gleason Marsh (downstream limit near Mattaponi River mile 13) to as far upstream as Walkerton (upstream limit near Mattaponi River mile 28) (Perry, 1993). The closest known populations of this species have historically been observed on the north side of the Mattaponi River, across from the proposed intake site, and on the south side of the river, approximately 600 feet upstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992; Rouse 1996).

VIMS conducted a study of the Sensitive Joint-vetch in the vicinity of the proposed intake site on the Mattaponi River. The study is documented in ***Distribution of Aeschynomene virginica in the Scotland Landing Region of the Mattaponi River, Virginia*** (Perry, 1993) which is included as an appendix to the ***Biological Assessment for Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is appended to this document as Report E.

Methods used in the VIMS study included a review of historical data on the species and a field survey of the project area by boat. Habitats which appeared similar to those which contain populations of the species were further investigated by walking the habitat area and inspecting for the Sensitive Joint-vetch. Although approximately 2.5 acres of the species' habitat were identified in this area, no specimens of ***Aeschynomene virginica*** were located along either side of the Mattaponi River in the vicinity of Scotland Landing (Perry, 1993). However, the USFWS ***Draft Sensitive Joint-vetch (Aeschynomene virginica) Recovery Plan*** indicates that 49 plants were observed at the Garnetts Creek site during another survey in 1993 (USFWS, 1993).

In 1994, Garrie Rouse conducted a study of the Sensitive Joint-vetch at nine sites along the Mattaponi River. His findings are described in ***Sensitive Joint-Vetch Life History and Habitat Study, 1994 Field Season, Mattaponi River System, Virginia*** (Rouse, 1995). Observations during the growing season indicate that the vetch occurred at four of the nine sites examined. Approximately 88 individuals were recorded in Garnetts Creek marsh, across from the proposed intake at Scotland Landing. Historical data show that the size of the population at Garnetts Creek fluctuates from year to year. Factors influencing population size include environmental conditions, disease and predation (Rouse, 1995).

Further surveys by the Virginia Division of Natural Heritage (VDNH) and Malcolm Pirnie biologists recorded the presence of the Sensitive Joint-vetch at Garnetts Creek marsh and at a smaller marsh adjacent to White Oak Landing, upstream of Scotland Landing, on the south side of the river (VDCR, 1995, Malcolm Pirnie, 1995). A 1996 field survey by Garrie Rouse and Malcolm Pirnie confirmed the presence of over 460 Sensitive Joint-vetch individuals within 5 distinct sub-populations at Garnetts Creek marsh. In addition, 6 individuals of the Sensitive Joint-vetch were identified at the mouth of a small creek located between White Oak Landing and Scotland Landing, on the south side of the river (Rouse, 1996).

According to the VDNH, Garnetts Creek marsh also supports populations of the rare plants Prairie Senna and Parker's Pipewort (*Eriocaulon parkeri*). Prairie Senna is a Chesapeake Bay endemic and is known only from tidal marshes and estuaries in Virginia and Maryland. The Garnetts Creek population is described as being composed of less than 100 individuals located in small groups throughout the tidal marsh (VDNH, 1995). Parker's Pipewort is a low, erect perennial herb with small white flowers in dense button-shaped heads at the end of stalks. It occurs in tidal freshwater and occasionally in slightly brackish marshes from Maine to North Carolina (Tiner, 1993). It is a rare species in Virginia but does not hold federal or state legal status.

Mat-forming Water-hyssop is a perennial herb which was identified by the VDACS as occurring in the vicinity of the project area and is listed by the VDCR as a natural heritage resource of the tidal Mattaponi River. It has been found in King and Queen, King William, and New Kent counties. The closest known population of this species occurs approximately 1 mile downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

The Bald Eagle, which is a federally-listed threatened and state-listed endangered species, was identified by the VDCR as a Natural Heritage Resource of the tidal Mattaponi River. It has been found in several counties adjacent to the river. The VDGIF has reported the presence of an

TABLE 4-43

ENDANGERED, THREATENED, AND CANDIDATE SPECIES OF THE TIDAL MATTAPONI RIVER

Scientific Name	Common Name	Federal Status	State Status
Aeschynomene virginica	Sensitive Joint-vetch	LT	PE
Bacopa stragula	Mat-forming Water-hyssop	NL	LE
Chamaecrista fasciculata var. macrosperma	Prairie Senna	SC	NL
Haliaeetus leucocephalus	Bald Eagle	LT	LE
Lampsilis cariosa	Yellow Lampmussel	SC	NL

Federal Legal Status

LE - Listed endangered
LT - Listed threatened
SC - Species of concern
NL - No listing available

State Legal Status

LE - Listed endangered
PE - Proposed endangered
NL - No listing available

Sources: VDCR, 1992; VDACS, 1993; VDCR, 1996.

observed in 1995, but Malcolm Pirnie staff did not observe specimens in either colony during a field survey in May 1996. The field studies are documented in Report E. Both locations containing the Small Whorled Pogonia would lie within the pool area of each King William Reservoir configuration.

Sensitive Joint-vetch. Because there are no tidal wetlands within the King William Reservoir area, there is no suitable habitat present to support this species and no search was undertaken.

Other Species. A 1992 VDGIF review of the proposed reservoir site identified two other species of concern in the vicinity of the proposed reservoir: Mabee's Salamander (*Ambystoma mabeei*) and Northern Diamondback Terrapin (*Malaclemys terrapin*) (VDGIF, 1992). Mabee's Salamander is a state-listed threatened species. While individuals have not been documented in the project area, suitable habitat for the species may be present. The Northern Diamondback Terrapin, which is a candidate for federal protection, is commonly found in brackish and saltwater estuaries and tidal marshes; therefore, it is not likely to be impacted by the impoundment (S. Carter-Lovejoy, VDGIF, personal communication, 1992). No individuals of this species have been found in the project area. A detailed herpetology survey was conducted within the project area by Dr. Joseph Mitchell and Malcolm Pirnie biologists in 1994. A detailed description of the sites surveyed, survey methods and results are presented in ***Amphibians and Reptiles of the Cohoke Mill Creek Watershed, King William County, Virginia*** incorporated herein by reference as Report O to this document. No threatened or endangered species were observed during the survey (Mitchell, 1994).

The VDACS identified no state-listed threatened or endangered plant or insect species as occurring in the immediate area of the proposed reservoir (J. R. Tate, VDACS, personal communication, 1992).

Pipeline

The VDGIF has reported the presence of an active Bald Eagle nest in New Kent County within 0.5 miles of the King William Reservoir pipeline to Diascund Reservoir (VDGIF, 1996).

Project review conducted by the VDCR, VDGIF and VDACS identified no additional known natural heritage resources or endangered or threatened animal, plant or insect species along the pipeline route or in the vicinity of the reservoir pump station associated with any King William Reservoir configuration component (T. J. O'Connell, VDCR, personal communication, 1992; H. E. Kitchel, VDGIF, personal communication, 1992; J. R. Tate, VDACS, personal communication, 1992; J. Trollinger, VDGIF, personal communication, 1996).

Fish and Invertebrates

Intake

Fish collection records for the Mattaponi River between 1939 and 1961 are summarized and included in Table 4-44.

Five species of anadromous fish have been documented utilizing the tidal freshwater reaches of the Mattaponi River for spawning and nursery grounds (Massmann, 1953; Olney et al., 1985):

- Striped Bass (*Morone saxatilis*)

active Bald Eagle nest approximately 1,800 feet west (0.34 mile) of the residence and pump station proposed at Scotland Landing (VDGIF, 1996).

The Prairie Senna and the Yellow Lampmussel (*Lampsilis cariosa*) are two candidate species for federal listing and are included on the VDCR list of resources of the tidal Mattaponi River.

Reservoir

Bald Eagle. As of August 11, 1995, the Bald Eagle has been listed as a threatened species on the federal list and remains listed as an endangered species on the Virginia list. No critical habitat has been designated by USFWS for the Bald Eagle (50 CFR 17.11).

The USFWS and other sources have documented the presence of a Bald Eagle nest located near the King William Reservoir site (K. L. Mayne, USFWS, personal communication, 1993). The nest was constructed during the 1992 nesting season, and has produced young each year (M. A. Byrd, The College of William & Mary, personal communication, 1995; VDGIF, 1996).

The nest is located approximately 375 feet downstream of the toe of the KWR-I dam site. To minimize wetland impacts and to avoid impacts to this Bald Eagle nest, the KWR-II dam site is located 2,900 feet (channel distance) upstream from the KWR-I site, thereby locating the dam 3,275 feet (channel distance) and 2,975 feet (direct distance) from the nest. The KWR-III dam site is approximately 7,900 feet upstream of the nest and the KWR IV dam is approximately 10,100 feet upstream.

The 1996 VDGIF aerial Bald Eagle survey confirmed that no other Bald Eagle nests are located in the vicinity of the proposed reservoir site (VDGIF, 1996).

Small Whorled Pogonia. The USFWS also indicated that appropriate habitat for Small Whorled Pogonia may exist at the King William Reservoir site (K. L. Mayne, USFWS, personal communication, 1993). The USFWS recommended conducting a survey of appropriate habitat in the reservoir area. USFWS' recommended methodology and the methodology selected for the survey are described in detail in Report E. No critical habitat has been designated for the Small Whorled Pogonia by USFWS (50 CFR 17.12).

Potential habitat for Small Whorled Pogonia within the King William Reservoir was identified in May 1993 by Dr. Donna Ware of The College of William & Mary, based on topographic mapping and color-infrared aerial photography of the area. A total of 37 potential locations were identified, and the total area of potential prime habitat was estimated to be 164 acres.

Malcolm Pirnie biologists and Small Whorled Pogonia experts conducted field surveys of the areas of potential habitat located within the proposed reservoir site, in June 1993 and again in June 1994. Specimens of Small Whorled Pogonia were discovered at two locations at the King William Reservoir site. During the 1993 field survey, an individual specimen was found in an approximately 60 to 70 year old upland deciduous forest adjacent to a cleared forested area, at the lower section of a southwest slope uphill from the confluence of two small streams. The same individual was found again during the 1994 survey. In addition, the 1994 survey found a colony of five specimens on an upland median in the floodplain of a braided stream in an east-facing ravine surrounded by a young (approximately 10 year old) pine plantation. Because of the high degree of habitat disturbance at these sites, the specimens are most likely remnants of a declining population; therefore, it is unlikely that a viable population would develop at either site (D.M.E. Ware, The College of William & Mary, personal communication, 1995). These plants were again

- American Shad (*Alosa sapidissima*)
- Hickory Shad (*Alosa mediocris*)
- Alewife (*Alosa pseudoharengus*)
- Blueback Herring (*Alosa aestivalis*)

In September 1996, Malcolm Pirnie biologists sampled the lower tidal freshwater benthic community from Scotland Landing downstream to Gleason Marsh. The oligohaline community was sampled from Gleason Marsh to the Route 33 bridge crossing adjacent to West Point. Figure 4-1B depicts the sample locations. Sampling areas at Gleason Marsh were conducted in the transition zones where the vegetative community consists of Wild Rice (*Zizania aquatica*), Pickerelweed (*Pontederia cordata*), and Saltmarsh Cordgrass (*Spartina alterniflora*). Benthic collections were performed using an Eckman Dredge and a 0.5 mm screen (ASTM 40 sieve) and all organisms and organic material were preserved in a solution of formalin. Samples were sorted and identified by Malcolm Pirnie biologists to the lowest possible taxon. Results from the macroinvertebrate surveys for the Mattaponi River are summarized in Table 4-45A. Dominant invertebrates in the tidal freshwater samples included midge larvae (Subfamily Chironominae and Subfamily Tanypodinae), Mayfly larvae (Genus *Hexagenia*), and Asiatic Clam (*Corbicula manilensis*). Dominant invertebrates in the oligohaline samples included midge larvae and aquatic earthworms (Class Oligochaeta).

Reservoir

Both VDGIF and Malcolm Pirnie have conducted numerous fish surveys in Cohoke Creek, above, within, and below Cohoke Millpond. VDGIF conducted surveys in 1992 and 1993, and Malcolm Pirnie conducted surveys in 1990 and 1994. The combined results of those surveys are presented in Table 4-45B. This table was revised based on review by Dr. Robert Jenkins of Roanoke College (Jenkins, 1996). Species that are not likely to persist in Cohoke Creek under normal conditions were eliminated from the table. A detailed discussion of the methodology and results of the surveys is presented in Report H.

The fish survey results indicate that no listed or candidate threatened or endangered fish species inhabit Cohoke Creek. However, the Least Brook Lamprey *(Lamptern aepyptera)*, which was found in the non-tidal portion of Cohoke Creek, apparently has declined in Virginia and is considered threatened in North Carolina.

VDGIF has identified herring species as a primary focus of its concerns, due to the currently depressed condition of regional herring populations. VDGIF reported that it captured seven adult blueback herring (five in pre- or post-spawning condition) and missed others in the pool below the Cohoke Millpond spillway, in its 1993 survey, and it stated that: "This catch indicates that ripe herring would potentially spawn in the upper reaches of this creek if fish passage was provided" (VDGIF, 1993) (Appendix 4 of Report H). Anadromous fish passage to the non-tidal portions of Cohoke Creek is currently blocked by the Cohoke Millpond dam as well as by numerous beaverdams above Cohoke Millpond. It is possible that the turbulent waters in the tailrace of the Millpond dam attract migrating herring, resulting in the concentration of herring observed by VDGIF (1993).

TABLE 4-44

FISH SPECIES OF THE MATTAPONI RIVER (1939-1961)

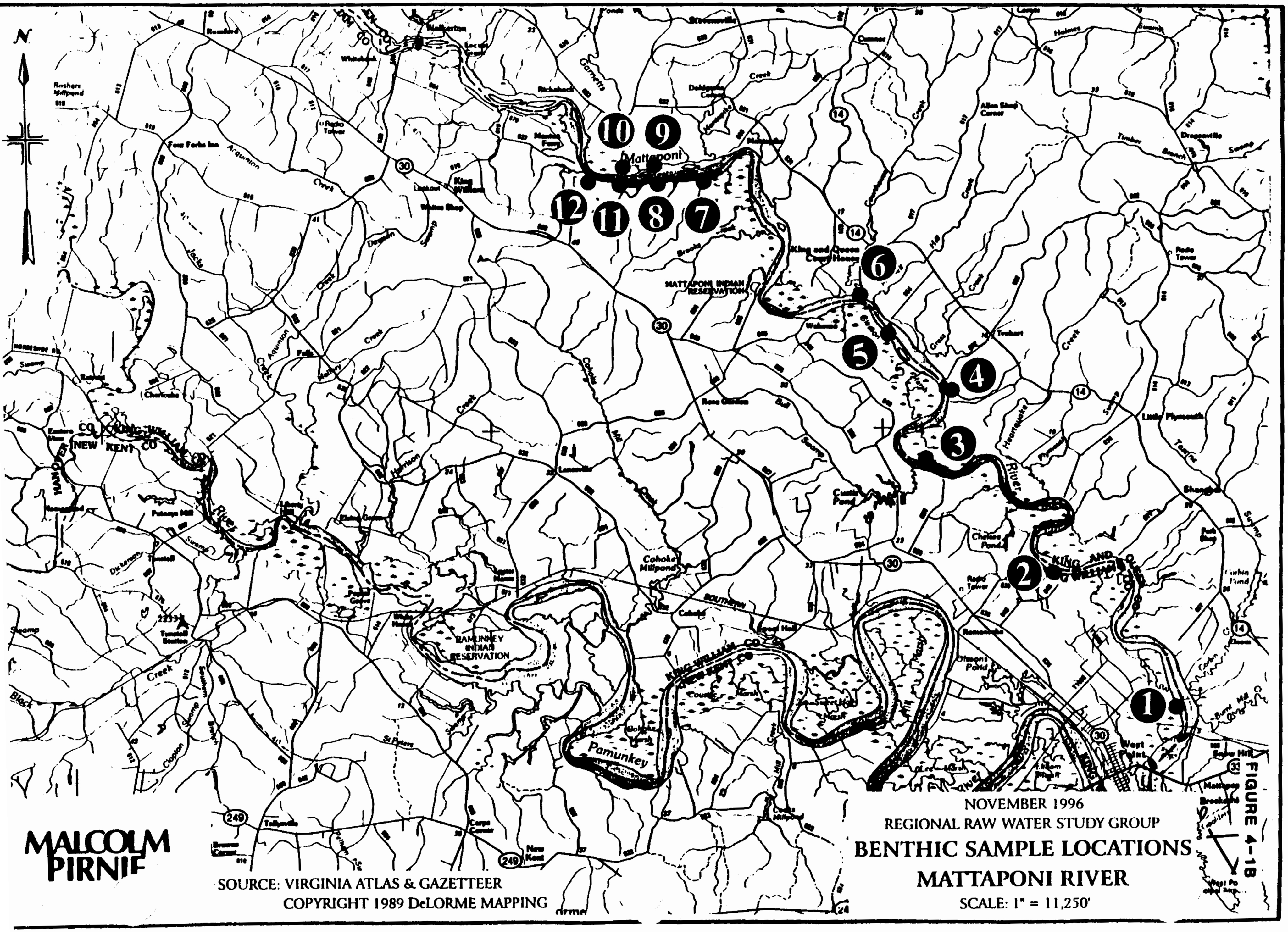
Scientific Name	Common Name	1939	1954	1958	1961
Alosa sapidissima	American Shad				■
Anguilla rostrata	American Eel				■
Enneacanthus gloriosus	Bluespotted Sunfish		■		
Etheostoma olmstedi	Tessellated Darter		■		
Fundulus diaphanus	Banded Killifish	■	■	■	■
Hybognathus regius	Eastern Silvery Minnow		■	■	■
Ictalurus catus	White Catfish		■	■	■
Lepomis auritus	Redbreast Sunfish		■		
Lepomis gibbosus	Pumpkinseed				■
Morone americana	White Perch		■		
Morone saxatilis	Striped Bass		■		
Notropis hudsonius	Spottail Shiner		■	■	
Trinectes maculatus	Hogchoker				■

Sources: H. E. Kitchel, VDGIF, personal communications, August 9, 1989 and August 11, 1992.

■ Indicates observation of fish species in particular year.

Table 4-45A
Benthic Macro-Invertebrate Survey within the Mattaponi River

		Site Number											
Macro- Invertebrates		Mesohaline Sites						Oligohaline Sites					
Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12
ORDER Diptera	Aquatic Flies, Midges, Mosquitos												
FAMILY Chironomidae	Midges												
Chironomidae pupae	Midge pupae	1					3	10	1			10	2
SUBFAM. Chironominae													
GENUS/SPECIES #1				1(L)	1(L)		6(L)		1(L)	5(L)		6 (L)	5(L)
GENUS/SPECIES #2							14(L)	190(L)	3(L)	27(L)	2 (L)	108 (L)	15(L)
SUBFAM. Tanypodinae		1(L)	3 (L)	1(L)	3(L)	7(L)	1(L)	7(L)		20(L)	4 (L)	11 (L)	5(L)
SUBFAM. Orthocladinae									1(L)	2(L)			
SUBFAM. Diamesinae											1(L)		
FAMILY Ceratopogonidae	Biting Midges												
GENUS *Bezzia*					2(L)		3 (L)	7 (L)	3(L)	1 (L)	6(L)	2 (L)	
ORDER Megaloptera	Fishflies, Dobsonflies, Alderflies												
FAMILY Sialidae	Alderflies												
GENUS *Sialis*								1 (L)				1 (L)	
ORDER Trichoptera	Caddisflies												
FAMILY Polycentropodidae	Trumpet + Tubemaking Caddisflies												
SUBFAM. Dipseudopsinae								1 (L)					
FAMILY Hydropsychidae	Common Netspinners							1 (P)					
FAMILY Leptoceridae	Longhorned Case Makers												
Oecetis inconspicua													1 (L)
ORDER Ephemeroptera	Mayflies												
FAMILY Ephemeridae	Common Burrowers												
GENUS *Hexagenia*					2(L)	1 (L)	2(L)	19 (L)	7 (L)	13 (L)	7 (L)	~35 (L)	
FAMILY Caenidae	Small Squaregills												
GENUS *Brachycercus*								2 (L)				1 (L)	
GENUS *Caenis*								1 (L)					
ORDER Coleptera	Water Beetles												
FAMILY Hydrophilidae	Water Scavenger Beetle												
?GENUS *Berosus*								1 (L)				1 (L)	
FAMILY Elmidae	Rifle Beetles								1(L)				6(L)1(A)
GENUS *Stenelmis*													
FAMILY Chrysomelidae	Aquatic Leaf Beetles												
GENUS *Donacia*				3 (L)				1 (L)				1 (L)	



MALCOLM PIRNIE

SOURCE: VIRGINIA ATLAS & GAZETTEER
COPYRIGHT 1989 DeLORME MAPPING

NOVEMBER 1996
REGIONAL RAW WATER STUDY GROUP

BENTHIC SAMPLE LOCATIONS
MATTAPONI RIVER

SCALE: 1" = 11,250'

FIGURE 4-18

Table 4-45B

Combined Fish Survey Results
Cohoke Creek Watershed

Location	Species		MPI	VDGIF	VDGIF	MPI
	Scientific Name	Common Name	1990	1992	1993	1994-95
Non-Tidal Waters Above Millpond	*Ameiurus natalis*	Yellow Bullhead				X
	Ameiurus nebulosus	Brown Bullhead				X
	Amia calva	Bowfin		X		X
	Anguilla rostrata	American Eel	X	X		X
	Aphrediderus sayanus	Pirate Perch				X
	Centrarchus macropterus	Flier				X
	Enneacanthus gloriosus	Bluespotted Sunfish	X	X		X
	Erimyzon oblongus	Creek Chubsucker		X		X
	Esox niger	Chain Pickerel				X
	Esox americanus	Redfin pickerel	X			
	Etheostoma olmstedi	Tessellated Darter	X			X
	Gambusia holbrooki	Eastern Mosquitofish		X		X
	Lampetra aepyptera	Least Brook Lamprey				X
	Lepomis gibbosus	Pumpkinseed				X
	Lepomis gulosus	Warmouth		X		X
	Lepomis macrochirus	Bluegill Sunfish		X		X
	L. gibbosus X.L. macrochirus	Hybrid Sunfish				X
	Micropterus salmoides	Largemouth Bass				X
	Notemigonus crysoleucas	Golden Shiner		X		X
	Notorus gyrinus	Tadpole Madtom	X			X
	Rhinichthys atratulus	Blacknose Dace				X
	Umbra pygmaea	Eastern Mudminnow	X			X
	Total Number of Species		22			
Cohoke Millpond	*Ameiurus nebulosus*	Brown Bullhead			X	
	Anguilla rostrata	American Eel			X	
	Cyprinus carpio	Common Carp			X	
	Dorosoma cepedianum	Gizzard Shad			X	
	Erimyzon oblongus	Creek Chubsucker		X	X	
	Esox niger	Chain Pickerel			X	
	Lepomis gibbosus	Pumpkinseed		X	X	
	Lepomis gulosus	Warmouth		X	X	
	Lepomis macrochirus	Bluegill Sunfish		X	X	
	Lepomis microlophus	Redear Sunfish		X	X	
	Micropterus salmoides	Largemouth Bass		X	X	
	Morone americana	White Perch			X	
	Notemigonus crysoleucas	Golden Shiner		X	X	
	Perca flavescens	Yellow Perch		X	X	
	Pomoxis annularis	White Crappie			X	
	Pomoxis nigromaculatus	Black Crappie		X	X	
	Total Number of Species		16			

Table 4-45A
Benthic Macro-Invertebrate Survey within the Mattaponi River

Macro- Invertebrates		Site Number											
		Mesohaline Sites						Oligohaline Sites					
Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12
ORDER Isopoda	Aquatic Sow Bugs												
FAMILY Anthuridae													
Cyathura polita	Slender Isopod	3					4						
FAMILY Sphaeromidae													
Sphaeroma sp.	Sea Pill Bug						1						
ORDER Amphipoda	SCUDS												
FAMILY Gammaridae													
GENUS *Gammarus*			18						1		1		3
(CLASS Bivalvia)	Bivalves												
ORDER Pelecepoda	Clams, Mussels												
FAMILY Corbiculidae													
Corbicula manilensis	Common Asiatic Clam					1		53	12	5	5	31	18
FAMILY Mactridae	Mactra Surf Clams												
Rangia cuneata	Brackish-water Clam					1						3	
FAMILY Sphaeriidae													
Sphaerium spp.	Fingernail Clams					1			3	6			
FAMILY Tellinidae													
Macoma tenta	Tenta Macoma	1											
(CLASS Gastropoda)	Snails		2			13	7	15	1	3	6	1	9
((PHYLUM Nematoda))		2	7						1	2	2	2	1
(CLASS Oligochaeta)	Aquatic Earthworms			~15	20	3	~35		8		3		1
(CLASS Hirudinea)	Leeches								1				
(CLASS Crustacea)													
ORDER Decapoda	Crabs, Shrimp, Crayfish, Lobster												
FAMILY Xanthuridae	Mud Crabs	1		carap.	2							pincer	
(CLASS Arachnoidea)													
ORDER Hydracarina	Water Mites		2										

Notes: (1) (L) = Larval Stage, (A) = Adult Stage
(2) Refer to Figure 4-1B for site location map

White Perch *(Morone americana)*, which are considered semi-anadromous (Jenkins and Burkhead, 1993), have been found in the tidal portions of Cohoke Creek, below the Millpond Dam. Like fully anadromous fish, White Perch move upstream to spawn in the spring; but instead of returning to the sea, they remain in mid-estuary zones.

The American Eel (*Anguilla rostrata*) was found in the non-tidal waters above the millpond in 1990, 1992, and 1994 surveys (VDGIF, 1993; Malcolm Pirnie, 1995). Eels are catadromous fish, living most of their life in freshwater and migrating to the Atlantic Ocean to spawn.

In order to determine the wildlife habitat value provided by the wetlands and uplands of the KWR project area and proposed buffer, a baseline evaluation using the Habitat Evaluation Procedures (HEP) methodology is being conducted. An interagency team has selected eleven wildlife evaluation species and one fish species as indicators of all species which utilize the area. The Redfin Pickerel was selected to determine the habitat value provided by the open water and vegetated wetlands of the project area to fish species. A more complete description of the HEP methodology is provided in the Other Wildlife section below.

Invertebrate species observed in Cohoke Creek by Malcolm Pirnie biologists are listed in Table 4-46. Because this water body is typical of Lower Peninsula freshwater streams, invertebrate species listed in Table 4-31 may also be present in Cohoke Creek.

Pipeline

Construction of the new pipeline associated with the KWR-I configuration would require minor crossings of 9 perennial and 17 intermittent streams. The pipeline associated with KWR-II would require crossings of 33 perennial and 19 intermittent streams. The pipeline associated with KWR-III would cross 32 perennial and 18 intermittent streams. The pipeline associated with KWR-IV would cross 35 perennial and 18 intermittent streams.[3] Fish species expected to occur in these streams would be similar to those found in freshwater tributaries of the Chesapeake Bay (see Table 4-39). Invertebrate species found within intermittent and perennial streams crossed by the pipeline are expected to be typical of freshwater invertebrates of the Lower Peninsula (see Table 4-31).

Major crossings of the Pamunkey River and an arm of Little Creek Reservoir would also be required for each KWR configuration. Fish and invertebrate species present in the Pamunkey River are discussed in Section 4.3.1 and listed in Tables 4-26 and 4-27, respectively. Fish species present in Little Creek Reservoir are discussed in Section 4.3.4. Invertebrate species within the Little Creek Reservoir pool area are expected to be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

No wetlands or stream crossings would be associated with the construction of the booster pump station.

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[3] The pipeline route for KWR I follows the gravity pipeline route as proposed in the DEIS. The pipeline route for KWR II, III, and IV follows a different pumped pipeline route. This different route accounts for the large difference in stream crossings between KWR I and the other dam configurations.

Table 4-45B

Combined Fish Survey Results
Cohoke Creek Watershed
(Continued)

Location	Species		MPI	VDGIF	VDGIF	MPI
	Scientific Name	Common Name	1990	1992	1993	1994-95
Tidal Waters Below Millpond	*Alosa aestivalis*	Blueback Herring			X	
	Ameiurus catus	White Catfish				X
	Ameiurus nebulosus	Brown Bullhead				X
	Anguilla rostrata	American Eel			X	
	Cyprinella analostana	Satinfin Shiner			X	
	Dorosoma cepedianum	Gizzard Shad			X	X
	Etheostoma olmstedi	Tessellated Darter			X	X
	Fundulus diaphanus	Banded Killifish			X	
	Fundulus heteroclitus	Mummichog				X
	Hybognathus regius	Eastern Silvery Minnow			X	X
	Ictalurus punctatus	Channel Catfish			X	X
	Lepisosteus osseus	Longnose Gar			X	X
	Lepomis gibbosus	Pumpkinseed			X	
	Lepomis macrochirus	Bluegill Sunfish			X	X
	Lepomis microlophus	Redear Sunfish			X	
	Micropterus salmoides	Largemouth Bass			X	X
	Morone americana	White Perch			X	X
	Notropis hudsonius	Spottail Shiner				X
	Perca flavescens	Yellow Perch			X	
	Pomoxis nigromaculatus	Black Crappie			X	X
	Total Number of Species	20				
Total Number of Species for Watershed		38				

Other Wildlife

Intake

Field studies of the proposed intake site were conducted by Malcolm Pirnie during the Spring of 1990 to determine the feasibility of the site as a potential raw water intake/pumping station location (Malcolm Pirnie, 1990). Based on review of color-infrared aerial photography, vegetation community types at the site were classified according to Anderson et al. (1976). Community types adjacent to the intake area include coniferous forest, deciduous forest, mixed forest, old field, and wetlands. Wildlife species typical of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.3, which is appended to this document.

Reservoir

The protocol employed in these biological analyses is described in Section 4.3.2 above. The community type classification for the King William Reservoir watershed and pool area has been revised using improved aerial photography, topographic mapping, the final King William Reservoir wetland delineation, and the field work for the King William Reservoir Habitat Evaluation Procedures (HEP) study.

Based on this analysis, the vegetation community types in the KWR-II reservoir drainage area, including the pool area, were estimated to comprise 1,545 acres of coniferous forest; 3,070 acres of mixed coniferous/deciduous forest; 218 acres of cove hardwood forest; 1,165 acres of early successional logged area; 739 acres of agricultural, residential, and open field communities; and 574 acres of wetlands and open water communities. The remaining few acres consist of roads, which have limited wildlife habitat value. As defined by the KWR HEP team, cove hardwood forests are older deciduous forests composed mainly of beech, oak, and hickory, typically found at the heads of ravines and on slopes.

Vegetation community types for each KWR pool area are presented in Table 4-46A. A cover type map of the King William Reservoir watershed area is presented in Plates 3A, 3B, and 3C (see map pockets at rear of report).

A Great Blue Heron (*Ardea herodias*) rookery is located in the reservoir area on the first major tributary to Cohoke Creek north of Route 626. During the 1994 wetland field mapping, the rookery was observed to include seventeen nests, with fledglings in six nests. Most of the nests were located in dead white oak trees (*Quercus alba*) within an open water beaver pond. This species thrives in natural habitats, preferentially nesting in riparian swamps with large trees with limited predator and human access (Erwin and Spendelow, 1991).

In February 1994, Dr. Joseph Mitchell and Malcolm Pirnie biologists conducted a survey of the amphibians and reptiles within the King William Reservoir project area. A total of 12 sites of various community types were examined. A listing of the reptile and amphibian species collected during the survey is presented in Table 4-47A.

In order to determine the wildlife habitat value provided by the wetlands and uplands of the KWR II project area and proposed buffer, a baseline evaluation using the Habitat Evaluation Procedures (HEP) methodology is being conducted. An interagency team has selected 11 wildlife evaluation species and 1 fish species as indicators of all species which utilize the area. The evaluation species were selected to accurately reflect the wildlife value of the cover types within the project area. Published HSI models were used to the extent possible for the evaluation species

TABLE 4-46

INVERTEBRATE SPECIES OF COHOKE CREEK (1990)

Scientific Name	Common Name
Argia spp.	Damselfly
Cicindela spp.	Tiger Beetle
Corydalus cornutus	Eastern Dobsonfly
Gerris spp.	Water Strider
Palaemonetes paludosus	Grass Shrimp
Procambarus spp.	Crayfish

Source: Preliminary Report on Field Studies for the Environmental Impact Statement, Malcolm Pirnie, 1990.

TABLE 4-47A

TAXONOMIC CHECKLIST OF THE AMPHIBIANS AND REPTILES OF THE COHOKE CREEK WATERSHED, KING WILLIAM COUNTY, VIRGINIA

Scientific Name	Common Name
Class Amphibia	
Order Anura	**Frogs and Toads**
Family Bufonidae	**Toads**
Bufo americanus americanus Holbrook	Eastern American Toad
Bufo terrestris (Bonnaterre)	Southern Toad
Bufo woodhousii fowleri Hinkley	Fowler's Toad
Family Hylidae	**Treefrogs**
Acris crepitans crepitans Baird	Northern Cricket Frog
Hyla chrysoscelis Cope	Cope's Gray Treefrog
Hyla cinerea (Schneider)	Green Treefrog
Hyla femoralis Bosc *in* Daudin	Pine Woods Treefrog
Pseudacris crucifer crucifer Wied-Neuwied	Northern Spring Peeper
Pseudacris triseriata feriarum (Baird)	Upland Chorus Frog
Family Pelobatidae	**Spadefoot Toads**
Scaphiopus holbrookii holbrookii (Harlan)	Eastern Spadefoot
Family Ranidae	**True Frogs**
Rana catesbeiana Shaw	Bullfrog
Rana clamitans melanota (Rafinesque)	Green Frog
Rana palustris LeConte	Pickerel Frog
Rana sphenocephala Cope	Southern Leopard Frog
Family Microhylidae	**Narrow-mouthed Toads**
Gastophryne carolinensis (Holbrook)	Eastern Narrow-mouthed Toad

Table 4-46 A

Cover Types Within the King William Reservoir Pool Area

Cover Type	KWR I Acreage	KWR II Acreage	KWR III Acreage	KWR IV Acreage
Mixed Deciduous/Evergreen Forest	[redacted]	877	803	661
Evergreen Forest	[redacted]	383	245	114
Deciduous Forest	[redacted]	~	~	~
Cove Hardwood Forest	[redacted]	134	134	100
Early Successional Logged Area	[redacted]	254	216	214
Agriculture/Open Field	[redacted]	<1	0	0
Vegetated Wetlands and Open Water	653	574	511	437
Total	2284	2222	1909	1526

Note: The cover type breakdown has been altered since publication of the DEIS, so upland acreages are not comparable. However, uplands within the KWR I pool area total 1631 acres.

TABLE 4-47A

TAXONOMIC CHECKLIST OF THE AMPHIBIANS AND REPTILES OF THE COHOKE CREEK WATERSHED, KING WILLIAM COUNTY, VIRGINIA

Scientific Name	Common Name
Class Reptilia	
Order Testudines	**Turtles**
Family Chelydridae	**Snapping Turtles**
Chelydra serpentina serpentina (Linnaeus)	Snapping Turtle
Family Emydidae	**Pond Turtles**
Chrysemus picta picta (Schneider)	Eastern Painted Turtle
Clemmys guttata (Schneider)	Spotted Turtle
Pseudemys rubriventris rubriventris (LeConte)	Red-bellied Turtle
Terrapene carolina carolina (Linnaeus)	Eastern Box Turtle
Family Kinosternidae	**Mud and Musk Turtles**
Kinosternon Baurii (Garman)	Striped Mud Turtle
Kinosternon subrubrum subrubrum (Bonnatere)	Eastern Mud Turtle
Sternotherus odoratus (Latreille *in* Sonnini and Latreille)	Stinkpot
Order Squamata	**Lizards, Snakes, and Amphisbaenians**
Suborder Sauria	**Lizards**
Family Iguanidae	**Sceloporine Lizards**
Sceloporus undulatus hyacinthinus (Green)	Northern Fence Lizard
Family Scincidae	**Skinks**
Eumeces fasciatus (Linnaeus)	Five-lined Skink
Eumeces laticeps (Schneider)	Broad-headed Skink
Scincella lateralis (Say *in* James)	Ground Skink
Family Teiidae	**Tegus and Whiptails**
Cnemidophorus sexlineatus sexlineatus (Linnaeus)	Six-lined Racerunn

TABLE 4-47A

TAXONOMIC CHECKLIST OF THE AMPHIBIANS AND REPTILES OF THE COHOKE CREEK WATERSHED, KING WILLIAM COUNTY, VIRGINIA

Scientific Name	Common Name
Class Amphibians (Continued)	
Order Caudata	**Salamanders**
Family Ambystomatidae	**Mole Salamanders**
Ambystoma maculatum (Shaw)	Spotted Salamander
Ambystoma opacum (Gravenhorst)	Marbled Salamander
Family Plethodontidae	**Lungless Salamanders**
Desmognathus fuscus fuscus (Green)	Northern Dusky Salamander
Eurycea bislineata (Green)	Northern Two-lined Salamander
Eurycea longicauda guttolineata (Holbrook)	Three-lined Salamander
Hemidactylium scutatum (Schlegel)	Four-toed Salamander
Plethodon cinereus (Green)	Eastern Red-backed Salamander
Plethodon cylindraceus (Harlan)	White-spotted Slimy Salamander
Pseudotriton montanus montanus Baird	Eastern Mud Salamander
Pseudotriton ruber ruber (Latreille *in* Sonnini and Latreille)	Northern Red Salamander
Family Sirenidae	**Sirens**
Siren intermedia intermedia Barnes	Eastern Lesser Siren
Family Amphiumidae	**Congo Eels**
Amphiuma means Garden	Two-toed Amphiuma
Family Salamandridae	**True Salamanders**
Notophthalmus viridescens viridescens (Rafinesque)	Red-spotted Newt

with modifications applied to tailor the model to the project area or for use with a surrogate species. Field work for the HEP study was conducted with 4 interagency teams of 3 to 4 members each for 3 weeks during July 1996. Variables sampled within each cover type corresponded to the selected evaluation species using that habitat. A total of 231 wildlife sites and 34 fish sites across 14 cover types were sampled. Cover type maps were updated using data collected during the extensive field work. Results of the field sampling are being analyzed and will be used for comparison with the habitat value provided by the proposed mitigation sites.

Pipeline

The river water pipeline from the intake site to the reservoir, and the portion of the pipeline route from the directionally drilled crossing under the Pamunkey River to Diascund Reservoir, then from Diascund Reservoir to Little Creek Reservoir, remains as proposed in the DEIS for all KWR configurations. The entire pipeline for KWR I remains a gravity pipeline with the route as proposed in the DEIS. For KWR II, III, and IV, pumped pipelines are included with new portions of the pipeline routes identified from each proposed pump station to the Pamunkey River directional drill location. In addition, the outfall location into Diascund Reservoir is extended 0.5 miles downstream from that proposed in the DEIS, for KWR II, III, and IV.

Assuming a pipeline right-of-way of 50 feet, the new pipeline for KWR I would disturb approximately 103 acres of land. Existing vegetation community types along the pipeline route were identified through review of USGS topographic mapping and color-infrared aerial photography. Based on a review of these resources, the 17.0 miles of new pipeline would impact primarily mixed forested and agricultural land. Typical wildlife species of these community types are included in Tables 4-39A through 4-39G.

Assuming a pipeline right-of-way width of 50 feet, the new pipeline for the KWR II configuration would disturb approximately 105 acres of land (excluding the Little Creek Reservoir crossing). Existing vegetation community types along the proposed pipeline route were identified through reviews of USGS topographic maps and color-infrared aerial photography.

One of the criteria used in siting the pipeline route was to utilize existing maintained rights-of-way, such as roads or power lines, and avoid forested or wetland areas when feasible. Of the total 17.4 miles of new pipeline required for the King William Reservoir II project, approximately 7.7 miles (44 percent) would be along or within existing rights-of-way. Approximately 4.3 miles of new pipeline between Diascund Reservoir and Little Creek Reservoir would be laid and maintained within an existing raw water pipeline right-of-way through New Kent and James City County. Because the rights-of-way are periodically mowed, vegetation is typical of early stages of succession or old field communities. An additional 3.4 miles of stages of the King William Reservoir pipeline route would follow existing road or utility corridors, thereby minimizing forest fragmentation.

Approximately 4,500 linear feet of pipeline under the Pamunkey River and 3,000 linear feet under high ground would be directionally drilled, thereby avoiding impacts to the surface vegetation.

Based on USGS topographic maps, approximately 6.3 miles (36 percent) of the total King William Reservoir II pipeline route would be located in forest or wetland areas, and 1.9 miles (11 percent) would cross agricultural fields. Wildlife species typical of these community types are listed in Tables 4-39A through 4-39G.

TABLE 4-47A

TAXONOMIC CHECKLIST OF THE AMPHIBIANS AND REPTILES OF THE COHOKE CREEK WATERSHED, KING WILLIAM COUNTY, VIRGINIA

Scientific Name	Common Name
Suborder Serpentes	**Snakes**
Family Colubridae	**Colubrids**
Carphophis amoenus amoenus (Say)	Eastern Worm Snake
Coluber constrictor constrictor (Linnaeus)	Northern Black Racer
Diadophis punctatus punctatus (Linnaeus)	Southern Ring-necked Snake
Elaphe obsoleta obsoleta (Say *in* James)	Black Rat Snake
Heterodon platirhinos Latreille *in* Sonnini and Latreille	Eastern Hog-nosed Snake
Lampropeltis getula getula (Linnaeus)	Eastern Kingsnake
Nerodia sipedon sipedon (Linnaeus)	Northern Water Snake
Opheodrys aestivus aestivus (Linnaeus)	Rough Green Snake
Storeria dekayi dekayi (Holbrook)	Northern Brown Snake
Storeria occipitomaculata occipitomaculata (Storer)	Northern Red-bellied Snake
Thamnophis sauritus sauritus (Linnaeus)	Eastern Ribbon Snake
Thamnophis sirtalis sirtalis (Linnaeus)	Eastern Garter Snake
Virginia striatula (Linnaeus)	Rough Earth Snake
Virginia valeriae valeriae (Baird and Girard)	Smooth Earth Snake
Family Viperidae	**Vipers and Pitvipers**
Agkistrodon contortrix mokasen (Daudin)	Northern Copperhead

Source: Mitchell, 1994.

Available information from existing map sources was first compiled to identify wetland acreage at the site. The following wetland acreages were obtained through interpretation of the listed map sources for the King William Reservoir I.

MAP SOURCE	ACRES OF WETLANDS
USFWS NWI Maps	293
SCS Soils Maps	554

Because these sources did not agree on wetland acreage, color-infrared aerial photography of the site was obtained. Detailed wetland mapping of the proposed reservoir area was conducted using the following sources:

- USGS Topographic Maps - New Kent, King and Queen Courthouse, and King William Quadrangles (Scale: 1 inch = 2,000 feet)
- USFWS NWI maps - New Kent, King and Queen Courthouse, and King William Quadrangles (Scale: 1 inch = 2,000 feet)
- SCS Soils Maps, 1990 (Scale 1 inch = 1,320 feet)
- Aerial Photography - 1982 NHAP (Scale 1 inch = 1,270 feet; Date flown; 3/29/82)
- Aerial Photography - 1989 Air Survey Corporation maps (Scale 1 inch =200 feet, and 1 inch = 1,000 feet; Date flown; 3/7/93)

A preliminary wetland map was developed using the 1982 NHAP photographs (1 inch = 1,270 feet) as a base and overlaying the USGS topographic maps adjusted to the same scale. The 1993 photography (1 inch = 1,000 feet) was used to verify areas on the NHAP mapping that were difficult to interpret. Upon completion of the aerial photograph interpretation, field studies were conducted to correct the map based on actual field conditions. Virtually the entire proposed reservoir perimeter was inspected and the wetland line adjusted in several places. Based on this analysis, it was estimated that 479 acres of wetlands would be inundated by King William Reservoir I below a normal pool elevation of 90 feet msl.

A final detailed wetland delineation was planned for the site to eliminate differences in the quality of base maps and the level of field verification for each alternative reservoir site, so that the alternatives could be properly compared. Detailed field mapping of all the wetlands within the King William Reservoir I impoundment area was conducted using the routine on-site inspection methodology from the ***Corps of Engineers Wetlands Delineation Manual*** (USCOE, 1987). The methodology for the field mapping was developed and agreed upon by the USCOE, representatives from the RRWSG, and representatives from James City County. Teams were composed of two or three wetland professionals with at least one representative from the RRWSG and James City County on each team.

Field work for the wetlands field mapping was conducted from May 9 to May 24, 1994. The methodology for the field mapping entailed taking field measurements of wetland dimensions and marking the wetland/upland border on topographic maps (1 inch = 200 feet). Wetland dimensions were measured with hip chains or by pacing and wetland/upland mosaic areas were

Much of the KWR-III pipeline route would match that of KWR-II with an additional 0.8 miles located in forested and wetland areas. The total length for the KWR III pipeline would be 18.2 miles with an approximate disturbance area of 110 acres. The KWR-IV pipeline route would also be similar to the KWR-II pipeline route, with an additional 1.3 miles located in forested and wetland areas. The total length for the KWR-IV pipeline would be 18.7 miles with an approximate disturbance area of 113 acres.

A reservoir pump station for KWR-II, -III, and -IV would be located adjacent to the toe of each dam. Each proposed pump station would disturb less than 3 acres of mixed forest (KWR-IV) or evergreen forest (KWR-II and KWR-III) habitat. The wildlife species associated with these cover types are listed in Tables 4-39A and 4-39C.

Sanctuaries and Refuges

No existing designated sanctuaries or refuges are located within the vicinity of the proposed intake at Scotland Landing, King William Reservoir watershed, or pipeline routes for this alternative (VDCR, 1989; Delorme Mapping Company, 1989; KWCPD, 1991; JCC, 1991).

Wetlands and Vegetated Shallows

Intake

Tidal freshwater marshes and swamps are found along the Mattaponi River from Gleason Marsh (southwest of Truhart) upstream to the Village of Aylett (Silberhorn and Zacherle, 1987; Doumlele, 1979). These freshwater wetlands are similar to those tidal wetlands found on the Pamunkey River (see Section 4.3.1).

The Scotland Landing intake site was inspected by Malcolm Pirnie biologists in January 1989 and by SDN Water Resources engineers in October 1989. The site consists of a large tract of upland situated on a small bluff well above the floodplain of the Mattaponi River. No wetlands are found within the footprint of the proposed pump station site; scouring on the outside bend of the river has prevented the accumulation of fringe wetlands on the southern bank of the Mattaponi.

An extensive tidal freshwater marsh is located directly across from the intake site, on the King and Queen County side of the Mattaponi River. This marsh is dominated by herbaceous species such as Pickerelweed, Arrow Arum, Spatterdock, Wild Rice, and Beggar Ticks with lesser amounts of smartweeds, Arrow-leaved Tearthumb (*Polygonum sagittatum*), Rice Cutgrass, and Walter's Millet (*Echinochloa walteri*) (Priest et al., 1987).

A small tidal freshwater marsh is located about 500 feet downstream from the intake site on the south side of the Mattaponi. This small "pocket" marsh is dominated by Sweet Flag (*Acorus calamus*), Pickerelweed, Arrow Arum, and Spatterdock (Silberhorn and Zacherle, 1987).

Reservoir

Wetlands at the King William Reservoir site have been identified and delineated using the criteria described in the ***Corps of Engineers Wetlands Delineation Manual*** (USCOE, 1987). The methodology used to delineate wetlands included a combination of in-house and routine on-site methods for estimating wetland impacts. Wetland classification, diversity analysis, and functional assessment studies were also conducted. Detailed descriptions of the methodology and results of these studies are presented in Report F and in Appendix II-1 of Report D (Volume II).

Table 4-48

Wetland Types Found in the King William Reservoir Impoundment Area

Wetland Class	Abbreviation	KWR I Acreage	KWR II Acreage	KWR III Acreage	KWR IV Acreage	Description
Unvegetated U.S. Waters	Channel	3	<0.5	<0.5	0	Small unvegetated stream channel
	POWZb	38	30	30	28	Palustrine, open water, intermittently exposed, beaver
	POWZh	8	11	11	6	Palustrine, open water, intermittently exposed, impoundment
	PUBHh	25	0	0	0	Palustrine, unconsolidated bottom, permanently flooded, impounded
Palustrine Emergent	PEM1A	9	2	2	2	Palustrine, emergent, persistent, temporarily flooded
	PEM1B		3		0	Palustrine, emergent, persistent, saturated
	PEM1C	7	4	3	1	Palustrine, emergent, persistent, seasonally flooded
	PEM1Cb	4	0	0	0	Palustrine, emergent, persistent, seasonally flooded, beaver
	PEM1E		2	2	2	Palustrine, emergent, persistent, seasonally flooded/saturated
	PEM1F	14	2	2	2	Palustrine, emergent, persistent, semipermanently flooded
	PEM1Fb	1	0	0	0	Palustrine, emergent, persistent, semipermanently flooded, beaver
	PEM1H		6	6	6	Palustrine, emergent, persistent, permanently flooded
	PEM1Zb		2	2	2	Palustrine, emergent, persistent, intermittently exposed, beaver
	PEM2C		1	1	0	Palustrine, emergent, non-persistent, seasonally flooded
	PEM2E		2	2	2	Palustrine, emergent, non-persistent, seasonally flooded/saturated
	PEM2Eb		<1	0	0	Palustrine, emergent, non-persistent, seasonally flooded/saturated, beaver
	PEM2F		5	5	5	Palustrine, emergent, non-persistent, semipermanently flooded
	PEM2H	16	10	7	7	Palustrine, emergent, non-persistent, permanently flooded
	PEM2Hb	19	4	3	2	Palustrine, emergent, non-persistent, permanently flooded, beaver
Palustrine Forested	PFO1A	154	88	84	71	Palustrine, forested, broad-leaved deciduous, temporarily flooded
	PFO1B		34	34	34	Palustrine, forested, broad-leaved deciduous, saturated
	PFO1C	66	62	60	55	Palustrine, forested, broad-leaved deciduous, seasonally flooded
	PFO1Cb	1	<1	0	0	Palustrine, forested, broad-leaved deciduous, seasonally flooded, beaver
	PFO1E		23	23	21	Palustrine, forested, broad-leaved deciduous, seasonally flooded/saturated
	PFO1F	24	8	6	6	Palustrine, forested, broad-leaved deciduous, semipermanently flooded
	PFO1Fb	30	8	8	8	Palustrine, forested, broad-leaved deciduous, semipermanently flooded, beaver
Palustrine Scrub-Shrub	PSS1A	1	3	2	2	Palustrine, scrub/shrub, broad-leaved deciduous, temporarily flooded
	PSS1B		2	2	2	Palustrine, scrub/shrub, broad-leaved deciduous, saturated
	PSS1C	7	4	4	3	Palustrine, scrub/shrub, broad-leaved deciduous, seasonally flooded
	PSS1E		3	1	1	Palustrine, scrub/shrub, broad-leaved deciduous, seasonally flooded/saturated
	PSS1F	9	4	4	4	Palustrine, scrub/shrub, broad-leaved deciduous, semipermanently flooded
	PSS1Fb	17	<1	0	0	Palustrine, scrub/shrub, broad-leaved deciduous, semipermanently flooded, beaver
	PSS1H		1	1	1	Palustrine, scrub/shrub, broad-leaved deciduous, permanently flooded

assigned a wetland percentage based on transects or visual estimation agreed upon by all team members. Wetland acreage was calculated by planimetry of the final field maps and by computer analysis after the wetland boundaries were digitized. Using these methods, a total of 653 acres of wetlands were delineated at the site below 90 feet msl (normal pool elevation) for KWR-I.

Simply moving the dam 2,900 feet upstream of the KWR-I location would avoid inundation of 94 acres of wetlands. However, raising the normal pool elevation by six feet to 96 feet msl (to maintain the proposed reservoir volume) would inundate an additional 15 acres of wetlands above elevation 90 feet msl in the reconfigured reservoir. Therefore, the net reduction in total wetlands inundated by the reservoir would be 79 acres (574 acres for the KWR-II configuration versus 653 acres for the KWR-I configuration) as a result of moving the dam site upstream. Wetland acreage between elevations 90 and 96 feet msl was estimated by identifying points on the final field maps where wetlands continued above the 90-foot contour. At those points, the distance between the 90- and 96-foot contours was measured and multiplied by the width of the wetlands at the 90-foot contour. Generally, wetlands decrease in width or end as elevation increases. Therefore, this methodology should provide a conservative estimate of the wetland acreage avoided by the revised King William Reservoir configuration. The final estimate of wetlands that would be inundated with the KWR-II configuration is 574 acres.

Based on the detailed mapping available, estimates of wetlands within the remaining proposed pool areas were made. Approximately 511 acres of wetlands lie within the KWR-III pool area and approximately 437 acres of wetlands lie within the KWR-IV pool area.

Wetlands within the King William Reservoir impoundment areas were classified according to the classification system developed by Cowardin et al. and published in ***Classification of Wetlands and Deepwater Habitats of the United States*** (Cowardin et al., 1979). For the purposes of this analysis, no distinction was made between dominant and subdominant subclasses (i.e., PFO1/EM1 was considered the same as PEM1/FO1).

Wetland classification was accomplished with field notes from the detailed wetland field mapping and aerial photograph interpretation. The field notes assisted the scientists in identifying the aerial photograph signatures for each wetland type. Table 4-48 presents the wetland types identified in the King William Reservoir impoundment area. Wetland classifications for KWR wetlands are included in the watershed cover type map presented in Plates 3A, 3B, and 3C. The materials used in the wetland classification analysis include the following:

- 1 inch = 200 feet scale enlargements of 1 inch = 660 feet scale aerial photographs (ASC, 2/17/94)

- 1 inch = 200 feet scale topographic maps (ASC, 2/17/94)

Typical species found in non-tidal forested wetlands at the King William Reservoir site include Red Maple, Smooth Alder *(Alnus serrulata)*, Bayberry *(Myrica cerifera)*, Sycamore, River Birch, Silky Dogwood *(Cornus amomum)*, and various sedges, rushes, cattails, ferns, and grasses. Dominant species in palustrine forested/scrub-shrub wetlands include Smooth Alder, Bayberry, Silky Dogwood, Buttonbush, and various young maples, ashes, gums, and willows. Dominant species in palustrine emergent wetlands at the site include sedges *(Carex spp.)*, Soft Rush, Arrow Arum, Sensitive Fern, Switch Grass *(Panicum virgatum)*, Smartweeds, Pickerelweed, Woolgrass Bulrush, Marsh Fern *(Thelypteris thelypteroides)*, and Broad-leaved Cattail *(Typha latifolia)*, with American Beech *(Fagus grandiflora)* and American Holly *(Ilex opaca)* in drier portions. Palustrine open water wetlands, palustrine scrub shrub/palustrine emergent wetlands and palustrine forested/palustrine open water wetlands are also located within the proposed reservoir area.

Table 4-48

Wetland Types Found in the King William Reservoir Impoundment Area

Wetland Class	Abbreviation	KWR I Acreage	KWR II Acreage	KWR III Acreage	KWR IV Acreage	Description
Palustrine	PFO1/SS1A	28	10	10	10	
Forested/	PFO1/SS1B		9	7	6	
Scrub-Shrub	PFO1/SS1C	9	15	15	0	
	PFO1/SS1Cb	3	<1	0	0	
	PFO1/SS1E		18	8	8	
	PFO1/SS1Eb		2	2	2	
	PFO1/SS1F	1	6	6	6	
	PFO1/SS1Fb	<1	0	0	0	
Palustrine	PFO1/SS1/EM1Eb		0	0	0	
Forested/	PFO1/SS1/EM2C		6	0	0	
Scrub-Shrub/	PFO1/SS1/EM2E		5	0	0	
Emergent	PFO1/SS1/EM2Fb		6	6	6	These remaining wetland types depict situations in which
Palustrine	POW/EM1F		3	3	3	two distinct subsystems or classes occur within a single
Open Water/	POW/EM1Fb		<0.5	0	0	ecological system. For instance, PFO1/EM1C refers to a wetland
Emergent	POW/EM1Zb	8	3	3	3	in the palustrine ecological system, which is co-dominated by
	POW/EM2Eb		1	1	1	broad-leaved deciduous trees and persistent emergent vegetation.
	POW/EM2H		3	3	3	The water regime for the wetland in this case is seasonally flooded.
	POW/EM2Hb		<1	0	0	
	POW/EM2Z	1	4	4	4	
	POW/EM2Zb		6	5	4	
Palustrine	POW/SS1C		2	2	2	
Open Water/	POW/SS1Fb	3	0	0	0	
Scrub-Shrub	POW/SS1Hb		0	0	0	
	POW/SS1Zb		2	2	0	
Palustrine Open Water/Emergent/Forested	POW/EM1/FO1F		2	0	0	
Total		853	674	511	437	

Note: Nomenclature and abbreviations used are from 'Classification of Wetlands and Deepwater in the United States' (Cowardin, et. al., 1979).

Table 4-48

Wetland Types Found in the King William Reservoir Impoundment Area

Wetland Class	Abbreviation	KWR I Acreage	KWR II Acreage	KWR III Acreage	KWR IV Acreage	Description
Palustrine	PEM1/SS1A	2	0	0	0	
Emergent/	PEM1/SS1B		2	2	2	
Scrub-Shrub	PEM1/SS1C	8	8	7	7	
	PEM1/SS1Cb	2	2	2	1	
	PEM1/SS1E		5	5	5	
	PEM1/SS1F	60	9	9	8	
	PEM1/SS1Fb	10	0	0	0	
	PEM1/SS1H		5	5	5	
	PEM2/SS1C		2	2	2	
	PEM2/SS1E		21	20	20	
	PEM2/SS1F		16	16	7	
	PEM2/SS1H	31	29	15	3	
	PEM2/SS1Hb	19	3	3	3	These remaining wetland types depict situations in which
Palustrine	PFO1/EM1A	2	0	0	0	two distinct subsystems or classes occur within a single
Forested/	PFO1/EM1B		1	1	1	ecological system. For instance, PFO1/EM1C refers to a wetland
Emergent	PFO1/EM1C	2	7	7	7	in the palustrine ecological system, which is co-dominated by
	PFO1/EM1Cb	2	2	2	2	broad-leaved deciduous trees and persistent emergent vegetation.
	PFO1/EM1H		2	2	2	The water regime for the wetland in this case is seasonally flooded.
	PFO1/EM1Hb		2	2	2	
	PFO1/EM2B		<0.5	0	0	
	PFO1/EM2C		11	11	10	
	PFO1/EM2E		15	15	15	
	PFO1/EM2Eb		<1	0	0	
	PFO1/EM2H		1	1	1	
Palustrine	PFO1/OWF	2		0	0	
Forested/	PFO1/OWFb	6		0	0	
Open Water	PFO5/OWFb			0	0	

Table 4-48B

Wetland Diversity Analysis
King William Reservoir II

Diversity Index		Equation	Result
Composition	Shannon's Index (Base 2 log)	H = [log N - sum(n*log n)/N]	2.48
	Brillouin's Index (Base 2 log)	H = [log N! - sum(log n!)]/N	2.40*
	Romme's Relative Evenness	E = -100(ln(sum Pi^2))/ln(s)	60.51
Configuration	Modified Fractal Dimension	D = 2*ln((P+(2*(A-1)*C/(Ct-1))/4) / ln(A))	1.45

* For purposes of comparison to the wetlands at Ware Creek, the Brillouin Index calculated for the NWI wetland acreage for the King William Reservoir II impoundment area is 1.62.

To better describe the wetland complexes of the King William Reservoir II site, a diversity analysis was performed. In landscape level analyses, diversity can be broken down into two components: composition and configuration. Composition is a non-spatial feature related to the number of cover types and the proportion of the total area that each type represents (also known as evenness). Configuration relates to the shape of the landscape patches and the spatial arrangement of those patches. (A patch is a subunit of the landscape which is generally homogeneous in cover type for the scale at which the analysis is performed.) More complexity in patch shape within a landscape (i.e., areas with irregular edges) generally allows for more interaction between patches and thus, increases diversity. Likewise, greater numbers of cover types immediately adjacent to one another generally increases the interaction between cover types.

Diversity indices traditionally are used to measure community diversity, including species richness (the number of species) and species evenness (the relative abundance of individuals within each species). By substituting cover types for species and acres for individuals, the diversity index also can be used to measure landscape diversity.

Composition diversity was calculated for the King William Reservoir II impoundment area, using the wetland classes from detailed wetland classification. The Brillouin Index, Shannon's Index, and Romme's Relative Evenness were calculated (Murdoch et al., 1972). The Brillouin Index was selected from the many diversity indices because it is designed for situations where data has been collected on the entire area in question. The Brillouin Index calculates a relationship between the total number of wetland acres in the project area and the number of acres in each wetland cover type. When wetland acres for an examined area are distributed among many wetland classes, compositional diversity is high. However, when a large percentage of wetland acres are concentrated in few wetland classes, compositional diversity is low.

Shannon's Index is very similar to the Brillouin Index in that it incorporates the number of wetland classes, the total number of classes, and the evenness of acreage distribution. However, it is designed to measure the compositional diversity of a sample from a larger population. Romme's Relative Evenness addresses only the evenness of acreage distribution and normalizes for the number of wetland classes.

To measure configuration diversity, a Modified Fractal Dimension (Olsen et al., 1993) was used. Fractal dimensions are commonly used in landscape analyses to describe the complexity of patch shape and the associated patch interaction. The Modified Fractal Dimension calculates a relationship between the modified perimeter of a patch, the area of the patch, the number of adjacent cover types, and the total number of cover types in the project area.

Table 4-48B presents the diversity indices calculated for the King William Reservoir II impoundment area using the detailed wetland classification.

The results of the wetland diversity analysis indicate that the King William Reservoir II impoundment area includes a diverse wetland complex. The King William Reservoir area is less diverse in composition and similar in configuration to the Southern Branch of Black Creek Reservoir wetland complex. The lower compositional diversity is primarily due to the domination of the total wetland area by a few wetland types. Therefore, Romme's Relative Evenness is much lower for the KWR II wetlands than for the Black Creek wetlands. A full description of the wetland diversity analysis is presented in Report F.

In April 1993, a wetland evaluation was completed for non-tidal wetlands within the area of the King William Reservoir II impoundment. The USCOE's Wetland Evaluation Technique (WET) was utilized to assess the functions and values of the wetlands at the proposed reservoir site

TABLE 4-49

SUMMARY OF WET ANALYSIS RESULTS
KING WILLIAM RESERVOIR II WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	H	M	*
Floodflow Alteration	M	H	M
Sediment Stabilization	M	H	*
Sediment/Toxicant Retention	M	H	H
Nutrient Removal/Transformation	H	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	H	*
Wildlife Diversity/Abundance (Migration)	*	H	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	M	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note:
"H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

(Adamus et al., 1987; Adamus et al., 1991). WET is a broad brush approach to wetland evaluation, based on information about predictors of wetland functions that can be gathered quickly. WET estimates the probability that particular functions will occur in a wetland area and provides insight into the importance of those functions. A detailed discussion of the methodology and results of this analysis is contained in Appendix II-1 of Report D (Volume II).

For purposes of this analysis, the impoundment was considered the assessment area (AA) and the impact area (IA). Therefore, this WET analysis provides an assessment of the palustrine wetland complex as a whole. Because the palustrine system consists of many different types of wetlands, the evaluation of any particular wetland site could be different from the results achieved in this analysis.

Table 4-49 summarizes the results of the WET analysis for the King William Reservoir II palustrine wetlands. At the time this analysis was performed, the only wetland acreage estimate available was based on NWI maps; therefore the acreage of wetlands was considered to be 293 acres.

The results of the WET analysis indicate that the palustrine system has a high probability of being effective in providing floodflow alteration, sediment stabilization, sediment/toxicant retention, and wildlife habitat. It has a moderate probability of providing groundwater discharge and production export functions. It received a low score for groundwater recharge, nutrient removal/transformation, and aquatic diversity/abundance.

As a portion of the functional assessment of the wetland impacts associated with the King William Reservoir project, the Evaluation for Planned Wetlands (EPW) methodology, developed by Environmental Concern, Inc. (Bartoldus et. al., 1994), was applied to the wetlands within the KWR II project area. The EPW format provides a quantitative evaluation of the wetlands through the following six wetland functions:

- Shoreline bank erosion control
- Sediment stabilization
- Water Quality
- Fish
- Wildlife
- Uniqueness/Heritage

In EPW, specific physical, chemical, and biological elements of the wetland or landscape are identified. These elements are quantified by their relationship to a particular function and are combined in assessment models to derive Functional Capacity Indices (FCIs). FCIs are multiplied by the size of the assessed wetland to acquire Functional Capacity Units (FCUs).

Table 4-49A summarizes the Functional Capacity Indices and Functional Capacity Units for the wetlands within the KWR II project area. Acreage calculations were based on the results of the detailed wetland delineation. The results indicate that the existing wetlands provide a high degree of sediment stabilization and water quality functions and a moderate degree of wildlife and fish functions. A full description of the EPW study is presented in the ***King William Reservoir***

TABLE 4-49A
EVALUATION FOR PLANNED WETLANDS
KING WILLIAM RESERVOIR II

Wetland Type	Site #	SB	SS	WQ	WL	FS	FP	UH	Geographic Descriptor
Palustrine Emergent Wetlands									
PEM2Zb	7	0.78	0.9	0.93	0.38	0.56	-	NA	main stem, northern branch
PEM2A	55	0.71	0.82	0.78	0.39	0.5	-	NA	large tributary on west side
PEM1Zb	17	0.57	0.74	0.77	0.53	-	0.73	NA	larger western tributary
PEM1H	10	NA	0.81	0.75	0.57	-	0.81	NA	main stem
PEM2H	Y	0.67	0.65	0.76	0.59	0.54	-	NA	main stem, southern portion
Avg. PEM	**5 sites**	**0.68**	**0.78**	**0.8**	**0.49**	**0.53**	**0.77**	**NA**	
FCU	**71 ac.**	**48.28**	**55.38**	**56.8**	**34.79**	**37.63**	**54.67**	**0**	
Palustrine Scrub-Shrub/Emergent Wetlands									
PSS1/EM2C	56	0.95	0.78	0.79	0.35	0.31	-	NA	upper end of a large western tributary
PSS1/EM2H	33	0.82	1	0.96	0.69	0.53	-	NA	main stem
PSS1/EM1C	35	0.57	0.45	0.58	0.43	0.44	-	NA	mouth of small tributary to the eastern branch
PSS1/EM2H	37	0.62	0.66	0.9	0.68	0.59	-	NA	main stem, southern portion (closest to dam site)
PSS1/EM1Fb	S	0.47	0.89	0.89	0.64	0.54	-	NA	main stem, northern branch
PSS1/EM2E	32	0.6	0.85	0.83	0.59	0.53	-	NA	larger western tributary, near confluence with main stem
PSS1/EM1Fb	30A	0.57	0.64	0.85	0.61	-	0.74	NA	main stem, northern branch
Avg. PSS/EM	**7 sites**	**0.66**	**0.75**	**0.83**	**0.57**	**0.49**	**0.74**	**NA**	
FCU	**117 ac.**	**77.22**	**87.75**	**97.11**	**66.69**	**57.33**	**86.58**	**0**	
Palustrine Scrub-Shrub Wetlands									
PSS1Zb	6	0.82	0.79	0.79	0.51	0.56	-	NA	main stem, northern branch
PSS1C	51	0.82	0.74	0.79	0.75	0.6	-	NA	main stem
PSS1Zb	9	0.67	0.74	0.64	0.64	-	0.79	NA	northwest tributary
PSS1C	15A	NA	0.88	0.97	0.54	0.44	-	NA	small tributary at confluence with main stem
PSS1F	12	0.66	0.66	0.79	0.61	0.54	-	NA	main stem
Avg. PSS	**5 sites**	**0.74**	**0.76**	**0.79**	**0.61**	**0.54**	**0.79**	**NA**	
FCU	**35 ac.**	**25.9**	**26.6**	**27.65**	**21.35**	**18.9**	**27.65**	**0**	

TABLE 4-49A
EVALUATION FOR PLANNED WETLANDS
KING WILLIAM RESERVOIR II

Wetland Type	Site #	SB	SS	WQ	WL	FS	FP	UH	Geographic Descriptor
Palustrine Forested Wetlands									
PFO1C	21	0.6	0.74	0.58	0.39	0.53	-	NA	small tributary, near confluence with eastern branch
PFO1C	W	0.67	0.74	0.86	0.51	0.53	-	NA	main stem, southern end
PFO1Fb	T	0.67	0.58	0.87	0.57	0.53	-	NA	main stem, northernmost sample location
PFO1C	40	0.58	0.79	0.59	0.42	0.51	-	NA	small eastern tributary
PFO1C	16	0.82	0.72	0.85	0.7	0.54	-	NA	eastern branch, near confluence with main stem
PFO1E	14	0.55	0.42	0.66	0.58	0.2	-	NA	upper end of eastern tributary, downstream of farm pond
PFO1C	15	0.82	0.79	0.55	0.58	0.45	-	NA	small eastern tributary
PFO1C	8	0.57	0.79	0.65	0.65	0.57	-	NA	upper end of northern tributary
PFO1A	13	0.67	0.79	0.57	0.57	0.45	-	NA	upper end of a western tributary
PFO1C	1	0.77	0.89	0.78	0.76	0.59	-	NA	northwest tributary near confluence with main stem
PFO1A	53	0.79	0.79	0.5	0.64	0.44	-	NA	upper end of western tributary, upstream of a pond
PFO1C	52	NA	0.78	0.89	0.69	0.65	-	NA	main stem
PFO1A	5	0.82	0.79	0.79	0.52	0.36	-	NA	main stem, northern branch
PFO1C	A	0.92	0.89	0.88	0.68	0.49	-	NA	small tributary to the eastern branch, near mouth
Average PFO	**14 sites**	**0.71**	**0.75**	**0.72**	**0.59**	**0.49**	-	**NA**	
FCU	**262 ac.**	**186.02**	**196.5**	**188.64**	**154.58**	**128.38**	**0**	**0**	
Palustrine Forested/Emergent Wetlands									
PFO/EM1	30	0.69	0.68	0.7	0.74	0.57	-	NA	main stem, northern branch
PFO/EM1	19	0.91	0.84	0.71	0.46	0.43	-	NA	near mouth of western tributary
PFO/EM2	22	0.6	0.78	0.72	0.54	0.53	-	NA	eastern branch
Avg. PFO/EM	**3 sites**	**0.73**	**0.77**	**0.71**	**0.58**	**0.51**	-	**NA**	
FCU	**9 ac.**	**6.57**	**6.93**	**6.39**	**5.22**	**4.59**	**0**	**0**	
Palustrine Forested/Scrub-Shrub Wetlands									
PFO1/SS1C	50	0.76	0.89	0.85	0.69	0.67	-	NA	main stem
PFO1/SS1C	18	0.91	0.86	0.91	0.67	0.57	-	NA	main stem
PFO1/SS1A	34	NA	0.82	0.93	0.49	0.1	-	NA	main stem
PFO1/SS2A	20	0.9	0.82	0.73	0.65	0.72	-	NA	upper end of small eastern tributary
PFO1/SS1E	Z	0.79	0.75	0.81	0.62	0.54	-	NA	main stem
PFO1/SS1B	38	0.79	0.84	0.86	0.53	0.53	-	NA	larger western tributary
PFO1/SS1C	36	0.54	0.82	0.76	0.49	0.51	-	NA	eastern branch
Avg. PFO/SS	**7 sites**	**0.78**	**0.83**	**0.84**	**0.59**	**0.52**	-	**NA**	
FCU	**30 ac.**	**23.4**	**24.9**	**25.2**	**17.7**	**15.6**	**0**	**0**	

TABLE 4-49B

Potential Stream/Wetland Area Impacts from Pipeline Construction
King William Reservoir Project

Wetland Type	Wetland Area				Wetland Area
	King William Reservoir I Pipeline (square feet)	King William Reservoir II Pipeline (square feet)	King William Reservoir III Pipeline (square feet)	King William Reservoir IV Pipeline (square feet)	Diascund to Little Creek Reservoir Pipeline Upgrade (square feet)
L1OWHh	13,000	13,000	13,000	13,000	25,000
PEM1C	5,500				
PEM1E					25,000
PEM1F	6,500				
PFO1A	22,750	28,250	24,250	24,250	26,250
PFO1C	39,375	39,375	39,375	41,375	25,000
PFO1E	18,000	25,000	25,000	25,000	
PFO1Eb	12,000	12,000	12,000	12,000	
PFO1Eh					12,500
PFO1F	15,500	15,500	15,500	15,500	
PFO1R		30,000	30,000	30,000	
PFO3A	1,500				
PSS1C		5,500			12,500
PSS1E	23,500	23,500	23,500	23,500	
PSS1Eb	30,500	30,500	30,500	30,500	
PEM2/SS1C			17,000		
PEM1/SS1F				4,500	
PSS1/EM1E	37,500	37,500	37,500	37,500	
PSS1/EM1Eb	2,000	2,000	2,000	2,000	
PFO1/SS1B				3,750	
PUBHh					27,500
PUBFb	10,000	10,000	10,000	10,000	
R2UB4	1,750	600	600	600	
R1OWV		24,000	24,000	24,000	
Total (Sq.Ft.)	239,375	296,725	304,225	297,475	
Diascund to Little Creek Upgrade Total (Sq. Ft.)	153,750	153,750	153,750	153,750	Total (Sq. Ft.) 153,750
Total (Sq. Ft.)	393,125	450,475	457,975	451,225	
Total (Acres)	9.02	10.34	10.51	10.36	

Project Conceptual Mitigation Plan for the Virginia Department of Environmental Quality (Malcolm Pirnie, 1996).

The wildlife habitat value provided by the wetlands of the KWR-II project area will be evaluated as part of the KWR HEP study. Several wetland indicator species were selected by the interagency HEP team to accurately reflect the wildlife value of the wetland cover types within the project area. Results of the HEP field sampling are being analyzed and will be used for comparison with the habitat value provided by the proposed mitigation sites.

According to aerial photography interpretation, there are approximately 55.3 acres of wetlands in the main channel of Cohoke Creek between KWR-I dam site and the Pamunkey River. There are approximately 78.3 acres of wetlands between the KWR-II dam site and the Pamunkey River. Forty acres of wetlands occur between KWR-II and the upper reaches of Cohoke Millpond, nearly all of which are permanently flooded. Approximately 81 acres and 105 acres of wetlands occur between KWR-III and KWR-IV, respectively and Cohoke Millpond. The hydrology of these wetlands ranges from seasonally flooded to permanently flooded. There are approximately 1.3 acres of fringe wetlands associated with Cohoke Millpond and 37 acres of tidal wetlands downstream of the Millpond dam. Additional wetland acreage downstream, which would have been inundated with the KWR-I configuration, would no longer be affected with the KWR-II, KWR-III, or KWR-IV dam locations.

Pipeline

There are approximately 65 potential stream/wetland area crossings associated with the 17.0 miles of new pipeline for KWR-I. Approximately 60 potential stream/wetland area crossings are involved along the 17.4 miles of new pipeline needed for KWR-II. The new pipeline associated with KWR-III has 58 potential stream/wetland area crossings along the total 18.2 miles. The pipeline associated with KWR-IV has 60 potential stream/wetland area crossings along the total 18.7 miles. This estimate of stream/wetland area crossings was based on a review of the following sources:

- USGS Topographic Maps, 1 inch = 2000 feet scale
- USFWS National Wetlands Inventory Maps, 1 inch = 2000 feet scale
- Aerial Photographs, National High Altitude Photography (NHAP), 1 inch = 1300 feet scale
- Aerial Photographs, National Aerial Photography Program (NAPP), 1989, 1 inch = 650 feet scale
- Aerial Photography, Air Survey Corporation (ASC), 1994, 1 inch = 650 feet scale (impoundment area and pipeline routes)
- Topographic Maps, Air Survey Corporation (ASC), 1994, 1 inch = 200 feet scale (impoundment area and pipeline routes)

Table 4-49B summarizes the stream/wetland types and acreage which occur along the King William Reservoir pipeline routes, including the segment of pipeline between Diascund Reservoir and Little Creek Reservoir. Most of the affected stream/wetland areas would be palustrine forested, broad-leaved deciduous wetlands. Typical tree species of these Virginia Coastal Plain were classified according to Anderson et al. (1976). Based on this analysis, the predominant vegetation community type within the proposed impact area would be mixed forest. Wildlife species typical of this community type are included in Table 4-39A.

Sanctuaries and Refuges

There are no existing designated sanctuaries or refuges in the immediate vicinity of the proposed groundwater well locations at Diascund Creek and Little Creek Reservoirs.

Wetlands and Vegetated Shallows

The eight proposed well sites located at Little Creek and Diascund Creek reservoirs are all located in upland areas. The discharge pipelines to the reservoirs would not cross stream/wetland areas, assuming that the pipelines would travel the shortest distances to stream beds.

Mud Flats

No mud flats are located in the vicinity of proposed groundwater wells or associated pipelines and outfall structures at Diascund Creek or Little Creek Reservoirs.

4.3.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Endangered, Threatened, or Sensitive Species

The VDCR has records of Loesel's Twayblade (*Liparis loeselii*) along State Route 641 near Jones Pond in York County. This very rare fen orchid does not have federal or state legal status, nor is it a candidate for listing. The concentrate pipeline for the Site 2 (Upper York County) facilities would parallel a portion of State Route 641 on the southwest side of Interstate 64 before crossing the interstate along Route 641. However, after crossing to the northeast side of Interstate 64, the pipeline would leave Route 641 and avoid portions of the road which are located near Jones Pond. Therefore, negative impacts to Loesel's Twayblade are not anticipated as a result of the proposed concentrate pipeline construction.

VDCR did not identify any natural heritage resources in the other groundwater desalination project areas (T. J. O'Connell, VDCR, personal communication, 1993).

Fish and Invertebrates

Wells would be installed at finished water storage and distribution locations within the City of Newport News and on existing Newport News Waterworks property in York County. Because withdrawal locations are spread evenly across the service area, the amount of pipeline required is reduced, and the local groundwater levels would not be as deeply depressed. Therefore, potential impacts to the Coastal Plain aquifer system, and the surface water bodies which recharge the aquifers, would be minimized. Any potential effects on fish and invertebrates due to groundwater withdrawals should be negligible.

The Site 1 (Copeland Industrial Park Ground Storage Tank) concentrate discharge pipeline route would not cross any streams. The outfall would discharge into Hampton Roads. Fish and invertebrate species typical of this water body would be typical of those found in the polyhaline waters (18 to 30 ppt salinity) of the lower Chesapeake Bay.

palustrine systems include Sweetgum, River Birch, Black Gum, Red Maple, Green Ash, and Sycamore.

The pipeline also would cross underneath the Pamunkey River and the open water of an arm of Little Creek Reservoir.

The proposed reservoir pump stations for KWR-II, KWR-III, or KWR-IV would not impact any existing stream/wetland areas.

Mud Flats

No mud flats are located in the immediate vicinity of the intake site at Scotland Landing on the Mattaponi River based on review of USGS topographic maps and USFWS NWI maps; however, mud flats are located 3,500 feet upstream of the intake site and 2,200 feet downstream of the intake site.

No mud flats were identified within the proposed reservoir area or below any of the proposed dam sites on Cohoke Creek. Also, no mud flats were identified along the pipeline route or in the vicinity of the reservoir pump station for KWR II, KWR III, or KWR IV.

4.3.4 Fresh Groundwater Development

Endangered, Threatened, or Sensitive Species

Project review conducted by the VDCR, VDGIF, and VDACS identified no known natural heritage resources or endangered or threatened animal, plant or insect species at the eight proposed groundwater well locations at Diascund Creek and Little Creek reservoirs (T. J. O'Connell, VDCR, personal communication, 1992; H. E. Kitchel, VDGIF, personal communication, 1992; J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Diascund and Little Creek reservoirs are currently monitored by a fishery management program in cooperation with the VDGIF. Fish stocking of the Little Creek Reservoir was initiated in 1982 and continued through 1992. Species stocked include Largemouth Bass, Bluegill, Blue Catfish, and Channel Catfish. Since 1986, only Walleye have been stocked. (VDGIF, 1993). Fish surveys conducted by VDGIF in 1992 revealed that Bluegill, Largemouth Bass, Brown Bullhead, and American Eel were the most abundant fish species in Little Creek Reservoir.

Fish species stocked at Diascund Creek Reservoir between 1969 and 1980 include Red-ear Sunfish, Northern Pike, Muskellunge, and Channel Catfish (VDGIF, 1993). Fish surveys conducted by VDGIF in 1992 revealed that Bluegill, Gizzard Shad, Black Crappie, and Red-ear Sunfish were numerically the most abundant fish species in Diascund Creek Reservoir.

Invertebrate species present in these two reservoirs would be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

Other Wildlife

Existing vegetation community types in the vicinity of proposed groundwater well locations along the perimeter of Diascund Creek and Little Creek reservoirs were identified based on review of USGS topographic maps and color-infrared aerial photography. Vegetation community types

TABLE 4-50

FISH SPECIES OF SKIFFE'S CREEK (1990)

Scientific Name	Common Name
Alosa sapidissima	American Shad
Anchoa mitchilli	Bay Anchovy
Brevoortia tyrannus	Atlantic Menhaden
Cynoscion regalis	Weakfish
Dorosoma cepedianum	Gizzard Shad
Fundulus majalis	Striped Killifish
Ictalurus catus	White Catfish
Ictalurus melas	Black Bullhead
Ictalurus punctatus	Channel Catfish
Leiostomus xanthurus	Spot
Menidia beryllina	Inland Silverside
Micropogonias undulatus	Atlantic Croaker
Morone americana	White Perch
Morone saxatilis	Striped Bass
Mugil cephalus	Striped Mullet
Pomatomus saltatrix	Bluefish
Trinectes maculatus	Hogchoker

Source: International Science & Technology, 1990.

The Site 2 (Upper York County Ground Storage Tank) concentrate discharge pipeline route would cross one perennial tributary of Jones Millpond and one intermittent tributary of Jones Millpond. Centrarchid (i.e. sunfish) species would most likely dominate in this habitat type. Fish species occurring in this water body would be similar to those listed in the freshwater tributaries of the Chesapeake Bay (see Table 4-39). Invertebrate species would be similar to those listed in Table 4-27. The proposed concentrate pipeline would discharge into polyhaline waters on Queens Creek, a tributary of the York River.

The Site 3 (Harwood's Mill WTP Clearwell) concentrate discharge pipeline route would cross one perennial and one intermittent stream. Fish and invertebrate species present in these streams would be similar to those listed in Tables 4-39 and 4-27, respectively. The concentrate pipeline outfall would be on the Poquoson River in polyhaline waters.

The Site 4 (Lee Hall WTP Clearwell) concentrate discharge pipeline route would not cross any streams. The outfall at Skiffe's Creek would occur in waters which are typically mesohaline and sometimes oligohaline. Anadromous and resident fish surveys were conducted on Skiffe's Creek in April 1990 and August 1990, respectively (International Science & Technology, 1990). Fish species identified during these surveys are listed in Table 4-50.

Other Wildlife

Each of the wells and associated RO (reverse osmosis) treatment plants are within the City of Newport News or on existing Newport News Waterworks property, within urbanized areas. A maximum area of disturbance of approximately 1 acre would be required for each well and treatment plant. Assuming a maximum pipeline right-of-way width of 40 feet, an additional 65 acres would be disturbed to construct 13.4 miles of new pipeline. The majority of the alternative sites are located in developed areas. Wildlife species typical of these areas would be similar to those found in agricultural fields (see Table 4-39D), but because of the proximity of human activity, species diversity would be expected to be limited.

Sanctuaries and Refuges

There are no existing designated sanctuaries or refuges within the project areas associated with this alternative.

Wetlands and Vegetated Shallows

The facilities at Site 1 (Copeland Industrial Park Ground Storage Tank) would not affect wetland areas. The proposed concentrate discharge pipeline would run southeast along Chestnut Avenue, to Oak Avenue, to Hampton Avenue, and terminate at Anderson Park emptying directly into Hampton Roads. This pipeline would not cross any stream/wetland areas between the Copeland Industrial Park and Anderson Park. The outfall structure and associated rip-rap would affect an estuarine intertidal flat, regularly inundated wetland (E2FLN).

The Site 2 (Upper York County Groundwater Storage Tank) facilities would include concentrate pipeline crossings of one perennial and one intermittent stream. The concentrate discharge pipeline would leave the Upper York County site and follow State Route 641/642, cross under Interstate 64, cross the Cheatham Annex railroad spur, follow Winchester Road, run due north parallel to the Cheatham Annex - Jones Pond area property line, and cross the Colonial National Historic Parkway, eventually emptying into Queens Creek, approximately 5,500 feet upstream from its confluence with the York River. The outfall structure and associated rip-rap would affect estuarine intertidal emergent, irregularly inundated wetlands (E2EMP).

Other Wildlife

The implementation of the Additional Conservation Measures and Use Restrictions alternative should have no effect on existing wildlife on the Lower Peninsula.

Sanctuaries and Refuges

The implementation of the Additional Conservation Measures and Use Restrictions alternative should have no effect on sanctuaries or refuges in the region.

Wetlands and Vegetated Shallows

The implementation of the Additional Conservation Measures and Use Restrictions alternative would have no effect on wetlands in the region.

Mud Flats

The implementation of the Additional Conservation Measures and Use Restrictions alternative would have no effect on mud flats in the region.

4.3.7 No Action

Endangered, Threatened, or Sensitive Species

The No Action alternative would require that the RRWSG jurisdictions increasingly rely on existing reservoirs to satisfy growing water demands. The Harwood's Mill, Lee Hall, Skiffe's Creek, Diascund Creek, Little Creek, Waller Mill, and Big Bethel impoundments would be utilized to supply larger amounts of raw water. Endangered, threatened, and sensitive species within these areas are described in Sections 4.3.1 through 4.3.5.

Fish and Invertebrates

Fish and invertebrates associated with existing reservoirs are described in Sections 4.3.1 through 4.3.5

Other Wildlife

Wildlife species dependent on communities within and adjacent to existing reservoirs are identified in Sections 4.3.1 through 4.3.5

Sanctuaries and Refuges

If no action is taken to augment the existing water supplies on the Lower Peninsula, existing designated sanctuaries and refuges would not be affected.

Wetlands and Vegetated Shallows

The No Action alternative would require that the RRWSG jurisdictions increasingly rely on existing reservoirs to satisfy growing water demands. As a result, these reservoirs would be increasingly drawn down to levels which could negatively affect adjacent wetland communities. Wetlands within project areas are described in Sections 4.3.1 through 4.3.5.

The Site 3 (Harwood's Mill WTP Clearwell) facilities would include concentrate pipeline crossings of one perennial and one intermittent stream. The concentrate discharge pipeline would leave the Harwood's Mill site and run north on U.S. Route 17, northeast on Lakeside Drive, and east on Dare Road, eventually emptying into the Poquoson River south of Hodges Cove. The outfall structure and associated rip-rap would affect an estuarine intertidal, open water wetland (E2OWN).

The facilities at Site 4 (Lee Hall WTP Clearwell) would not affect wetland areas. The concentrate discharge pipeline would leave the Lee Hall site and run north, cross U.S. Route 60, and head west on Picketts Line and Enterprise Drive, eventually emptying into Skiffe's Creek adjacent to the Oakland Industrial Park. The outfall structure and associated rip-rap would affect estuarine intertidal emergent, irregularly inundated wetlands (E2EMP).

There is no submerged aquatic vegetation (SAV) found in the vicinity of the Queens Creek, Skiffe's Creek, or Hampton Roads concentrate discharge points. SAV beds are found 2,900 feet east of, and 1,100 feet northeast of, the Poquoson River discharge point. Ground-truth surveys completed in 1989 and 1990 by VIMS in conjunction with the Virginia Council on the Environment reported that Eelgrass (*Zostera marina*) and Widgeongrass (*Ruppia maritima*) were the dominant species in these SAV beds (Orth et al., 1991).

Mud Flats

The facilities at Site 1 (Copeland Industrial Park Ground Storage Tank) would not affect mud flat areas. The concentrate discharge pipeline would not cross mud flat areas between Copeland Industrial Park and Anderson Park. However, mud flats do exist at the location of the proposed concentrate pipeline outfall structure and associated rip rap.

The facilities at Site 2 (Upper York County Ground Storage Tank) would not affect mud flat areas. The concentrate discharge pipeline would not cross mud flats between the Upper York County site and the Queens Creek outfall structure. No mud flats were identified in the immediate vicinity of the outfall structure on Queens Creek based on review of USGS topographic maps and USFWS NWI maps; however, mud flats are located 400 feet upstream and 500 feet downstream of the discharge area.

No mud flats were identified in the project areas for the proposed facilities at Site 3 (Harwood's Mill WTP Clearwell) and Site 4 (Lee Hall WTP Clearwell).

4.3.6 Additional Conservation Measures and Use Restrictions

Endangered, Threatened, or Sensitive Species

The implementation of the Additional Conservation Measures and Use Restrictions alternative should not affect endangered, threatened, or sensitive species.

Fish and Invertebrates

The implementation of the Additional Conservation Measures and Use Restrictions alternative should have no effect on fish and invertebrate species on the Lower Peninsula.

Reservoir

In the USCOE's (1984) evaluation of Ware Creek Reservoir, the "Stonehouse" archaeological site was identified as being located adjacent to the proposed dam and roadway. This site is listed on the National Register of Historic Places.

A coordination meeting to discuss cultural resource studies associated with RRWSG water supply alternatives was held at the Virginia Department of Historic Resources (VDHR) offices on April 22, 1993. Representatives from the VDHR, USCOE, RRWSG, MAAR Associates and Malcolm Pirnie were in attendance. It was agreed at this meeting that the RRWSG would rely on the report, ***A Phase I Archaeological Survey of the Proposed Ware Creek Reservoir Area - James City and New Kent Counties, Virginia*** (Hunter and Kandle, 1986) to obtain cultural resources information for the proposed Ware Creek Reservoir area.

In the report by Hunter and Kandle (1986), the identification of resources was limited to the area at and below the proposed 35-foot normal pool elevation. Approximately 45 percent of the total pool area was surveyed, and it was estimated that 85 percent of high probability areas of the entire pool area were examined in this survey. A total of 45 prehistoric and historic-period sites were identified at or below the 35-foot contour level, and an estimated 10 additional sites may be found in the unsurveyed portion of the project site.

The report cited that an additional 16 historic-period sites are listed in the general project area.

Pipeline

Five known cultural resource sites identified through review of VDHR records are located along the proposed pipeline route for this alternative component, and are listed below along with their VDHR identification codes:

Historic Sites:

- Unnamed site (44NK81). This site is classified as an historic, domestic site. It was last investigated in December 1979.
- Mrs. Hockaday's House (44JC269). This site is classified as a domestic site and was most recently investigated in November 1983.
- Boswell House (44JC297). This site is classified as a domestic site and was most recently investigated in November 1983.

Architectural Site:

- Burnt Ordinary (47JC63). This site houses an 18th century tavern which was burnt during the revolution. It was most recently investigated in July 1971.
- Slater House (47JC19). Abandoned early 19th century structure. It was most recently investigated in early 1970s.

In addition to the above listed sites, several archaeological sites are located within the vicinity of the proposed pipeline route through the community of Toano.

Mud Flats

The No Action alternative would result in more frequent and severe drawdowns in existing water supply reservoirs serving the Lower Peninsula. Mud flats along the peripheral areas of reservoirs would, therefore, be more exposed to the atmosphere.

4.4 CULTURAL RESOURCES

The cultural resources impact category was developed, in part, from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential effects on human use characteristics (40 CFR § 230.54). In addition, Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. § 470(f)) requires that the head of any Federal department or independent agency having authority to license any undertaking shall, prior to the issuance of the license, take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (see generally 36 CFR § 800).

In Virginia, the Director of the Virginia Department of Historic Resources (VDHR) functions as the State Historic Preservation Officer, and is responsible for conducting review of projects involving federal action to assure their compliance with Section 106.

The VDHR designates cultural resources as archaeological and architectural resources. Archaeological resources are further categorized as prehistoric and historic sites. Prehistoric sites may date from as early as ca. 10,000 B.C. to ca. A.D. 1600 and consist of Native American sites; historic sites may date from ca. A.D. 1600 to the present. Architectural sites include structures and objects, which date back at least 50 years in time and/or are unique enough to be considered culturally significant.

4.4.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Intake

The proposed intake site on the Pamunkey River was investigated in conjunction with the Report G, ***Phase I Cultural Resource Survey for the Proposed King William Reservoir, King William County, Virginia and a Background Review, Architectural Survey and Archaeological Reconnaissance for the Proposed Black Creek Reservoir, New Kent County, Virginia*** (MAAR Associates, 1996) which is incorporated herein by reference and is an appendix to this document. While a complete Phase I Survey was not conducted for the pump station site, the area was examined as part of a Preliminary Phase I study. The study identified the presence of one previously recorded prehistoric site at the proposed pump station site on the Pamunkey River, and indicated that it is likely that other sites may be present in adjacent areas.

VDHR records indicate that there is also an architectural resource in the vicinity of the proposed Pamunkey River withdrawal site at Northbury. "Chericoke" is located in King William County approximately 0.7 miles north of the Northbury withdrawal site. This site is designated as 50KW13 by the VDHR.

The proposed intake site at Northbury was also evaluated by the USCOE feasibility study (1984). While the general project area was defined as having a high potential for cultural resources at that time, no known sites were identified in the immediate vicinity of the proposed intake site.

The Phase IA Cultural Resources Survey report by MAAR Associates was reviewed, in draft form, by the VDHR in the Fall of 1993 (H. B. Mitchell, VDHR, personal communication, 1993). Comments received from the VDHR are included in Report G. The proposed Black Creek Reservoir project was cited as having the potential for adverse effects on the following four properties (VDHR and MAAR identification codes are listed):

- Crump's Mill (VDHR 63-70)
- Iden (VDHR 63-41; MAAR 2)
- VDHR 63-203 (MAAR 13)
- VDHR 63-178 (MAAR 70)

The New Kent County Historical Society has indicated that there are 14 additional known historic sites in the vicinity of the proposed Black Creek Reservoir site (J. M. H. Harris, New Kent County Historical Society, personal communication, 1992):

- McKay House and Route 606 - located outside the reservoir watershed.
- Brickhouse site - located within the reservoir normal pool area.
- Water Mill - located within the reservoir normal pool area.
- Mt. Prospect - located within the reservoir watershed.
- Zongquarter - located within the reservoir watershed.
- Cherry Lane - located within the reservoir watershed.
- Glebe House - located within the reservoir watershed.
- Wade House and Graveyard - located within the reservoir watershed.
- Grafts - located within the reservoir watershed.
- Nances - located within the reservoir watershed.
- Harrison House - located within the reservoir watershed.
- Ford House - located within the reservoir watershed.
- Crumps House - located within the reservoir normal pool area.
- Callowell-Clopton House - located within the reservoir watershed.

4.4.2 Black Creek Reservoir with Pumpover from Pamunkey River

Intake

Cultural resources in the vicinity of the proposed Pamunkey River intake site at Northbury are discussed in Section 4.4.1.

Reservoir

A Phase IA Cultural Resources Survey was conducted for the proposed Black Creek Reservoir area in New Kent County during the summer of 1993 by MAAR Associates, Inc. This survey is described in Report G. No Phase IB Field Survey was conducted for the Black Creek alternative due to the selection of the King William Reservoir as the RRWSG's preferred alternative.

Research for the Phase IA survey included literature and archival review. Materials reviewed included:

- Archaeological and architectural site files at the VDHR.
- Maps at the Virginia State Library, the Virginia Historical Society, the Library of Congress, and the National Archives.
- Secondary historic sources identified at Swem Library at The College of William and Mary.
- Museums at the Mattaponi and Pamunkey Indian reservations in King William County.

Architectural resources greater than 50 years old in the immediate vicinity of the reservoir site were also inventoried.

Additional steps in the study included the development of a predictive model for the reservoir site using data from two previous reservoir studies conducted in similar environments. A field reconnaissance was also conducted on accessible tracts of the site and on some associated pipeline routes.

No previously identified prehistoric archaeological sites were identified in the Black Creek Reservoir area. Only one previously recorded architectural site, Crump's Mill, is located within the reservoir area. Available information from the VDHR on the identified site and its VDHR identification code are presented below:

- Crump's Mill (63NK70). The mill dates from the 18th century and has undergone renovations. It is believed that the mill was earlier "Clopton's Mill" which was owned by the Clopton family whose home stood in the vicinity of the site. The mill is located within the boundaries of the proposed reservoir site and would be inundated with a normal pool elevation of 100 feet msl.

The predictive model for the Black Creek Reservoir area, based on soil types and topography, suggest that there should be few prehistoric sites located in the impoundment area.

the architectural survey was conducted within a somewhat larger area of potential effect which considered not only the area of direct impact defined by the 96-foot flood pool elevation, but also areas adjacent to the impoundment which might be within the viewshed of individual historic structures (MAAR 1996). The Area of Potential Effect was subsequently narrowed and confined to all those areas located within 500 feet of the 110-foot contour interval.

The preliminary Phase I survey conducted prior to the initiation of the subsequent systematic field survey relied primarily on archival research and limited field reconnaissance for archaeological resources, and a systematic windshield and pedestrian reconnaissance for architectural resources. The subsequent systematic field reconnaissance of the proposed reservoir involved the excavation of over 6,000 shovel test pits placed at systematic intervals across the project area, based on the perceived sensitivity as defined in a predictive model, and surface collection in those portions of the project area where surface exposures were present (i.e. tilled fields, erosional gullies, etc.).

Architectural Sites:

Preliminary Phase I data indicated that there were no previously recorded architectural sites located below the 110-foot contour interval; however, the site files of the VDHR contained three known historic structures near the 110-foot contour which could potentially be affected. These resources and their respective VDHR site numbers are as follows:

- Canton (50KW11)
- Colosse Baptist Church (50KW15)
- Malbourne (50KO40)

In addition to the above-listed resources, the King William Historical Society indicated that there were 15 sites in the vicinity of the proposed King William Reservoir (S.A. Colvin, King William County Historical Society, personal communication, 1993). The sites include the following: Mt. Hope, Mt. Rose, Free Hall, Locust Hill, Sheltons, French Town, Lilly Point, Poplar Spring, Brooks Springs, Cedar Lane, Rose Garden House, Woodside, Marl Hill, Churchville, and Bethany Church.

The subsequent comprehensive survey examined all of the above-enumerated architectural sites and also resulted in the identification and recordation of over 100 additional sites which were determined to be at least 50 years old. The subsequent narrowing of the Area of Potential Effect, to include only those areas within 500 feet of the 110-foot contour, resulted in the intensive survey of 76 architectural sites. Of the 76 sites which were studied in detail, 13 were subsequently determined to be eligible for nomination to the National Register of Historic Places, and three additional sites were determined to be "potentially" eligible (VDHR 1993).

Archaeological Sites:

The comprehensive Phase I survey of the King William County Reservoir impoundment resulted in the identification of 132 sites, 125 of which are located at or below the 96-foot contour interval, and seven of which are located adjacent to, but at a higher elevation. These 132 sites include 25 prehistoric basecamps, 82 prehistoric transient procurement camps, and 37 historic Euro-American sites, several of which overlap prehistoric sites. All 25 prehistoric basecamps, 50 of the prehistoric transient camps, and 25 of the sites containing historic period resources have been identified as potentially eligible for nomination to the National Register of Historic Places (MAAR 1996). Two of the historic period sites overlap prehistoric transient camps.

Pipeline

As part of the Phase IA Cultural Resources Survey conducted for the proposed Black Creek Reservoir (see Report G), information was collected to identify cultural resources which could be affected along some of the associated pipeline routes. However, a complete Phase IA Survey of the pipeline routes was not conducted. The pipeline route was identified as passing near two previously recorded sites west of Tunstall Station (MAAR Associates, 1996). The closest previously recorded sites along the portion of the pipeline route from the pump station site to the reservoir site are designated as 44NK77 and 44NK81 by the VDHR.

Pipeline routes which would connect the proposed reservoir with Diascund Creek Reservoir and the existing Waterworks system have some potential for cultural resources, but the route is likely to have fewer archaeological resources than the pipeline route from the Pamunkey River to the proposed reservoir (MAAR Associates, 1996).

Review of VDHR records for this alternative indicated that two additional archaeological sites are located along the pipeline route. Additional known archaeological resources are located within the vicinity of the pipeline. Available information on the identified sites and their VDHR identification codes are presented below.

Prehistoric Sites:

- 44JC642 - This site is classified as a possible campsite. It was last investigated in October 1990. Due to badly eroding site conditions, no further work was recommended.
- 44JC644 - This site is classified as a possible campsite. It was last investigated in October 1990. Due to badly eroding site conditions, no further work was recommended.

The USCOE's evaluation for this alternative component indicated that portions of the pipeline would be located in a region with a high potential for cultural resources (USCOE, 1984).

4.4.3. King William Reservoir with Pumpover from Mattaponi River

Intake

The proposed intake for the King William Reservoir consists of a pump station to be located at Scotland Landing and a segment of pipeline extending approximately 1.5 miles south to the proposed reservoir impoundment. The initial preliminary Phase I study indicated that there were no previously recorded cultural resources near the proposed pump station and pipeline. The subsequent comprehensive field survey confirmed that no architectural resources were located near the proposed facilities; however, five archaeological sites were located in the course of systematic testing. These archaeological sites include two prehistoric base camps, one transient camp, and two historic period homesteads/farmsteads. All five of the sites have been identified as potentially eligible for nomination to the National Register of Historic Places.

Reservoir

The investigated reservoir impoundment area includes all the terrain from the Cohoke Creek stream bed to the 96-foot contour upstream of the originally proposed KWR-I dam site. The Phase I archaeological survey (See Report G) was conducted in the area defined by these parameters, while eligibility. Of the four groundwater desalting project areas, VDHR believes that Site 4 has the greatest potential to affect previously unidentified archaeological sites.

4.4.6 Additional Conservation Measures and Use Restrictions

Implementation of this alternative would not affect any cultural resources.

4.4.7 No Action

If no action is taken by local purveyors to augment existing water supplies, there would be no effect on cultural resources within the region.

4.5 SOCIOECONOMIC RESOURCES

This section provides a general description of the socioeconomic environment in the vicinity of project areas for the alternatives. Socioeconomic resource categories by which the alternatives were evaluated are described below.

Municipal and Private Water Supplies

Municipal and private water supplies consist of surface water or groundwater which is directed to the intake of a municipal or private water supply system. This section identifies these resources in the vicinity of alternatives. The municipal and private water supplies impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential effects on human use characteristics (40 CFR § 230.50).

Recreational and Commercial Fisheries

Recreational and commercial fisheries consist of harvestable fish, crustaceans, shellfish, and other aquatic organisms used by man. This section describes the use of project areas for recreational and commercial fishing. The recreational and commercial fisheries impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.51).

Other Water-Related Recreation

Water-related recreation encompasses activities undertaken for amusement and relaxation. These activities include consumptive uses such as harvesting resources by hunting or fishing, and non-consumptive uses such as canoeing and sight-seeing. This section describes existing water-related recreational opportunities in project areas. The other water-related recreation impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.52).

Aesthetics

Aesthetics applies to the perception of beauty by one or a combination of the senses of sight, hearing, touch, and smell. This section describes the aesthetic setting of each potential project site. The aesthetics impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.53).

Pipeline

The pipeline for the King William Reservoir extends from the originally proposed KWR-I dam site, in a southeasterly direction through parts of King William and New Kent Counties over a distance of approximately 13 miles. The preliminary Phase I survey of the gravity pipeline route indicated that there were three previously recorded archaeological sites and no architectural sites located within or adjacent to the proposed pipeline right-of-way. The preliminary survey also indicated that the pipeline route intersected several high potential areas. The subsequent comprehensive field survey confirmed the absence of architectural sites likely to be affected by the proposed pipeline, and also resulted in the location of nineteen archaeological sites. The 19 archaeological sites include six prehistoric basecamps, 11 transient camps, and three historic period sites, one of which overlaps a transient prehistoric site. Twelve of the sites, including six basecamps, five transient camps, and one historic site, have been identified as potentially eligible for nomination to the National Register of Historic Places (MAAR 1996), (see Report G). It is possible that further pipeline route studies could lead to a different route and, consequently, create the need for additional cultural resource investigations.

4.4.4 Fresh Groundwater Development

The VDHR conducted a search of its cultural resource site inventory for the project areas encompassed by the Fresh Groundwater alternative and identified two previously recorded archaeological sites in the vicinity of the Diascund Creek Reservoir well sites. However, VDHR indicated that impacts to these sites should not occur given the considerable distances which separate these sites from the project areas.

The VDHR identified seven archaeological sites in the vicinity of the Little Creek Reservoir well sites. All of these sites are 19th century domestic sites predicted to exist on the basis of historic maps. None of the sites have been verified through site visit. These sites' VDHR identified codes are: 44JC204, 44JC205, 44JC206, 44JC207, 44JC208, 44JC209, and 44JC263.

4.4.5 Groundwater Desalination in Newport News Waterworks Distribution Area

The VDHR conducted a search of its cultural resource site inventory for the project areas encompassed by this Groundwater Desalination alternative. The results of this search are summarized below for each of the four groundwater desalting project areas.

Site 1 - The VDHR did not identify any previously recorded archaeological sites within the Site 1 area.

Site 2 - The VDHR identified 47 previously recorded archaeological sites in close proximity to the Site 2 project area. The majority of these sites were identified in a survey of the York County New Quarter Park conducted in 1978. None of these sites have been evaluated for National Register eligibility. Of the four groundwater desalting project areas, VDHR believes that Site 4 has the greatest potential to affect previously unidentified archaeological sites.

Site 3 - The VDHR identified five previously recorded archaeological sites in close proximity to the Site 3 project area.

Site 4 - The VDHR identified 18 previously recorded archaeological sites in close proximity to the Site 4 project area. Of these 18 sites, 4 appear to be directly in the path of the proposed concentrate discharge pipeline. None of these sites have been evaluated for National Register

Additional water use for thermoelectric power generation was reported as 2,064.1 mgd for 1990, and is the largest single use of water within the basin. There are also many irrigators in the Pamunkey River basin whose total withdrawals between 1984 and 1991 averaged 496 million gallons per year (or 2.72 mgd assuming all irrigation occurs between April and September) (G. S. Anderson, USGS, personal communication, 1991; S. Torbeck, SWCB, personal communication, 1992). USGS hydrologists have estimated that the installed capacity of irrigation equipment along the Pamunkey River is approximately 25 mgd (Black & Veatch, 1989).

Summing all of the above withdrawal figures results in an estimated current average water withdrawal of 2,103.7 mgd within the Pamunkey River basin. Of this current estimated water demand in the basin (exclusive of Virginia Power and Chesapeake Corporation), 12 percent is for domestic, commercial, and institutional use; 12 percent is for irrigation; and 76 percent is for industrial and manufacturing purposes.

Actual net streamflow reductions would be less than total Pamunkey basin withdrawals because the 2,103.7 mgd figure (1) includes groundwater withdrawals which do not directly reduce streamflows, and (2) ignores surface water return flows, such as wastewater treatment plant effluent and crop irrigation return flows (i.e., non-consumptive surface water withdrawals). Consumptive use is the portion of water withdrawn that is not returned to the river because it has been evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed from the water environment. The portion of the withdrawal that is not consumed is returned to the resource.

The ***York Water Supply Plan*** (SWCB, 1988) contains an estimated consumptive use factor of 0.44 for the Pamunkey River basin (excluding Chesapeake Corporation and Virginia Power withdrawals) which is based on published USGS data (Solley et. al., 1983). Applying this factor to reported average Year 1990 withdrawals (excluding Chesapeake Corporation and Virginia Power) and estimated irrigation withdrawals results in an estimated consumptive use of 10.1 mgd. Chesapeake Corporation's (West Point Facility) Pamunkey River withdrawals are non-consumptive industrial cooling water withdrawals, and therefore, are not included in the calculation of total consumptive use. Consumptive use by Virginia Power's North Anna Nuclear Power Plant is estimated to be 24.1 mgd. The derivation of this consumptive use estimate is described in Section 2.3.2 of Report I, ***Pamunkey River Salinity Intrusion Impact Assessment for Black Creek Reservoir Alternative*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document. Adding together all of the estimated consumptive uses results in an estimated Year 1990 consumptive use of 34.2 mgd within the entire Pamunkey River basin.

Total freshwater discharge at the mouth of the Pamunkey River is estimated at 883 mgd. Estimated Year 1990 consumptive water use in the basin represents 3.9 percent of the average discharge. A list and location map of major reservoirs, stream intakes, and groundwater withdrawals within the Pamunkey River basin is presented in Table 4-51 and Figure 4-6.

There is also an interbasin transfer of water to the Pamunkey River basin from the Rapidan River (Rappahannock River basin). The Rapidan Service Authority recently submitted a Joint Permit Application to the USCOE to increase its Rapidan River withdrawal from 1.1 mgd to 3.0 mgd. The withdrawal is used to supply the Germanna Highway Corridor, a portion of which is located within the Pamunkey River basin (Black & Veatch, 1996).

Parks and Preserves

This section describes the existing parks and preserves within proposed project areas. For purposes of this analysis, parks and preserves are defined as areas designated under federal, state, or local authority to be managed for their aesthetic, educational, recreational, or scientific value. Parks are more commonly designed to provide recreational and aesthetic benefits to the public, while preserves are commonly used for educational or scientific pursuits. The parks and preserves impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.54).

Land Use

This section describes existing land uses within the proposed project areas. Current land use was determined primarily through review of aerial photography and contact with the jurisdictions involved. The land use impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Noise

This section discusses existing noise in the vicinity of each alternative component. The noise impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Infrastructure

This section describes the existing infrastructure in the vicinity of each alternative component. Transportation, utilities, and navigation are discussed. The infrastructure impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Other Socioeconomic Impacts

The following indicators of the socioeconomic well-being of an area may be affected as a result of water supply development: regional population; existing land use; income and income distribution; property values; local tax base; existing lifestyles; residential, commercial, and industrial growth; and recreational services. The other socioeconomic impacts category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

4.5.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Municipal and Private Water Supplies

Intake

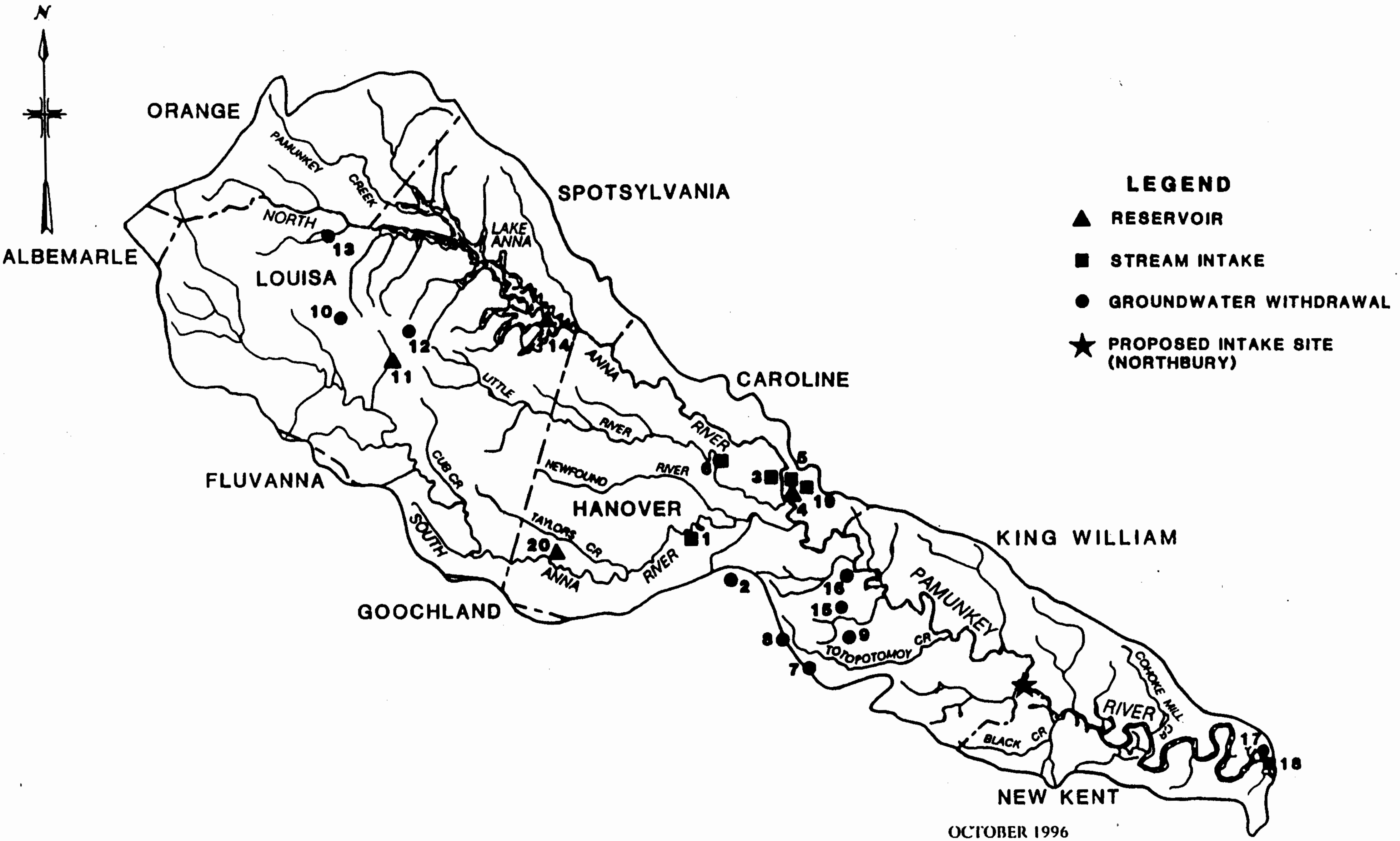
An analysis of existing water use and cumulative streamflow reduction in the Pamunkey River basin was conducted. Total reported surface and groundwater withdrawals within the entire Pamunkey River basin, exclusive of power use and non-consumptive industrial cooling water withdrawals, averaged 20.2 mgd in the Year 1990 (P. E. Herman, SWCB, personal communication, 1993). However, surface water withdrawals made by Chesapeake Corporation which have recently been reported as 16.65 mgd (SWCB, 1988) must be added to this figure.

TABLE 4–51

MAJOR RESERVOIRS, STREAM INTAKES, AND GROUNDWATER WITHDRAWALS IN THE PAMUNKEY RIVER BASIN

Map Number (a)	Description	1990 Withdrawal (b) (mgd)
1	Stream Intake South Anna River Town of Ashland (Ashland WTP)	0.903
2	Groundwater Withdrawal 3 Wells Hanover County	0.019 (c)
3	Stream Intake North Anna River Hanover County (Doswell WTP)	1.833
4	Stream Intake North Anna River Bear Island Paper Company (Doswell Plant)	0.462
5	Reservoir (Meadows Pond) Bear Island Paper Company (Doswell Plant)	0.995
6	Stream Intake Little River General Crushed Stone Company (Verdon Plant)	0.256
7	Groundwater Withdrawal 13 Wells Hanover County and Private	0.144 (c)
8	Groundwater Withdrawal 3 Wells Hanover County and Private	0.027 (c)
9	Groundwater Withdrawal 6 Wells Hanover County and Private	0.086 (c)
10	Groundwater Withdrawal 2 Springs, 4 Wells Town of Mineral	0.079
11	Reservoir (Northeast Creek) Louisa County Water Authority	0.155
12	Groundwater Withdrawal 4 Wells, 1 Spring Louisa County Water Authority	0.005
13	Groundwater Withdrawal 2 Wells Blue Ridge Shores	0.047
14	Reservoir (Lake Anna) Virginia Power	2,064.1
15	Groundwater Withdrawal 2 Wells Virginia Department of Corrections (Barrett Learning Center)	0.022
16	Groundwater Withdrawal 2 Wells Virginia Department of Corrections (Hanover Learning Center)	0.022
17	Groundwater Withdrawal 2 Wells Town of West Point	0.415
18	Stream Intake Pamunkey River Chesapeake Corporation (West Point Facility)	16.65 (d)
19	Stream Intake North Anna River Diamond Energy (Doswell Combined Cycle Facility)	Operational since April 1992
20	Retention Ponds (runoff–fed) Closed System off South Anna River Feldspar Corporation (Montpelier Plant)	14.400

a) See Figure 4–6.
b) Reported 1990 withdrawals retrieved from the Virginia Water Use Data System (P.E. Herman, SWCB, personal communication, 1993).
c) 1984 withdrawal as reported in York Water Supply Plan (SWCB, 1988).
d) 1983 non–consumptive industrial cooling water withdrawal as reported in York Water Supply Plan (SWCB, 1988).



OCTOBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

MALCOLM PIRNIE

MAJOR RESERVOIRS, STREAM INTAKES AND GROUNDWATER WITHDRAWALS IN THE PAMUNKEY RIVER BASIN

10 0 10
SCALE IN MILES

FIGURE 4-6

Reservoir

Effective March 25, 1991, the SWCB granted Stonehouse, Inc. the right to withdraw a total of 184,096,600 gallons per month (6.05 mgd) from its 10 wells within the Ware Creek watershed. In addition to these wells, many individual homeowners in the vicinity of the proposed Ware Creek Reservoir site have their own wells. No municipal or private surface water supplies were identified in the immediate vicinity of the proposed reservoir site.

Pipeline

Two raw water outfalls (40 mgd and 80 mgd capacities) would be located on Diascund Creek upstream of Newport News Waterworks' Diascund Creek Reservoir. There are no known municipal or private water supplies along Diascund Creek upstream of the existing reservoir. However, Diascund Creek Reservoir itself is part of a municipal water supply system (i.e., Newport News Waterworks).

Recreational and Commercial Fisheries

Intake

The Pamunkey River and its banks in the proposed project area are utilized for recreational fishing. The nearest public boat ramp on the Pamunkey River is near Putneys Mill in New Kent County, off of Route 607, and approximately 2.8 river miles downstream of Northbury (Delorme Mapping Company, 1989).

Commercially important fish species harvested during 1989, 1990, and 1991 in the Pamunkey River included catfish, American Shad, Striped Bass, and American Eel. Blue Crab (*Callinectes sapidus*) are also harvested from the Pamunkey River (VMRC, 1992).

Reservoir

According to the USEPA, minimal recreational fishing in the Ware Creek Basin occurs, except for occasional fishing in Richardson's Millpond (USEPA, 1992). Richardson's Millpond has not been surveyed by the VDGIF and is not currently stocked (D. L. Fowler, VDGIF, personal communication, 1992). Recreational fishing is limited due to lack of public access. However, recreational navigation does include the use of small powerboats and canoes on Ware Creek (USCOE, 1987). Fish species present in the Ware Creek Reservoir impoundment are discussed in Section 4.3.1.

Because Ware Creek's shallow depth would limit access by larger commercial vessels, this area has a limited potential for commercial fisheries.

The nearest leased shellfish area to the proposed impoundment site extends from the mouth of Ware Creek to a point approximately 1.6 river miles upstream of the mouth (VMRC, 1992). Any shellfish beds in Ware Creek have been closed by the Virginia Department of Health due to high coliform bacteria levels in the creek (J. C. Dawson, James City County, personal communication, November 1992). Invertebrates of commercial importance would not be abundant farther upstream in the actual impoundment site due to the low salinity at and upstream of the proposed dam site.

Pipeline

Based on review of USGS topographic maps and color infrared aerial photography of the pipeline route, most of the route traverses forested lands.

Other Water-Related Recreation

Intake

The Pamunkey River and its bottomlands in the proposed project area are utilized for various recreational pursuits including fishing, hunting, and boating. The nearest public boat ramp on the Pamunkey River is near Putneys Mill in New Kent County, off State Route 607, and approximately 2.8 river miles downstream of Northbury (Delorme Mapping Company, 1989). The Pamunkey River is tidal at the proposed intake location and is well-suited for year-round recreational boat activity. Several privately owned duck blinds and hunt clubs are located in the vicinity of Northbury (J. Taylor, VDGIF, personal communication, 1992).

Reservoir

As noted in the USEPA's second veto of James City County's proposed Ware Creek Reservoir, the Ware Creek watershed supports numerous species of birds and mammals sought by hunters (USEPA, 1992). Existing use of the Ware Creek Reservoir watershed for water-related recreation includes hunting, fishing, boating, and canoeing; however, there is no public access in the basin and most of the land adjacent to the waterway is posted. Recreational navigation is limited to small powerboats and canoes because of the shallow depth of Ware Creek (USCOE, 1987). According to the USEPA, administrative records indicate that there is minimal recreational fishing in the Ware Creek basin except for occasional fishing in Richardson's Millpond (USEPA, 1992). Several privately owned duck blinds and hunt clubs are located in the basin (USCOE, 1987).

Pipelines

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the 26.3-mile route traverses forested lands. It is likely that portions of this area are leased to private hunt clubs.

Aesthetics

Intake

The aesthetic value of the proposed river intake area is its predominantly natural, scenic beauty. The shoreline surrounding the Pamunkey River in the vicinity of the proposed intake is a sloping, forested terrain which is relatively undeveloped in the immediate vicinity. Four houses were identified within 500 feet of the proposed pump station, with the nearest house located 300 feet from the pump station site (see Table 4-52).

Reservoir

The Ware Creek watershed is mostly rural with residential and commercial development scattered along roads and highways. The aesthetic value of the proposed reservoir area is its scenic

TABLE 4-52

SUMMARY OF HOUSES NEAR THE PROPOSED ALTERNATIVE PROJECT AREAS

Alternative	Intake * within 500 feet		Dam within 500 feet		Reservoir within 500 feet		Pipeline within 300 feet		Total	
	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses
Ware Creek Reservoir	425	4	0	0	354	33	133	107	192	144
Black Creek Reservoir **	425	4	250	1	268	41	171	62	210	104
King William Reservoir										
KWR I	0	0	0	0	263	28	188	45	217	73
KWR II	0	0	0	0	275	27	188	45	221	72
KWR III	0	0	0	0	275	27	188	45	221	72
KWR IV	0	0	0	0	283	24	188	45	221	69
Fresh Groundwater Development	350	9	N/A	N/A	N/A	N/A	0	0	350	9
Groundwater Desalination In Newport News Waterworks Distribution Area	400	19	N/A	N/A	N/A	N/A	140	205	162	224

* Major river withdrawal or groundwater withdrawal points.
** Does not include 3 existing houses that would be directly impacted by the proposed Black Creek Reservoir.
N/A = Not Applicable

beauty, a product of its vegetation and wildlife. However, Ware Creek has limited and seasonally variable visibility from public roads, so its aesthetic appeal is present but is not apparent to the casual observer. No houses were identified within the pool area or within 500 feet of the proposed dam site. A total of 33 houses were identified within 500 feet of the proposed reservoir pool area, with the nearest house located approximately 50 feet from the pool area (see Table 4-52).

Ware Creek is included in the U.S. National Park Service's (NPS) Nationwide Rivers Inventory as part of the York River System. The principal features of Ware Creek which elevate it to inventory status are its free-flowing and generally undeveloped nature; a channel length greater than 5 river miles; and being adjacent to or within a related land area that possesses an outstanding remarkable geologic, ecologic, cultural, historic, scenic, botanical, recreational, or other similar value (NPS, 1981; J. G. Eugster, NPS, personal communication, 1983). The Wild and Scenic Rivers Act (16 U.S.C. 1271) establishes a procedure for designating certain rivers or river segments for protection as part of the National Wild and Scenic River System. The first step in this procedure is for a waterway to be listed on the Nationwide Rivers Inventory. Waterways on the Inventory are not protected by law, but Federal agencies must give special consideration to actions which could preclude a waterway on the Inventory from eventually being listed as a Wild and Scenic River (USCOE, 1987).

Pipeline

The pipeline route would traverse mostly rural areas; however, 107 houses were identified within 300 feet of the proposed pipeline route (see Table 4-52).

<u>Parks and Preserves</u>

Intake

The Pamunkey River is not currently designated as part of the Virginia Scenic Rivers System (VSRS). However, the Pamunkey River is identified in the ***1989 Virginia Outdoors Plan*** as being worthy of future evaluation.

There is currently one site in the Pamunkey River basin which is listed as part of the Chesapeake Bay National Estuarine Research Reserve System (CBNERRS). Sweet Hall Marsh, which is located approximately 24.5 river miles downstream of the proposed Northbury intake site, consists of an extensive tidal freshwater marsh with adjacent non-tidal bottomland forest on the mainland side and shallow flats on the river side (USDC and VIMS, 1990).

In addition, the 1,200-acre Cumberland Marsh Nature Conservancy Preserve is located on the Pamunkey River (T. McNeil, Nature Conservancy, personal communication 1996), approximately 11 river miles downstream of Northbury. Cumberland Marsh is a large, tidal freshwater marsh.

No other existing parks or preserves are located in the vicinity of the proposed Pamunkey River intake at Northbury.

Reservoir

There are no existing parks or preserves located within the Ware Creek Reservoir drainage area (USCOE, 1987; VDCR, 1989; JCC, 1991; RRPDC, 1991). However, the York River is identified in the ***1989 Virginia Outdoors Plan*** as being worthy of future evaluation under the VSRS.

Pipeline

No existing parks or preserves are located along the proposed pipeline route for this alternative component (VDCR, 1989; RRPDC, 1991; JCC, 1991).

Land Use

Intake

Field studies were conducted by Malcolm Pirnie during the spring of 1990 to determine the feasibility of the Northbury site as a potential raw water intake location. These studies indicated that the proposed Northbury intake site is a relatively isolated area with the predominant land uses being farmland and forest. Based on review of color-infrared aerial photography of the area, it is estimated that approximately 1.5 acres of farmland and 1.5 acres of forest would be affected by construction at the intake site. In addition, a small amount of land disturbance may be required for construction of an access road to the pump station and for placement of electrical transmission lines to power the pump station.

Expected future land use at the intake site is conservation lands. Conservation lands are designated by New Kent County "to ensure the protection of environmentally sensitive lands from inappropriate development" (RRPDC, 1991). Designation of an area as a conservation area does not preclude development. However, any development in these areas must be conducted in accordance with local, state, and federal environmental regulations.

Additional land use designations are applicable to the proposed intake site, and serve to regulate development at this site. The Chesapeake Bay Preservation Act is intended to protect and improve the water quality of the Chesapeake Bay. The goals of the Act are achieved through the regulation of development within designated Chesapeake Bay Preservation Areas (CBPAs). The CBPA has two components: Resource Protection Areas (RPAs) and Resource Management Areas (RMAs).

Within New Kent County, CBPAs have not been comprehensively mapped. Rather, site surveys are required to identify CBPAs in regions along rivers or streams depicted on USGS topographic maps which are proposed for development (N. Hahn, New Kent County, personal communication, 1992). It is likely that the proposed intake site would be designated as an RPA.

Development is limited within RPAs and RMAs. In an RPA, only water dependent uses are allowed. Specific performance criteria must be met, such as preservation of natural vegetation, minimal disturbance of land, and control of sedimentation and erosion. In an RMA, uses allowed under the local zoning ordinance are still allowed, but development must meet specific performance criteria.

An additional zoning designation which regulates development within project areas is the Agricultural and Forestal District (AFD). This zoning designation was set forth in the Virginia Agricultural and Forestal Districts Act of 1977 (Section 15.1-1512.D Virginia Code).

The proposed intake site is located entirely within the Hampstead-Northbury-Shimokins AFD. AFDs are defined by New Kent County as "land which requires conservation and protection for the production of food and other agricultural and forestal products and as such is a valuable natural and ecological resource providing open spaces for clean air and adequate and safe water supplies and other aesthetic purposes and is therefore valuable to the public interest" (New Kent County, 1991).

Reservoir

Land use data were compiled for the Ware Creek Reservoir watershed by Langley and McDonald in 1990. This information is presented in Table 4-53. The majority of the watershed consists of forested, agricultural, and residential land (69, 13, and 7 percent, respectively). Less than 2 percent of the total watershed area supports commercial or industrial uses, which are concentrated in the Toano area. Existing land uses within New Kent and James City counties are presented in Tables 4-54 and 4-55, respectively. These data are presented to provide an indication of the relative abundance of specific land use types within the region.

Because the land use data presented in Table 4-53 were collected in 1990, these data provide an indication of existing land use in the watershed. It is expected that the acreage of residential and commercial land uses within the watershed have increased to a small degree, and vacant land and forested acreage have decreased accordingly. It is expected that land uses within the pool area have not changed appreciably.

Color-infrared aerial photography of the reservoir site was inspected to determine land use areas within the proposed normal pool area (see Table 4-56). Land uses within the proposed reservoir pool area, with the exception of wetlands and forests, were measured directly from the color-infrared aerial photographs using planimetry. The primary land use within the reservoir pool area is forested land, which comprises approximately 625 acres of the 1,238-acre pool area. Residential acreage includes all subdivisions, groups of homes, and individual homes which are not associated with agricultural operations. The agricultural rural/residential acreage includes all agricultural lands and houses or structures associated with these lands. Wetland acreage and open water areas were identified through detailed field mapping of wetland areas.

No existing houses were identified that would be displaced by the proposed reservoir or dam.

Within the New Kent County portion of the watershed, anticipated future uses of the land are agriculture and conservation lands. The lands designated as conservation areas are concentrated along the York River and its tributaries in the watershed, while agricultural land is expected to comprise the remainder of the region (RRPDC, 1991).

A portion of the reservoir drainage area is designated for future industrial and commercial development in the vicinity of Toano. The majority of the watershed, however, is designated for low-density residential and mixed use development. Much of this anticipated growth in the watershed is expected as part of the Stonehouse Community (JCC, 1991).

The Stonehouse Community is currently being developed by Stonehouse Inc., which is a subsidiary of Chesapeake Corporation. The total community would comprise 7,230 acres located within the Ware Creek watershed of James City and New Kent counties. Rezoning for the 5,750 acres of this development within James City County was approved by the James City County Board of Supervisors in November 1991. Of James City County's 5,750 acres within Stonehouse, 4,000 acres would be in the reservoir drainage area (J. C. Dawson, James City County, personal communication, September 1992).

TABLE 4-53

WARE CREEK RESERVOIR WATERSHED LAND USE (1990)

Land Use Category	Acreage	% of Total
Light Commercial/Industrial	212	1.9
Residential	804	7.2
Roads	428	3.8
Agricultural	1,474	13.2
Forest	7,565	67.9
Wetlands and Open Water	590	5.4
Recreational	68	0.6
TOTAL	**11,141**	**100**

Source: Based on October 25, 1990 mapping of existing land use in the watershed (Langley and McDonald, 1990) and field investigations of wetland areas.

TABLE 4-54

NEW KENT COUNTY LAND USE (1989)

	Acreage	Percent of Total
Forest, Open Space, and Agricultural	126,556	93.3
Residential	5,846	4.3
Commercial	501	0.4
Industrial	112	0.1
Transportation/Utilities	2,521	1.9
Public Services	144	0.1
TOTAL	135,680	100

Source: RRPDC, 1991.

TABLE 4-55

JAMES CITY COUNTY LAND USE (1991)

Land Use Category	Land Use (Acres)	Percent of Total
Agriculture	13,000	14.1
Residential	15,000	16.3
Commercial	2,800	3.0
Industrial	1,300	1.4
Public Use (includes military land and public parks)	9,300	10.1
Forestry, Wetlands, Inland Water, Roads, Unimproved, Other	50,824	55.1
TOTAL	**92,224**	**100.0**

Source: T. Funkhouser, James City County, personal communication, 1991.

Note: Developed acreage for commercial and industrial uses includes an estimate of acreage of land uses that are grandfathered for an existing use or are operating under a special use permit.

There are currently 18,149 acres of land (20 percent of the total area) within Agricultural and Forestal Districts. James City County staff estimate that approximately 60,000 acres (65 percent of the total area) are in forests of one form or another.

TABLE 4-56

WARE CREEK RESERVOIR NORMAL POOL AREA LAND USE (1982)

Land Use Category	Acreage	% of Total[1]
Agricultural/Rural Residential [2]	4	0.3
Wetlands and Open Water	590	47.7
Forest	625	50.5
Roads	19	1.5
TOTAL	1,238	100

1 Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

2 Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

Source: Planimetry of identified land use boundaries on NHAP color-infrared aerial photography taken on March 29, 1982 (approximate scale 1"=1,270') and field investigations of wetland areas.

In accordance with the Chesapeake Bay Preservation Act, the entire land area of James City County is designated as a CBPA. Ware Creek, its tributaries and adjacent areas in James City County are designated as RPAs while the remainder of the watershed is located within an RMA.

CBPAs have not been comprehensively mapped within New Kent County. However, Ware Creek, its tributaries, and adjacent areas located within New Kent County are likely to be located within an RMA or an RPA.

Approximately 323 acres of the York River AFD are located within the northern section of the reservoir watershed in New Kent County. Of this area, approximately 126 acres would be located within the proposed reservoir normal pool area (N. Hahn, New Kent County, personal communication, 1992). Within James City County, approximately 120 acres of the Barnes Swamp AFD would be located within the reservoir normal pool area. It is anticipated that a buffer area around the normal pool area of the reservoir would be acquired by the RRWSG to regulate adjacent land uses to protect reservoir water quality. Existing land uses within the buffer area would include those land use types listed in Table 4-56 as occurring within the watershed.

Pipeline

The proposed pipeline, with a length of 26.3 miles and an assumed right-of-way (ROW) width of 50 feet, would disturb approximately 159 acres of land. Based on review of USGS topographic mapping and color-infrared aerial photography of the route, the pipeline would traverse forested land, agricultural land, and some commercial land.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the Ware Creek Reservoir alternative is approximately 2 to 3 years. This alternative component would include an intake and pumping station at the Pamunkey River, a pumping station at Diascund Creek Reservoir, and a pumping station at Ware Creek Reservoir. Six 20 mgd pumps would be needed at the Pamunkey River pumping station and four 10 mgd pumps would be required at both the Diascund Creek Reservoir and Ware Creek Reservoir pumping stations. There are very few residences within 500 feet of the proposed Pamunkey River intake and pumping station site, some near the Diascund Creek Reservoir pumping station, and a fair density of residences in the vicinity of the Ware Creek Reservoir pumping station which might be sensitive to elevated noise levels associated with the alternative. Background noise levels in the vicinity of the pumping stations would be those typical of a rural atmosphere.

Infrastructure

Transportation

The principal transportation routes through the immediate vicinity of the proposed impoundment area are Interstate 64 and State Route 168/30. There are numerous other lower order state routes throughout the reservoir area. Portions of State Routes 168/30, 600, and 606 would be inundated by construction of the reservoir. Interstate 64 crosses three arms of France Swamp and one arm of Bird Swamp.

The Chesapeake & Ohio Railway passes through the southern portion of the Ware Creek Reservoir drainage area. No rail lines fall within the proposed impoundment area.

TABLE 4-57

SUMMARY OF AFFECTED LAND USE IN ALTERNATIVE PROJECT AREAS

Alternative	Intake*			Reservoir**			Pipeline		Total		
	Acres Disturbed	AFD Land (acres)	Number of Houses	Acres Disturbed	AFD Land (acres)	Number of Houses	Acres Disturbed	Number of Houses	Acres Disturbed	AFD Land (acres)	Number of Houses
Ware Creek Reservoir	3	3	0	1,238	246	0	159	0	1,400	249	0
Black Creek Reservoir	3	3	0	910	376	3	119	0	1,032	379	3
King William Reservoir***											
KWR I	3	0	0	2,284	0	0	94	0	2,381	0	0
KWR II	3	0	0	2,222	0	0	97	0	2,322	0	0
KWR III	3	0	0	1,909	0	0	101	0	2,013	0	0
KWR IV	3	0	0	1,526	0	0	104	0	1,633	0	0
Fresh Groundwater Development	8	0	0	N/A	N/A	N/A	Minimal	0	8	0	0
Groundwater Desalination in Newport Waterworks Distribution Area	5	0	0	N/A	N/A	N/A	65	0	70	0	0

* Major river withdrawal of groundwater withdrawal points.
** Excludes reservoir buffer area.
*** King William County does not currently designate AFD lands.
N/A Not Applicable.

The proposed pipeline route would parallel and/or cross several existing roadways and rail lines located in New Kent County (NKC) and James City County (JCC). These roadways and rail lines include Interstate 64, (NKC and JCC), U.S. Route 60 (JCC), State Routes 607 (NKC), 606 (NKC), 612 (NKC), 609 (NKC), 642 (NKC), 249 (NKC), 608 (NKC), 628 (NKC), 621 (JCC), 622 (JCC), 601 (JCC), 30 (JCC), and 168/30 (JCC), and the Southern Railway (NKC) and Chesapeake & Ohio Railway (JCC).

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the operation of land clearing, excavation, and construction equipment. Electricity would be needed from the local utility to support construction activities unless diesel generators were utilized to generate electricity at the project site. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. The emergency generator set would require diesel fuel.

Virginia Power is the major producer and distributor of electrical power in the project area associated with this alternative component. Virginia Power owns and operates two steam-electric power plants in the York River basin. The North Anna Plant has an installed capacity of 1,720 megawatts (MW), and the Yorktown Plant has a capacity of 1,154 MW (SWCB, 1988).

Navigation

By regulation, all tidal water bodies in the United States are considered to be "navigable waters of the United States" (33 CFR § 329.4). Based on past studies, it is assumed for administrative purposes that the Pamunkey River is navigable for its entire length (K. M. Kimidy, USCOE - Norfolk District, personal communication, 1993).

The proposed river intake structure would be located at Northbury in tidal and navigable waters. The mean tidal range is 3.3 feet at Northbury (USDC, 1989). USGS topographic maps show a mid-channel depth at mean low water of 18 feet at Northbury. Water depths of 17 feet, taken at 80, 100, and 120 feet from the south shore (i.e., New Kent County), were recorded during a recent field inspection (Malcolm Pirnie, 1990). The Pamunkey River is approximately 260 feet wide at Northbury.

The proposed Ware Creek Reservoir dam site is located in tidal and navigable waters 4.7 river miles upstream of the confluence of Ware Creek and the York River. The Ware Creek channel is approximately 75 feet wide at the dam site (Wilber et al., 1987). Approximate channel depths of 4 to 5 feet have been observed in the vicinity of the dam site in an October 1992 field inspection by Malcolm Pirnie scientists. The Ware Creek channel is free from manmade obstructions from the proposed dam site to its confluence with the York River.

The tide is primarily semi-diurnal on Ware Creek. The mean tidal range has been measured at 2.8 feet (0.86 meters) at the mouth of Ware Creek and approximately 1.4 feet (0.42 meters) at or just upstream of the proposed dam site (Wilber et al., 1987). Based on field observations in 1992 by Malcolm Pirnie, tidal influence on Ware Creek extends to a point approximately 1,700 feet east of the State Route 600 crossing of Ware Creek at Richardson Millpond. A large beaver dam blocks tidal influence upstream of this point; however, tidal influence may extend farther upstream during extremely high spring tides or storm surges.

In the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek***, the USCOE pointed out that "recreational navigation is limited to small powerboats and canoes because of the shallow depth of the creek" (USCOE, 1987). Commercial navigation is not likely to occur in Ware Creek; any shellfish beds which may have been harvested in the past in Ware Creek have been closed by the Virginia Department of Health due to high coliform bacteria levels in the creek (J. C. Dawson, James City County, personal communication, November 1992).

Other Socioeconomic Impacts

The proposed Ware Creek Reservoir would be located within James City and New Kent counties, near the metropolitan areas of Newport News, Hampton, Williamsburg, and Richmond. Both counties have experienced substantial growth over the past decade. In 1980, the estimated population of James City County was 22,763, based on 1980 Census data. This population has increased by 53 percent during the last decade to 34,859 persons in 1990 (USDC, 1992). Within New Kent County, the 1980 Census estimated the County population to be 8,781. The population increased by 19 percent by 1990, to 10,445 persons (USDC, 1992).

Since the 1970s, great changes in land use in James City County have occurred. The County, which has historically been rural in nature, has transformed to a more urban and suburban environment. This expansion is expected to continue through the 1990s (JCC, 1991). While much growth has occurred within New Kent County in the past two decades, the County remains primarily rural in nature.

Median household income in James City County in 1989, as estimated by the 1990 Census, was $39,785 per year, as compared to $27,337 in 1982 (T. Funkhouser, JCC, personal communication, 1992). This represents a 45.5 percent increase in median household income in the County in those years. In New Kent County, the estimated median household income in 1989, according to the 1990 Census, was $38,403 per year. This is a 106 percent increase over the 1979 estimated median household income in New Kent County of $18,629 per year (RRPDC, 1991).

Within James City County, all categories of housing types have increased within the past decade, and single family homes have increased as a percentage of the total. Recently, the County has been experiencing extensive new upscale housing development. As of October 1996, real estate within the County was taxed at a rate of $0.87 per $100 assessed value.

Census data indicate that the majority of housing units within New Kent County are single-family dwellings. In the past two decades, the trend has been that the number of new single-family dwellings has decreased, while the number of duplex and multi-family dwellings has increased (RRPDC, 1991). As of January 1996, the County real estate tax rate was $0.82 per $100 assessed value. The total assessed value of taxable real estate in New Kent County increased 20 percent from 1995 to 1996, to a total value of $697.2 million (Richmond Times-Dispatch, 1996).

The economy of James City County is supported by an estimated 17,537 persons, 16 years of age or older, who are employed within the County (USDC, 1992). The type of industries which employ these people vary greatly. Based on employment data for the County (based on the 1990 Census), the greatest number of persons in the work force within the County are employed by the retail trade industry (20 percent). The next largest percentage (13 percent) work in the field of educational services.

Within James City County there are several large businesses which employ many people. Owens-Brockway Glass Container reported employing 240 persons when surveyed in 1990 as part of this study. Anheuser-Busch employed an additional 1,100 persons in 1990. Ball Metal and The Williamsburg Pottery are also large employers in the County (JCC, 1991).

Within New Kent County, the total number of persons 16 years of age or older who are employed is 5,326 (USDC, 1992). As in James City County, the largest employer category in the County is retail trade (14 percent). The next largest employer categories within the County are public administration (11 percent) and construction (11 percent). The largest employers are Cumberland Hospital, which employs over 200 persons, and the County.

4.5.2 Black Creek Reservoir with Pumpover from Pamunkey River

Municipal and Private Water Supplies

Intake

Municipal and private water supply withdrawals in the Pamunkey River basin are discussed in Section 4.5.1.

Reservoir

Many individual homeowners in the vicinity of the proposed Black Creek Reservoir site have their own wells. No municipal or private surface water supplies were identified in the immediate vicinity of the proposed reservoir site.

Pipeline

A 40-mgd capacity raw water outfall would be located on Diascund Creek upstream of Newport News Waterworks' Diascund Creek Reservoir. There are no known municipal or private water supplies along Diascund Creek upstream of the existing reservoir. However, Diascund Creek Reservoir itself is part of a municipal water supply system (i.e., Newport News Waterworks).

Recreational and Commercial Fisheries

Intake

Existing recreational and commercial fisheries at the proposed Pamunkey River intake site are described in Section 4.5.1.

Reservoir

Fish species present in the Black Creek Reservoir impoundment area are discussed in Section 4.3.2.

Because of their small size and limited access, the streams within the impoundment area have limited potential for commercial and recreational fishing. Crumps Millpond has not been surveyed by the VDGIF and is not currently stocked; however, it most likely is used for recreational fishing (D. C. Dowling, VDGIF, personal communication, 1992).

Invertebrate species of commercial importance would not be abundant in the proposed impoundment site due to the low salinity at and upstream of the proposed dam site.

Pipeline

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the route traverses forested lands.

The new pipeline would cross 10 perennial and 14 intermittent streams, as well as an arm of Little Creek Reservoir.

Other Water-Related Recreation

Intake

Existing recreational uses of the proposed Pamunkey River intake site area are described in Section 4.5.1.

Reservoir

The primary water-related recreational activity in the proposed Black Creek Reservoir watershed is hunting. The basin supports many bird and mammal species sought by hunters. Several private hunt clubs and duck blinds are located in the basin (J. Taylor, VDGIF, personal communication, 1992).

Pipelines

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the 19.6-mile route traverses forested lands. It is likely that portions of this area are leased to private hunt clubs.

Aesthetics

Intake

Existing aesthetic characteristics of the proposed Pamunkey River intake site area are described in Section 4.5.1.

Reservoir

The Black Creek watershed is remotely located within a rural area of New Kent County composed mainly of forested areas and scattered residential and agricultural areas. The aesthetic value of the proposed reservoir area is its natural beauty, composed of hardwood swamps, emergent vegetation, and wildlife. However, Black Creek has limited and seasonally variable visibility from public roads, so its aesthetic appeal is present but not apparent to the casual observer.

Three houses were identified within the proposed pool area and one house is located within 500 feet of a proposed dam. A total of 41 additional houses were identified within 500 feet of the proposed reservoir pool area (see Table 4-52).

Pipeline

The pipeline route would traverse mostly rural areas; however, 62 houses were identified within 300 feet of the proposed pipeline route (see Table 4-52).

Parks and Preserves

Intake

Parks and preserves in the vicinity of the proposed Northbury intake on the Pamunkey River are discussed in Section 4.5.1.

Reservoir

There are no existing designated parks or preserves located within the proposed Black Creek Reservoir drainage area (RRPDC, 1991; VDCR, 1989).

Pipeline

No existing parks or preserves are located along the proposed pipeline route for this alternative component (VDCR, 1989, RRPDC, 1991; JCC, 1991).

Land Use

Intake

Existing land uses at the proposed Pamunkey River intake site are described in Section 4.5.1.

Reservoir

High altitude aerial photographs, USGS topographic maps and field inspections were used to identify existing land uses within the proposed normal pool elevation of the reservoir and the reservoir watershed. Table 4-58 identifies existing land uses within the reservoir drainage area, which includes the normal pool area, while Table 4-59 identifies land uses within the normal pool area only.

Each of the land use categories, with the exception of forests, were measured directly from color-infrared aerial photographs using planimetry. The agricultural/rural residential acreage includes all agricultural lands and houses or structures associated with these lands. Wetland and open water acreage was determined through interpretation of aerial photographs and field inspections. Existing land uses within New Kent County are presented in Table 4-54 to provide an indication of the relative abundance of specific land use types within the region.

The majority of the watershed is currently forested (79 percent). Approximately 12 percent of the watershed supports the agricultural/rural residential land use and an additional 1 percent supports residential land use. The remaining 8 percent of the watershed is comprised of roads, open water, and wetlands.

Forested lands also comprise the majority of the reservoir pool area (60 percent), with wetlands and open water comprising the next largest land area (31 percent). Agricultural/rural residential land uses are also located within the reservoir pool area, constituting approximately 9 percent of total existing land use within the pool area.

Considerable residential growth has occurred and continues to occur in portions of the proposed 5.5-square mile reservoir watershed. For example, the Clopton Forest residential subdivision borders the western edge of the Southern Branch Black Creek impoundment site. Based on review of color-infrared aerial photography in conjunction with USGS topographic mapping and small-scale topographic mapping developed by Air Survey Corporation, there appear to be three

TABLE 4-58

BLACK CREEK RESERVOIR WATERSHED LAND USE (1989)

Land Use Category	Acreage	% of Total [1]
Residential [2]	49	1.4
Agricultural/Rural Residential [3]	409	11.6
Roads	1	0.036
Wetlands and Open Water	289	8.2
Forest	2,772	78.8
TOTAL	**3,520**	**100**

[1] Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

[2] Residential acreage includes all subdivisions, groups of homes, and individual homes not associated with agricultural operations.

[3] Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

Source: Planimetry of identified land use boundaries on NAPP color-infrared aerial photography taken on March 11, 1989 (approximate scale 1"=836') updated with more recent aerial photographs flown by Air Survey Corporation (March 1994), and field investigations of wetland areas.

TABLE 4-59

BLACK CREEK RESERVOIR NORMAL POOL AREA LAND USE (1989)

Land Use Category	Acreage	% of Total
Agricultural/Rural Residential [1]	79	8.7
Wetlands and Open Water	285	31.3
Forest	546	60.0
TOTAL	**910**	**100**

1 Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

Source: Planimetry of identified land use boundaries on NAPP color-infrared aerial photography taken on March 11, 1989 (approximate scale 1"=836') updated with more recent aerial photograpahs flown by Air Survey Corporation (March 1994),and field inspections of wetland areas.

existing houses which are at or below the proposed reservoir normal pool elevation of 100 feet msl or that would be displaced by the dams. At least three additional houses would be within the proposed reservoir buffer zones. The buffer zones are defined as the 100-foot buffer from the pool areas, or the 110-foot contour elevation, whichever is a greater distance from the proposed reservoir pool areas.

Anticipated future land uses within the vicinity of the reservoir drainage area are identified primarily as agriculture and conservation areas (RRPDC, 1991; New Kent County, 1991). Conservation lands are designated by New Kent County to protect environmentally sensitive lands. Within the watershed, these areas are expected to be concentrated along the Southern Branch Black Creek. Some medium density residential areas are expected to be located in the southwestern portion of the drainage area. The remainder of the watershed, and the majority, is designated for agricultural use.

CBPAs and AFDs are located within the reservoir drainage area. As described previously, CBPAs have not been comprehensively mapped in New Kent County. Rather, site surveys are required to identify CBPAs in regions along river or streams depicted on USGS maps which are proposed for development (N. Hahn, New Kent County, personal communication, 1992). Black Creek, its tributaries, and adjacent areas are likely candidates for inclusion in a CBPA.

Approximately 1,905 acres of the Pamunkey River Valley AFD are located within the northeast section of the watershed in New Kent County. Of this area, approximately 376 acres would be located within the proposed normal pool area of the reservoir (N. Hahn, New Kent County, personal communication, 1992).

It is anticipated that a buffer area around the normal pool area of the reservoir would be acquired by the RRWSG to regulate adjacent land uses to protect reservoir water quality. Existing land uses within this buffer area would include those land use types listed in Table 4-57 as occurring within the watershed.

Pipeline

The proposed pipeline, with a length of 19.6 miles and an assumed ROW width of 50 feet, would disturb approximately 119 acres of land (excluding Little Creek Reservoir crossing). Existing land uses along the proposed pipeline were identified through review of USGS topographic mapping and color-infrared aerial photography. The pipeline route would traverse forested and agricultural land, as well as some existing ROW's. To provide an indication of the portion of the pipeline route which would traverse existing undeveloped land, as opposed to land which has already been developed, the total acreage of undeveloped forest which would be cleared for the pipeline ROW is presented below.

Pipeline Length through Undeveloped Forest (miles)	Total Pipeline Length (miles)	Pipeline Length through Undeveloped Forest (as % of total length)
7.6	19.6	39

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the Black Creek Reservoir alternative is approximately 3 years. This alternative component would include an intake and pumping station at the Pamunkey River, a pumping station at Black Creek Reservoir, and a pumping station at Diascund Creek Reservoir. Six 20 mgd pumps would be needed at the proposed Pamunkey River pumping station and four 10 mgd pumps would be required at both the Black Creek and Diascund Creek reservoir pumping stations. There are very few residences within 500 feet of the Pamunkey River intake and pumping station site, and some near the Black Creek and Diascund Creek reservoir pumping stations, which might be sensitive to elevated noise levels associated with the alternative. Background noise levels in the vicinity of the pumping stations would be those typical of a rural environment.

Infrastructure

Transportation

The principal transportation route through the immediate vicinity of the proposed impoundment area is State Route 249. There are numerous other lower order state routes throughout the reservoir area. Route 249 is the only existing highway which would be inundated by construction of the reservoir.

The Southern Railway crosses Black Creek just north of the proposed dam sites. No rail lines fall within the proposed impoundment areas.

The proposed pipeline route would parallel and/or cross several existing roadways and rail lines located in New Kent County (NKC) and James City County (JCC). These roadways and rail lines include U.S. Route 60 (JCC), State Routes 607 (NKC), 606 (NKC), 612 (NKC), 609 (NKC), 642 (NKC), 249 (NKC), 608 (NKC), 603 (JCC), 621 (JCC), 601 (JCC), 657 (JCC), and 610 (JCC), and the Southern Railway (NKC) and Chesapeake & Ohio Railway (JCC).

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the operation of land clearing, excavation, and construction equipment. Electricity would be needed from the local utility to support construction activities unless diesel generators were utilized to generate electricity at the project site. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. The emergency generator set would require diesel fuel.

Virginia Power is the major producer and distributor of electrical power in the project area associated with this alternative component. Virginia Power owns and operates two steam-electric power plants in the York River basin. The North Anna Plant has an installed capacity of 1,720 megawatts (MW), and the Yorktown Plant has a capacity of 1,154 MW (SWCB, 1988).

Navigation

Navigational characteristics of the Pamunkey River at Northbury are described in Section 4.5.1.

The proposed Black Creek Reservoir dam sites are located in non-tidal waters upstream of the confluence of Black Creek and the Pamunkey River. No known commercial navigation currently occurs on Black Creek. Recreational navigation is unknown within the proposed impoundment sites. Limited recreational navigation may occur in the lowest reaches of Black Creek, well downstream of the proposed dam sites and downstream of the manmade obstructions which are described below.

Based on May 1992 field inspections by Malcolm Pirnie scientists, the Black Creek channel has at least three important manmade obstructions downstream of the proposed dam sites. The obstruction identified farthest downstream is the State Route 608 Bridge which spans a section of Black Creek approximately 40 feet wide. Four 9-foot wide, round culverts are situated under the bridge. There has also been some indication that downstream of the Route 608 Bridge is an old, submerged roadbed which may represent an additional obstacle to potential navigation.

The elevated Southern Railway Bridge is located south and upstream of the State Route 608 Bridge and spans a 20-foot wide section of Black Creek. The railroad bridge abutments are constructed of tar-covered wood timbers. The channel upstream of the Southern Railway Bridge narrows to an average width of approximately 12 feet. An additional obstruction to potential navigation is the State Route 606 Bridge which spans a 25-foot wide section of Black Creek. Three 6-foot by 6-foot box culverts are situated under the Route 606 Bridge.

Other Socioeconomic Impacts

The proposed Black Creek Reservoir would be located entirely within New Kent County, near the metropolitan areas of Newport News, Hampton, Williamsburg, and Richmond. The County has experienced substantial growth over the past decade. Within New Kent County, the 1980 Census estimated the County population to be 8,781 persons. The population increased by 19 percent by 1990, to 10,445 persons (USDC, 1992).

While much growth has occurred within New Kent County in the past two decades, the County remains primarily rural in nature. In New Kent County, the estimated median household income in 1989, according to the 1990 Census, was $38,403 per year. This is a 106 percent increase over the 1979 estimated median household income in New Kent County of $18,629 per year (RRPDC, 1991).

Census data indicate that the majority of housing units within New Kent County are single-family dwellings. In the past two decades, the trend has been that the number of new single-family dwellings has decreased, while the number of duplex and multi-family dwellings has increased (RRPDC, 1991). As of January 1996, the County real estate tax rate was $0.82 per $100 assessed value. The total assessed value of taxable real estate in New Kent County increased 20 percent from 1995 to 1996, to a total value of $697.2 million (Richmond Times-Dispatch, 1996).

Within New Kent County, the total number of persons 16 years of age or older who are employed is 5,326 (USDC, 1992). The largest employer category in the County is retail trade (14 percent). The next largest employer categories within the County are public administration (11 percent) and construction (11 percent). The largest employers are Cumberland Hospital, which employs over 200 persons, and the County.

4.5.3 King William Reservoir with Pumpover from Mattaponi River

Municipal and Private Water Supplies

Intake

An analysis of existing water use and cumulative streamflow reduction in the Mattaponi River basin was conducted. Total reported surface and groundwater withdrawals within the entire Mattaponi River basin, exclusive of Chesapeake Corporation, averaged 3.66 mgd in the Year 1990 (P. E. Herman, SWCB, personal communication, 1993). This total withdrawal excludes 18.3 mgd of groundwater withdrawals made in 1990 by Chesapeake Corporation at West Point since these withdrawals are from very deep aquifers which are not included in this cumulative streamflow reduction analysis. An estimated 22 percent of the groundwater withdrawals made by Chesapeake Corporation are consumed (SWCB, 1988).

In December 1991 the SWCB approved a groundwater withdrawal permit that allows Chesapeake Corporation to withdraw up to 700.6 million gallons per month (23.0 mgd). Recharge zones, with direct interconnection between surface water and the lower aquifers, are located within the area immediately east of the Fall Line where major tributaries have incised through the quaternary sediments. Therefore, large groundwater withdrawals from the lower aquifers, such as those made by Chesapeake Corporation, do have the potential to deplete surface water sources in the Mattaponi and Pamunkey river basins to some unquantified degree. However, an estimated 78 percent of Chesapeake Corporation's groundwater withdrawal is ultimately discharged to surface waters and augments river flows to that extent.

There are also irrigators in the Mattaponi River basin whose total estimated annual withdrawals in the Year 1985 were 179 million gallons (or 0.98 mgd assuming all irrigation occurs between April and September) (G. S. Anderson, USGS, personal communication, 1991). Adding this irrigation withdrawal to reported Year 1990 withdrawals results in an estimated current average water withdrawal of 4.64 mgd within the Mattaponi River basin (exclusive of Chesapeake Corporation). Of this current estimated water demand in the basin (exclusive of Chesapeake Corporation), approximately 71 percent is for domestic, commercial, and institutional use; 21 percent is for irrigation; and 8 percent is for industrial, manufacturing, and mining purposes.

Actual net streamflow reductions would be less than total Mattaponi basin withdrawals since the 4.64 mgd figure (1) includes groundwater withdrawals which do not directly reduce streamflows, and (2) ignores surface water return flows such as wastewater treatment plant effluent and crop irrigation return flows (i.e., non-consumptive surface water withdrawals). Consumptive use is the portion of water withdrawn that is not returned to the river because it has been evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed from the water environment. The portion of the withdrawal that is not consumed is returned to the resource.

The ***York Water Supply Plan*** (SWCB, 1988) contains an estimated consumptive use factor of 0.66 for the Mattaponi River basin which is based on published USGS data (Solley et al., 1983). Applying this factor to average Year 1990 withdrawals results in an estimated consumptive use of 3.1 mgd within the entire Mattaponi River basin (exclusive of Chesapeake Corporation).

Total freshwater discharge at the mouth of the Mattaponi River is estimated at 581 mgd. Estimated Year 1990 consumptive water use in the basin represents 0.5 percent of the average discharge. A list and location map of major reservoirs, stream intakes and groundwater withdrawals within the Mattaponi River basin are presented in Table 4-60 and Figure 4-7.

One private water supply system was identified in the vicinity of the proposed Mattaponi River intake site. Walkerton Water System, Inc. owns two deep wells located in the community of Walkerton in King and Queen County. One of these wells is not in service at this time. The second well was drilled in 1984 and is screened at depths of 282 to 292 feet and 363 to 383 feet. This water system is permitted by the VDH for 50 connections (S. Shaw, VDH, personal communication, 1993). Walkerton is located adjacent to the State Route 629 Bridge across the Mattaponi River which is approximately 5 river miles upstream of Scotland Landing.

Reservoir

Individual homeowners in the vicinity of the proposed King William Reservoir site (including all dam alternatives) have their own wells. No municipal or private surface water supplies were identified in the immediate vicinity of the proposed reservoir site.

Pipeline

A 50 mgd capacity raw water outfall would be located on Beaverdam Creek upstream of Diascund Creek Reservoir. There are no known municipal or private water supplies along Beaverdam Creek upstream of the existing reservoir. However, Diascund Creek Reservoir itself is part of a municipal water supply system (i.e., Newport News Waterworks).

<u>Recreational and Commercial Fisheries</u>

Intake

The Mattaponi River and its banks are utilized for recreational fishing, although no public boat landings are located in the immediate vicinity of Scotland Landing (Delorme Mapping Company, 1989). There is a privately-owned boat ramp to the Mattaponi River in King and Queen County, adjacent to the State Route 629 Bridge at Walkerton. However, public use of this boat ramp currently takes place and the VDCR and VDGIF have expressed an interest in acquiring this boating access (VDOT and FHA, 1992). The Walkerton Bridge is approximately 5 river miles upstream of Scotland Landing.

Commercially important fish species harvested in the Mattaponi River during 1990 and 1991 include Striped Bass and American Shad. Blue Crab are also harvested from the Mattaponi River (VMRC, 1992).

Reservoir

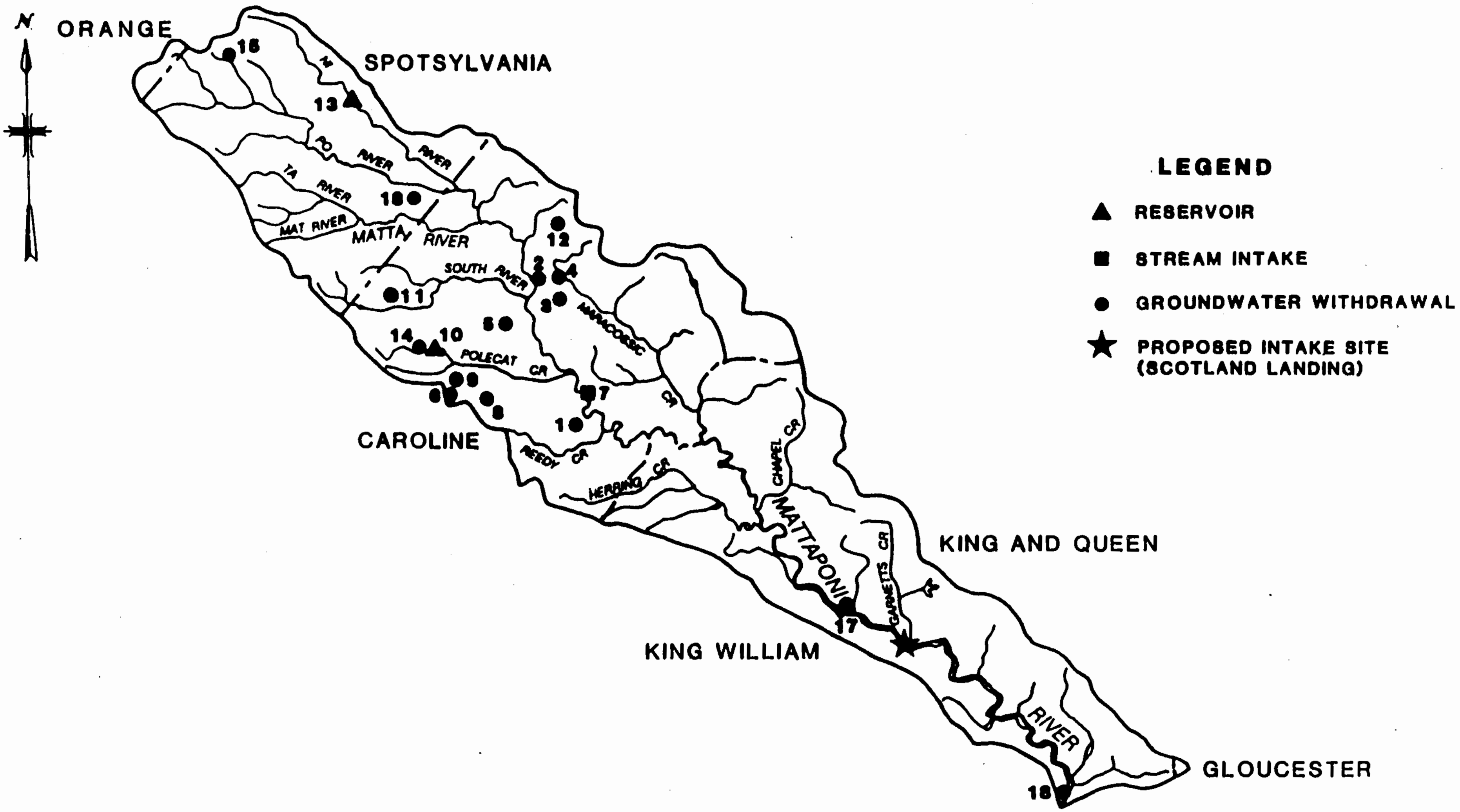
Within the proposed impoundment area (including all dam configurations), Cohoke Creek is shallow and has limited access. The creek is also isolated from navigable waters downstream by the existing Cohoke Millpond Dam. Therefore, the proposed impoundment area currently has limited potential for commercial fisheries since it would not accommodate larger commercial vessels.

TABLE 4-60

MAJOR RESERVOIRS, STREAM INTAKES, AND GROUNDWATER WITHDRAWALS IN THE MATTAPONI RIVER BASIN

Map Number (a)	Description	1990 Withdrawal (b) (mgd)
1	Groundwater Withdrawal 1 Well Alpha Water Corporation (Elsinore)	0.015
2	Groundwater Withdrawal 4 Wells Town of Bowling Green	0.135
3	Groundwater Withdrawal 1 Well Caroline County (Caroline High School)	0.005
4	Groundwater Withdrawal 1 Well Foreign & Domestic Woods, Inc. (Bowling Green Plant)	0.017
5	Groundwater Withdrawal 2 Wells Caroline County (Milford Sanitary District)	0.033
6	Groundwater Withdrawal 3 Wells Caroline County Utility System	0.156
7	Stream Intake Mattaponi River Smith Sand & Gravel, Inc. (Ruther Glen Plant)	0.349
8	Groundwater Withdrawal 1 Well Days Inn	0.026 (d)
9	Groundwater Withdrawal 3 Wells VA Dept. of Transportation (I-95 Bowling Green Rest Area)	0.048
10	Reservoir (Lake Caroline) Lake Caroline Water Company	0.395
11	Groundwater Withdrawal 2 Wells Sydnor Hydrodynamics,Inc. (Campbell's Creek)	0.037
12	Groundwater Withdrawal 26 Wells U.S. Army (Fort AP Hill)	0.015 (c)
13	Reservoir (Ni) Spotsylvania County (Ni River WTP)	2.319
14	Groundwater Withdrawal 1 Well Lake Land 'or Utility Company	0.053
15	Groundwater Withdrawal 2 Wells Spotsylvania County (Winewood Estates)	0.011
16	Groundwater Withdrawal 3 Wells Po River Water & Sewer Company (Indian Acres Club of Thornburg)	0.063
17	Groundwater Withdrawal 2 Wells Walkerton Water System, Inc.	0.015
18	Groundwater Withdrawal 14 Wells Chesapeake Corporation (West Point Facility)	18.295

a) See Figure 4-7.
b) Reported 1990 withdrawals retrieved from the Virginia Water Use Data System (P.E. Herman, SWCB, personal communication, 1993).
c) 1984 withdrawal as reported in York Water Supply Plan (SWCB, 1988).
d) 1986 withdrawal as reported in Virginia Water Withdrawals 1986 (SWCB, 1987).



OCTOBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

MAJOR RESERVOIRS, STREAM INTAKES AND GROUNDWATER WITHDRAWALS IN THE MATTAPONI RIVER BASIN

MALCOLM PIRNIE

FIGURE 4-7

The majority of the recreational fishing in the vicinity of the proposed impoundment area occurs downstream in Cohoke Millpond. Cohoke Millpond is a private 15-acre fishing pond owned by the Cohoke Club, Inc. The Cohoke Club has a small boathouse on the pond and a private fishing dock immediately downstream of the Cohoke Millpond Dam.

Invertebrates of commercial importance would not be abundant in the proposed impoundment site given the low salinity at and upstream of the proposed dam site. This would likely be the case with or without the existing Cohoke Millpond Dam which is located downstream of the proposed impoundment.

Pipeline

A review of color-infrared aerial photography, USGS topographic maps, and small-scale topographic maps developed by Air Survey Corporation was conducted to determine the number of pipeline stream crossings for the King William Reservoir project configurations. The number of stream crossings for each dam configuration are presented below:

Stream Type	Number of Crossings			
	KWR I	KWR II	KWR III	KWR IV
Perennial	9	33	32	35
Intermittent	17	19	18	18

The pipeline route for all dam configurations would also cross the Pamunkey River and an arm of Little Creek Reservoir. No commercial fishing occurs at Little Creek Reservoir. Commercial fishing in the Pamunkey River is discussed in Section 4.5.1.

Other Water-Related Recreation

Intake

The Mattaponi River and its banks in the proposed project area are utilized for various recreational activities including fishing, hunting, and boating. There is a privately-owned boat ramp on the Mattaponi River in King and Queen County, adjacent to the State Route 629 Bridge at Walkerton. However, public use of this boat ramp currently takes place, and the VDCR and VDGIF have expressed an interest in acquiring this boating access (VDOT and FHA, 1992). The Walkerton Bridge is approximately 5 river miles upstream of Scotland Landing.

The Mattaponi River is tidal at the proposed intake location and is well-suited for year-round recreational boat activity. Several privately owned duck blinds and hunt clubs are located in the vicinity of Scotland Landing (H. Garner, VDGIF, personal communication, 1992).

Reservoir

The primary water-related recreation within the proposed King William Reservoir watershed (for all dam configurations) is hunting. The basin supports several bird and mammal species sought by hunters. Hunt clubs within the watershed include the West Point Stillhunters Club which leases land adjacent to State Routes 626, 630, and 631 and the Holly Grove Hunt Club which leases land adjacent to State Routes 626, 632, and 651. Several other private hunt clubs and duck blinds are also located in the basin (H. Garner, VDGIF, personal communication, 1992).

The Cohoke Club, Inc. owns the Cohoke Millpond and some of the land near the existing millpond dam. The Cohoke Club has a small boathouse on the millpond and a private fishing dock immediately downstream of the Cohoke Millpond dam.

Pipeline

Based on review of color-infrared aerial photography, USGS topographic maps, and small-scale topographic maps developed by Air Survey Corporation, the majority of the pipeline routes traverse forested lands. It is likely that portions of these areas are leased to private hunt clubs. The pipeline routes for each dam configuration cross under the Pamunkey River, which may support hunting, fishing, and boating, although the nearest public boat landing, Brickhouse Landing, is located approximately 3,000 feet downstream of the proposed pipeline crossing.

<u>Aesthetics</u>

Intake

The aesthetic value of the proposed river intake area is its predominantly natural, scenic beauty. The shoreline surrounding the Mattaponi River in the vicinity of the proposed intake is a sloping, forested terrain which is relatively undeveloped in the immediate vicinity. No houses were identified within 500 feet of the proposed Mattaponi River pump station. However, there is a new, large-lot residential subdivision on the south shore of the Mattaponi River, with the nearest house located approximately 1,000 feet downstream of the proposed pump station building site. Some site work at the pump station site could be within 600 feet of the nearest house within this new subdivision (see Table 4-52).

Reservoir

The King William Reservoir watershed (for all dam configurations) is mostly rural with residential areas scattered along roads and highways. The aesthetic value of the proposed reservoir area is its scenic beauty, a product of its hardwood swamps, emergent vegetation, and wildlife. However, the proposed impoundment area on Cohoke Creek has limited and seasonally variable visibility from public roads, so its aesthetic appeal is present but not highly apparent to the causal observer. No existing houses were identified within the proposed reservoir pool area for any of the reservoir configurations or in the vicinity of any of the proposed dam sites. The number of houses identified within 500 feet of the proposed reservoir pool area for each dam configuration are presented in Table 4-52.

Pipeline

The pipeline route would traverse mostly rural areas; however, 45 houses were identified within 300 feet of the proposed pipeline route (see Table 4-52).

Parks and Preserves

Intake

The Mattaponi River is not currently designated as part of the Virginia Scenic Rivers System (VSRS). While it is currently not afforded protection under this system, it is designated in the ***1989 Virginia Outdoors Plan*** as a potential component which is worthy of future evaluation (VDCR, 1989). No existing parks or preserves are located in the vicinity of the proposed Mattaponi River intake at Scotland Landing (VDCR, 1991; KWCPD, 1991).

The Nature Conservancy currently holds a conservation easement on the Mattaponi River in King & Queen County. The easement protects 50 acres of marshland on the Mattaponi River, which includes an island marsh, at and immediately upstream of the State Route 629 Bridge at Walkerton (VCOE, 1987; Paust, 1988; VDOT and FHA, 1992). This easement is located approximately 5 river miles upstream of the proposed Scotland Landing intake site.

Reservoir

There are no parks or preserves located within the drainage area of any of the King William Reservoir configurations (VDCR, 1989; KWCPD, 1991).

Pipeline

The Sweet Hall Marsh component of the Chesapeake Bay National Estuary Research Reserve System (CBNERRS) is located approximately 2.7 river miles downstream of the proposed pipeline crossing of the Pamunkey River.

In addition, the 1,200-acre Cumberland Marsh Nature Conservancy Preserve is located on the Pamunkey River (T. McNeil, Nature Conservancy, personal communication, 1996), approximately 10 river miles upstream of the proposed pipeline crossing of the Pamunkey River.

No other existing parks or preserves are located along the proposed pipeline route for this alternative component (VDCR, 1989; KWCPD, 1991; JCC, 1991).

Land Use

Intake

It is assumed that construction of a pump station at Scotland Landing on the Mattaponi River would required disturbance of approximately 3 acres of land. In addition, a small amount of land would be required for construction of an access road to the pump station and for placement of electrical transmission lines to power the pump station. Field studies of the proposed intake site at Scotland Landing were conducted by Malcolm Pirnie during the spring of 1990 to determine the feasibility of the site as a potential raw water intake location. These studies identified the site as being located on a large tract of land (i.e., 188 acres) which can be subdivided, if necessary, for the pumping station.

To further characterize existing land uses at the site, USGS topographic mapping and color-infrared aerial photography were also reviewed. Based on inspection of these resources, the pump station building would be located on forested land.

The ***Comprehensive Plan for King William County, Virginia*** (KWCPD, 1991) identifies the intake site as being located within a designated CBPA. Due to the proximity of the site adjacent to the Pamunkey River, the area would be designated as an RPA.

As of October 1996, the provisions of the Virginia Agricultural and Forestal Districts Act of 1977 had been repealed in King William County. Therefore, no AFDs were in effect within the County (D. W. Carney, King William County, personal communication, 1996).

Reservoir

Color-infrared aerial photographs, USGS topographic mapping, small-scale topographic mapping developed by Air Survey Corporation, and field inspections were used to identify existing land uses within the proposed project areas for the King William Reservoir configurations. Existing land uses within the reservoir drainage area, including the pool area, for KWR I and KWR II are identified in Table 4-61. The land use categories present in the watersheds of the KWR III and KWR IV configurations would be the same as those identified in Table 4-61; however, the acreages would be less since the watersheds are smaller for KWR III and KWR IV. Land uses within the normal pool area for each configuration are identified in Table 4-62. Development within this region has been slow within the past decade (KWCPD, 1991).

The agricultural/rural residential category includes all agricultural lands and houses or structures associated with these lands. Wetland and open water acreage in the drainage area was determined through interpretation of aerial photography and wetland delineations. Existing land uses within King William County are presented in Table 4-63 to provide an indication of the relative abundance of specific land use types within the region.

As quantified in Table 4-62, the majority of the reservoir watershed is currently forested for each configuration. Aside from homes associated with agricultural operations, only limited residential land use was identified within the watershed. No existing homes were identified at or below 100 feet msl. However, some uninhabited structures were identified below 100 feet msl. The remainder of the watershed consists of open water, wetlands, and roads.

Forested lands also compose the majority of the proposed reservoir pool area for each configuration, with wetlands composing the next largest land area.

No existing houses were identified that would be displaced by the proposed reservoir or dam for any of the configurations. This determination was made based on review of recent color-infrared aerial photography, USGS topographic maps, and small-scale topographic mapping developed by Air Survey Corporation.

The King William Reservoir drainage area is designated as a CBPA in accordance with the Chesapeake Bay Preservation Act (KWCPD, 1991). Cohoke Creek and immediately adjacent

TABLE 4-61

KING WILLIAM RESERVOIR WATERSHED LAND USE

Land Use Category	Reservoir Configuration [1]			
	KWR I		KWR II	
	Acreage	% of Total [2]	Acreage	% of Total [2]
Agricultural/Rural Residential [3]	1,441	17.1	739	10.1
Roads Primary Roads Secondary Roads Subtotal	 62 67 129	 0.7 0.8 1.5	N/A[4]	N/A
Wetlands and Open Water	479	5.7	574	7.9
Forest	6,380	75.7	5,998	82.0
TOTAL	**8,429**	**100**	**7,311**	**100**

1 Existing land uses within the drainage area are presented for KWR I and KWR II. The land use categories present in the watersheds of KWR III and KWR IV would be the same as those identified above; however, the acreages would be less since the watersheds are smaller for KWR III and KWR IV.

2 Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

3 Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

4 Acreages for the KWR II configuration are based on computations from digital cover type mapping generated from field inspections. The acreage of roads within the area were not quantified in the field or covertype mapping exercise. It is likely that the acreage of roads in the watershed for KWR II are included in the total forested acreage, as the roads are likely to traverse forested areas.

Sources: KWR I - Planimetry of identified land use boundaries on color-infrared aerial photography taken by Air Survey Corporation on March 7, 1993 (approximate scale 1"=1,000') and field inspections of wetland areas.

KWR II - Land use acreages are based on computations from digital cover type mapping generated from field inspections using contour mapping at a scale of 1 inch equals 500 feet.

TABLE 4-62

KING WILLIAM RESERVOIR NORMAL POOL AREA LAND USE FOR EACH RESERVOIR CONFIGURATION

	KWR I		KWR II		KWR III		KWR IV	
Land Use Category	**Acres**	**% of Total**	**Acres**	**% of Total**	**Acres**	**% of Total**	**Acres**	**% of Total**
Agricultural/Rural Residential [1]	See Footnote[2]		<1	<1	0	0	0	0
Wetlands and Open Water	653	28.6	574	25.8	511	26.8	437	28.6
Forest	See Footnote[2]		1,648	74.2	1,398	73.2	1,089	71.4
TOTAL	**2,284**	**100**	**2,222**	**100**	**1,909**	**100**	**1,526**	**100**

1 Agricultural/Rural Residential acreage includes all agricultural lands and house or structures associated with these lands.

2 The land use breakdown has been altered since publication of the DEIS, so KWR I upland acreages are not comparable to other configurations. However, uplands within the KWR I pool area total 1,631 acres.

Source: Land use acreages are based on computations from digital cover type mapping generated from field inspections using contour mapping at a scale of 1 inch equals 500 feet.

TABLE 4-63

KING WILLIAM COUNTY LAND USE (1988)

	Acreage	Percent of Total
Urban	1,587	0.8
Agricultural	38,201	20.9
Forest and Other [1]	137,978	75.5
Water [2]	5,056	2.8
TOTAL	182,822	100

1 Includes recreational and wildlife areas.

2 Does not include ponds less than 40 acres in size or streams.

Source: *York Water Supply Plan* (SWCB, 1988).

areas are designated as RPAs. The remainder of the watershed is designated as an RMA. Residential, light commercial, and planned unit developments are anticipated to be located along the perimeter of the watershed in the future.

As of October 1996, no AFDs were in effect within King William County (D. W. Carney, King William County, personal communication, 1996).

As described in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), for water quality protection purposes, King William County would acquire and lease to the City of Newport News sufficient land to create a buffer zone around the reservoir. This buffer zone would extend a minimum of 100 feet horizontally from the water's edge at spillway elevation and a minimum of 7 feet vertically above spillway elevation. Existing land uses within this buffer area would include those land use types listed in Table 4-61 as occurring within the watershed.

Pipeline

The lengths of the proposed pipeline routes for each configuration and the anticipated area of disturbance (assuming a 50 foot ROW) associated with each are quantified in the following table:

Reservoir Configuration	Pipeline Length (Miles)	Area Disturbed (Acres)*
KWR I	17.0	94
KWR II	17.4	97
KWR III	18.2	101
KWR IV	18.7	104

* Excludes the Pamunkey River and Little Creek Reservoir crossing and directional drill segment below high ground.

Existing land uses along the proposed pipeline were identified through review of USGS topographic mapping and color-infrared aerial photography. The pipeline routes for each configuration would traverse forested and agricultural land, as well as some existing ROW's. To provide an indication of the portion of the pipeline route which would traverse existing undeveloped land, as opposed to land which has already been developed, the total acreage of undeveloped forest which would be cleared for the pipeline ROW for each configuration is presented below.

Reservoir Configuration	Pipeline Length through Undeveloped Forest (miles)	Total Pipeline Length (miles)	Pipeline Length through Undeveloped Forest (as % of total length)
KWR I	6.3	17.0	37
KWR II	6.6	17.4	38
KWR III	7.4	18.2	41
KWR IV	7.9	18.7	42

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the King William Reservoir alternative is approximately 3 years. This alternative component would include an intake and pumping station at the Mattaponi River and a pumping station at Diascund Creek Reservoir. Five 15 mgd pumps would be needed at the Mattaponi River pumping station and four 10 mgd pumps would be required at the Diascund Creek Reservoir pumping station. There are no residences within 500 feet of the proposed Mattaponi River intake and pumping station site, and some near the Diascund Creek Reservoir pumping station, which might be sensitive to elevated noise levels associated with the project. Background noise levels in the vicinity of the pumping stations would be those typical of a rural atmosphere.

Infrastructure

Transportation

The principal transportation route through the immediate vicinity of the proposed impoundment area is State Route 30. There are numerous other lower order state routes throughout the reservoir area. State Route 626 is the only existing highway which would be inundated by construction of the reservoir.

The Southern Railway crosses Cohoke Millpond just south of the proposed dam site. No rail lines fall within the proposed impoundment area.

The proposed pipeline route would parallel and/or cross several existing roadways and rail lines located in King William County (KWC), New Kent County (NKC), and James City County (JCC). These roadways and rail lines include U.S. Route 60 (JCC), State Routes 620 (KWC), 30 (KWC), 632 (KWC), 630 (KWC), 624 (NKC), 623 (NKC), 249 (NKC), 33 (NKC), 603 (JCC), 621 (JCC), 601 (JCC), 657 (JCC), and 610 (JCC), and the Southern Railway (KWC) and Chesapeake & Ohio Railway (JCC).

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the operation of land clearing, excavation, and construction equipment. Electricity would be needed from the local utility to support construction activities unless diesel generators were utilized to generate electricity at the project site. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. The emergency generator set would require diesel fuel.

Virginia Power is the major producer and distributor of electrical power in the project area associated with this alternative component. Virginia Power owns and operates two steam-electric power plants in the York River basin. The North Anna Plant has an installed capacity of 1,720 megawatts (MW), and the Yorktown Plant has a capacity of 1,154 MW (SWCB, 1988).

Navigation

Based on past studies, it is assumed for administrative purposes that the Mattaponi River is navigable from its confluence with the York River to as far upstream as Guinea Bridge in Caroline County (K. M. Kimidy, USCOE - Norfolk District, personal communication, 1993).

The proposed river intake structure would be located at Scotland Landing in tidal and navigable waters. The estimated mean tidal range at Scotland Landing is 3.56 feet (Basco, 1996). USGS topographic maps show mid-channel depths at mean low water ranging from 19 to 25 feet in the immediate vicinity of Scotland Landing. Water depths of 21 to 25 feet were measured at the proposed intake structure footprint during field inspections conducted by Malcolm Pirnie in April 1993. The Mattaponi River is approximately 450 feet wide at Scotland Landing.

The proposed King William Reservoir dam sites are located in non-tidal waters on Cohoke Creek. Cohoke Creek flows in a southeasterly direction into Cohoke Millpond, which is an existing impoundment downstream of the proposed dam sites, and is a tributary to the Pamunkey River.

No known commercial navigation currently occurs on Cohoke Creek. Recreational navigation is unknown within the proposed impoundment sites, and the main channel of Cohoke Creek is obstructed by a triple 10-foot by 10-foot box culvert underneath State Route 626. Recreational navigation does occur below the proposed dam sites in Cohoke Millpond. Limited recreational navigation may also occur in the short tidal reach of Cohoke Creek downstream of the Cohoke Millpond Dam (i.e., State Route 632 Bridge crossing).

<u>Other Socioeconomic Impacts</u>

The proposed King William Reservoir would be located entirely within King William County, near the metropolitan areas of Newport News, Hampton, Williamsburg, and Richmond. The County has experienced substantial growth over the past decade. Within King William County, the 1980 Census estimated the County population to be 9,334. Population increased by 17 percent by 1990, to 10,913 persons (USDC, 1992).

While some growth has occurred within King William County in the past two decades, the County remains primarily rural in nature. Most of the population growth is attributable to an influx of new residents, particularly in the southwest portion of the County (U. S. Route 360 corridor) closest to Richmond.

In King William County, the estimated median household income in 1989, according to the 1990 Census, was $33,676 per year. This is a 73 percent increase over the 1979 estimated median household income in King William County of $19,446 per year (RRPDC, 1991).

The number of households within King William County has increased greatly in the past two decades. The majority of these units are single- family and multi-family homes. There are currently no mobile/manufactured home parks or subdivisions in the County (KWCPD, 1991). As of November 1992, the County real estate tax rate was $1.17 per $100 assessed value (G. Baka, KWCPD, personal communication, 1992).

Within King William County, the total number of persons 16 years of age or older who are employed is 5,504 (USDC, 1992). The largest employer category in the County is retail trade (15 percent). The next largest employer category is manufacturing of nondurable goods (14 percent).

4.5.4 Fresh Groundwater Development

Municipal and Private Water Supplies

This alternative component would involve fresh groundwater withdrawals made from new well fields in western James City County and/or New Kent County. These groundwater withdrawals would be used to augment Diascund Creek and Little Creek reservoirs when Newport News Waterworks system reservoir volume is below 75 percent of total capacity. These withdrawals would be made from the Middle Potomac Aquifer. However, the potential exists for impacts (via leakage) to the multi-aquifer system.

In 1983 the total estimated withdrawal from the Potomac aquifers on the York-James Peninsula was 33.6 mgd. The estimated current withdrawal from the Middle Potomac aquifer is 15.9 mgd. These estimated Potomac aquifer withdrawals represent approximately 86 percent of the total estimated groundwater withdrawals on the York-James Peninsula (38.9 mgd). The largest groundwater withdrawal is made by Chesapeake Corporation (West Point Facility) and was reported as 18.295 mgd for 1990 (P. E. Herman, SWCB, personal communication, 1993). In December 1991 the SWCB approved a groundwater withdrawal permit that allows Chesapeake Corporation to withdraw up to 700.6 million gallons per month (23.0 mgd). Table 4-64 lists the 1983 estimated groundwater withdrawals from the York-James Peninsula by aquifer. Approximate locations of permitted or certified wells in the region surrounding the proposed well fields are shown in Figure 4-8.

Recreational and Commercial Fisheries

Diascund Creek and Little Creek reservoirs are currently monitored by a fishery management program in cooperation with the VDGIF. Recreational and commercial fisheries exist in both reservoirs.

TABLE 4-64

ESTIMATED GROUNDWATER WITHDRAWALS FROM YORK-JAMES PENINSULA BY AQUIFER (1983) *

Aquifer	Withdrawal (mgd)	Percentage of Total
Columbia	0.100	0.3
Yorktown-Eastover	1.373	3.5
Chickahominy-Piney Point	2.939	7.6
Aquia	0.903	2.3
Upper Potomac	14.168	36.4
Middle Potomac	15.873	40.8
Lower Potomac	3.560	9.1
Total	38.916	100.0

* Adapted from: Groundwater Resources of the York-James Peninsula of Virginia (Laczniak and Meng, 1988).

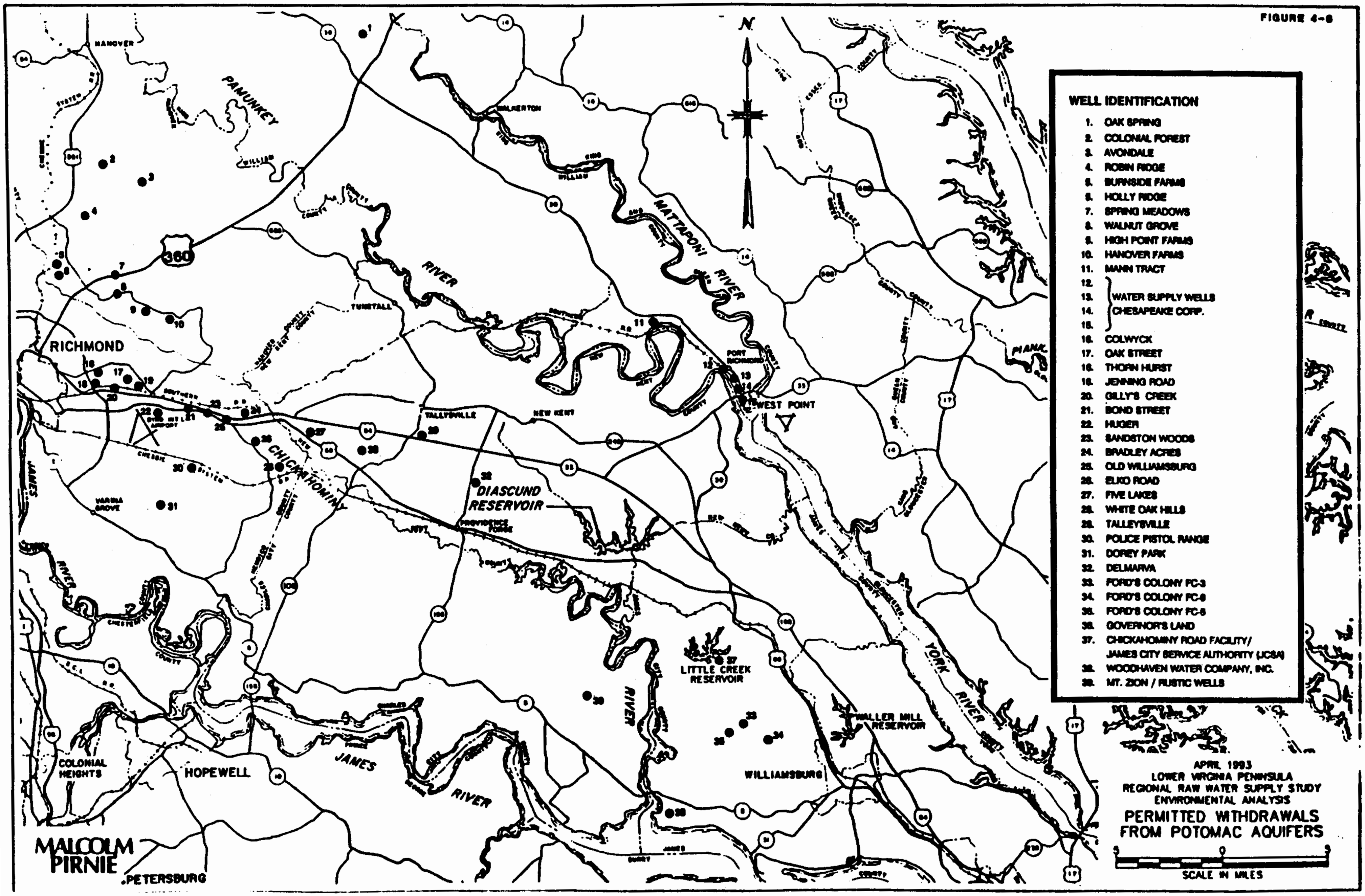


FIGURE 4-8
WELL IDENTIFICATION
1. OAK SPRING
2. COLONIAL FOREST
3. AVONDALE
4. ROBIN RIDGE
5. BURNSIDE FARMS
6. HOLLY RIDGE
7. SPRING MEADOWS
8. WALNUT GROVE
9. HIGH POINT FARMS
10. HANOVER FARMS
11. MANN TRACT
12. 13. 14. 15. WATER SUPPLY WELLS CHESAPEAKE CORP.
16. COLWYCK
17. OAK STREET
18. THORN HURST
19. JENNING ROAD
20. GILLY'S CREEK
21. BOND STREET
22. HUGER
23. SANDSTON WOODS
24. BRADLEY ACRES
25. OLD WILLIAMSBURG
26. ELKO ROAD
27. FIVE LAKES
28. WHITE OAK HILLS
29. TALLEYSVILLE
30. POLICE PISTOL RANGE
31. DOREY PARK
32. DELMARVA
33. FORD'S COLONY FC-3
34. FORD'S COLONY FC-8
35. FORD'S COLONY FC-5
36. GOVERNOR'S LAND
37. CHICKAHOMINY ROAD FACILITY/ JAMES CITY SERVICE AUTHORITY (JCSA)
38. WOODHAVEN WATER COMPANY, INC.
39. MT. ZION / RUSTIC WELLS
N
HANOVER
PAMUNKEY
RICHMOND
MATTAPONI RIVER
RIVER
WEST POINT
TALLEYSVILLE
NEW KENT
CHICKAHOMINY
DIASCUND RESERVOIR
PROVIDENCE FORGE
LITTLE CREEK RESERVOIR
WALLER MILL RESERVOIR
YORK RIVER
JAMES RIVER
WILLIAMSBURG
HOPEWELL
COLONIAL HEIGHTS
PETERSBURG
APRIL 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS
PERMITTED WITHDRAWALS FROM POTOMAC AQUIFERS
SCALE IN MILES
MALCOLM PIRNIE

Other Water-Related Recreation

No recreational facilities are located in the vicinity of proposed groundwater wells or associated pipelines at Diascund Creek or Little Creek reservoirs (VDRC, 1989; James City County, 1991).

Aesthetics

Potential aesthetic impacts from this alternative were evaluated by identifying houses within 300 feet of the proposed pipelines and 500 feet of the proposed groundwater withdrawal facilities. No houses were identified within 300 feet of the pipeline routes. A total of nine houses were identified within 500 feet of the proposed groundwater withdrawal points (see Table 4-52).

Parks and Preserves

There are no existing parks or preserves in the vicinity of proposed groundwater well locations at Diascund Creek or Little Creek reservoirs (VDCR, 1989; JCC, 1991; RRPDC, 1991).

Land Use

Existing land uses in the vicinity of proposed groundwater well locations along the perimeter of Diascund Creek and Little Creek reservoirs were identified based on review of USGS topographic maps and color-infrared aerial photography taken in March 1982. The predominant land use which would be impacted by the wells and pipelines is forested land.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the proposed fresh groundwater wells and pipelines is approximately 6 months. Eight 1.3 mgd pumps would be installed in James City and New Kent counties. There are some residences near the proposed well sites and pipeline routes which might be sensitive to elevated noise levels anticipated with the alternative. Background noise levels in the vicinity of the pumping stations would be those typical of a rural environment.

Infrastructure

Transportation

Any transportation impacts as a result of this alternative should be temporary and negligible.

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the minor operation of land clearing, excavation, construction, and well drilling equipment. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. However, energy demands would be relatively low since the well pumps would only be operated when Newport News Waterworks system reservoir volume is below 75 percent of total capacity.

At full project utilization, the wells would require an average of approximately 2,400 MWH per year of electrical power. To supply power to all eight well sites, approximately 17 miles of new or upgraded electrical transmission lines would be required for connections to suitable existing Virginia Power lines along U.S. Route 60.

Navigation

Fresh Groundwater Withdrawals would have no effect on navigation.

Other Socioeconomic Impacts

Potential socioeconomic effects would occur with this alternative in the form of increased water rates to consumers.

4.5.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Municipal and Private Supplies

This alternative component would involve the development of up to 10 mgd of deep brackish groundwater supply from wells screened in the Middle and Lower Potomac aquifers in eastern portions of the York-James Peninsula. The estimated current withdrawal from the Middle and Lower Potomac aquifers is 19.4 mgd.

Due to the potential for impacts (via leakage) to the multi-aquifer system, descriptions of the confined aquifers in the project area are discussed in Section 4.2.5. A discussion of current groundwater withdrawals on the York-James Peninsula is presented in Section 4.5.4.

Recreational and Commercial Fisheries

The concentrate pipeline for Site 1 (Copeland Industrial Park Ground Storage Tank) would not cross any streams before discharging into Hampton Roads.

The concentrate pipeline for Site 2 (Upper York County Ground Storage Tank) would cross one intermittent and one perennial tributary of Jones Millpond. The perennial tributary may be utilized for recreational fishing; however, due to its small size, this water body would not be commercially important. The proposed concentrate pipeline would discharge into Queens Creek, a tributary of the York River which is utilized for recreational fishing (York County, 1991).

The concentrate pipeline for Site 3 (Harwood's Mill WTP Clearwell) would cross one perennial and one intermittent stream before discharging into the Poquoson River. The perennial stream crossing is a tributary of the Poquoson River.

The concentrate pipeline for Site 4 (Lee Hall WTP Clearwell) would not cross any streams before discharging into Skiffe's Creek.

Fish species typical of the water bodies that would receive concentrate discharges are discussed in Section 4.3.5.

Other Water-Related Recreation

One groundwater well and associated RO treatment facility would be located within a recreational area. The Site 4 facilities (Lee Hall WTP Clearwell) would be located within the boundaries of Newport News Park which encompasses the drainage area of Lee Hall Reservoir. Current recreational uses of the park include boating, fishing, canoeing, sailing, and picnicking.

A portion of the concentrate discharge pipeline for Site 2 (Upper York County Ground Storage Tank) would traverse the York County New Quarter Park located adjacent to Queens Lake and the Colonial Parkway in York County. Existing recreational facilities in the park include a floating fishing pier, horse shoe courts, picnic areas, hiking trails, softball fields, and volleyball courts (York County, 1991).

Aesthetics

At Site 1 (Copeland Industrial Park Ground Storage Tank), there would be impacts to the visual surroundings that exist for the five buildings identified within 500 feet of the proposed RO treatment facility. The proposed concentrate discharge pipeline route would pass within 300 feet of five buildings, two churches, and one school (see Table 4-52).

At Site 2 (Upper York County Ground Storage Tank), 12 houses and one school were identified within 500 feet of the proposed RO treatment facility. A total of 38 houses and one building were identified within 300 feet of the proposed concentrate discharge pipeline route (see Table 4-52). The pipeline route would also cross York County New Quarter Park and the Colonial Parkway, of the Colonial National Historic Park.

At Site 3 (Harwood's Mill WTP Clearwell), no houses were identified within 500 feet of the proposed RO treatment facility, but 142 houses, 11 buildings, one school, and the Harwood's Mill Filtration Plant are within 300 feet of the proposed concentrate discharge pipeline route (see Table 4-52).

At Site 4 (Lee Hall WTP Clearwell), the Lee Hall Filtration Plant is located within 500 feet of the proposed RO treatment facility. Three buildings were identified within 300 feet of the proposed concentrate discharge pipeline route (see Table 4-52). Also, the proposed RO treatment facilities would be located within the boundaries of Newport News Park.

Parks and Preserves

Only one of the groundwater wells and associated RO treatment facilities would be located within a designated park or preserve. The Site 4 facilities (Lee Hall WTP Clearwell) would be located within the boundaries of Newport News Park. This City of Newport News park encompasses the drainage area of the Lee Hall Reservoir. A section of the concentrate discharge pipeline for this alternative would also be located within the park boundaries.

A portion of the concentrate discharge pipeline for the Site 2 facilities (Upper York County Ground Storage Tank) would traverse the York County New Quarter Park. This park is located adjacent to Queens Lake and the Colonial Parkway in York County. The park contains 545 acres and is designated primarily for passive recreation (York County Department of Planning and Community Development, 1991). This pipeline would also cross the Colonial National Historical Parkway in York County.

Land Use

Existing land uses in the vicinity of proposed groundwater well locations, associated RO treatment plants, and concentrate discharge lines for this alternative were identified based on review of USGS topographic maps of the region. Approximately 13.4 miles of concentrate discharge pipeline would be required for this alternative. Land uses in the vicinity of the concentrate discharge pipeline routes include commercial, residential, forested, and some industrial areas.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the proposed groundwater wells, RO plants, and concentrate discharge pipelines is approximately 1 year. Three 3.8 mgd pumps would be installed in the City of Newport News and two in York County. There are several residences near the well sites and pipeline routes which might be sensitive to elevated noise levels anticipated with the project. Background noise levels in the vicinity of the pumping stations would be those typical of a moderately urban environment.

Infrastructure

Transportation

Any transportation impacts as a result of the Groundwater Desalination alternative should be temporary and negligible.

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the minor operation of land clearing, excavation, construction, and well drilling equipment. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances.

At full project utilization, the wells and RO treatment facilities would require an average of approximately 17,500 MWH per year of electrical power. To supply power to all the well and treatment sites, only minor upgrades of electrical transmission lines would be required.

Wastewater (i.e., concentrate) generated at the four RO treatment plants would be pumped through four dedicated concentrate pipelines to discharge points in nearby tidal waters.

Other Socioeconomic Impacts

The potential socioeconomic effect of increased water rates to the consumer could also occur if this alternative component is implemented.

4.5.6 Additional Conservation Measures and Use Restrictions

Municipal and Private Water Supplies

Based on safe yield modeling results, this alternative would allow Lower Peninsula water systems to provide an additional 7.1 to 11.1 mgd of treated water safe yield.

Recreation and Commercial Fisheries

This alternative would have no adverse impacts on fish species of recreational or commercial importance.

Other Water-Related Recreation

Recreational activities within project areas are described in Sections 4.5.1 through 4.5.5.

Aesthetics

The aesthetic values of project areas are described in Sections 4.5.1 through 4.5.5.

Parks and Preserves

Use Restrictions would be likely to restrict irrigation of parks within the area. Park resources within project areas are described in Sections 4.5.1 through 4.5.5.

Land Use

Existing land uses within project areas are described in Sections 4.5.1 through 4.5.5.

Noise

This alternative would have no effect on ambient noise levels.

Infrastructure

This alternative should have no effect on existing infrastructure.

Other Socioeconomic Impacts

The socioeconomic setting of the project areas is presented in Sections 4.5.1 through 4.5.5.

4.5.7 No Action

Municipal and Private Water Supplies

Municipal and private water supplies in the region are described in Sections 4.5.1 through 4.5.5.

Recreational and Commercial Fisheries

Recreational and commercial fisheries within project areas are described in Sections 4.5.1 through 4.5.5.

Other Water-Related Recreation

Recreational activities within project areas are described in Sections 4.5.1 through 4.5.5.

Aesthetics

The aesthetic values of project areas are described in Sections 4.5.1 through 4.5.5.

Parks and Preserves

Existing parks and preserves within the region are described in Sections 4.5.1 through 4.5.5.

Land Use

Existing land uses in project areas are described in Sections 4.5.1 through 4.5.5.

Noise

If no action was taken, there would be no adverse impact on ambient noise levels.

Infrastructure

Existing infrastructure in project areas is described in Sections 4.5.1 through 4.5.5.

Other Socioeconomic Impacts

The socioeconomic setting of project areas is described in Sections 4.5.1 through 4.5.5.

4.6 SUMMARY OF AFFECTED ENVIRONMENT

The affected environment of the seven alternatives carried forward for detailed environmental analysis is summarized in Table 4-65. Detailed discussions of affected environment are presented in Section 4.0.

TABLE 4-65
SUMMARY OF AFFECTED ENVIRONMENT

IMPACT CATEGORY	WARE CREEK RESERVOIR	BLACK CREEK RESERVOIR	KING WILLIAM RESERVOIR
PHYSICAL RESOURCES			
SUBSTRATE	Contributes to the quantity and quality of affected aquatic ecosystem	Contributes to the quantity and quality of affected aquatic ecosystem	Contributes to the quantity and quality of affected aquatic ecosystem
WATER QUALITY			
Source	Water from Pamunkey pumped to Diascund then to WCR for storage	Water pumped from Pamunkey into BCR for storage	Water pumped from Mattaponi into KWR for storage
Stream/Groundwater Quality	Excessive levels of phosphorus, manganese, and zinc	Data not available	High levels of orthophosphate and total organic carbon, but data limited
Existing Discharges	Several municipal/industrial discharges located upstream of Northbury	Several municipal/industrial discharges located upstream of Northbury	Currently no major municipal/industrial discharges in Mattaponi River
Development	Intense watershed development underway; active landfill located in watershed	Residential area with several houses	Minor development anticipated, closed landfill located in watershed
HYDROLOGY			
Source	Average discharge of the Pamunkey at Northbury is 774 mgd	Average discharge of the Pamunkey at Northbury is 774 mgd	Average discharge of the Mattaponi at Scotland Landing is 494 mgd
Streams/Aquifers	Ware Creek and tributaries drain 17.4 sq. mi above the proposed dam	Two branches of Black Creek drain 5.47 sq. mi above proposed dam	Cohoke Creek drains 13.2, 11.5, 10.3, & 8.9 sq. mi above proposed dam for KWR- I, II, III, & IV, respectively
GROUNDWATER RESOURCES			
Aquifers Affected	Columbia and Yorktown aquifers	Columbia and Yorktown aquifers	Columbia and Yorktown aquifers
SOIL/MINERAL RESOURCES			
Predominant Soil Type	Gently sloping to very steep to floodplain which is clayey-loam	Moderately sloping to very steep to floodplain which is clayey-loam	Moderately sloping to very steep to floodplain which is clayey-loam
Prime Agricultural Soils	20 ac	17 ac	342, 298, 277, & 228 ac for KWR- I, II, III, & IV, respectively
AIR QUALITY			
Affected Area During Construction	Development near the proposed reservoir might be sensitive	Residential development near proposed reservoir might be sensitive	Residences near the proposed reservoir might be sensitive
BIOLOGICAL RESOURCES			
ENDANGERED, THREATENED AND SENSITIVE SPECIES	One location of Small Whorled Pogonia in proposed reservoir site	None Found	Sensitive Joint-vetch in vicinity of Mattaponi intake Two locations of Small Whorled Pogonia in proposed reservoir site Two Bald Eagle nests; one 1,800 feet from river pumping station and one 375, 2,975, 7,900, & 10,100 feet downstream of the dam for KWR- I, II, III, & IV, respectively
FISH AND INVERTEBRATES	Ware Creek Reservoir site is used by anadromous fish	Black Creek provides limited access for anadromous fish	Cohoke Creek blocked to anadromous fish
OTHER WILDLIFE			
Primary Habitat	Forested uplands which represent 625 ac of pool area Contains 98 nest Great Blue Heron rookery	Forested uplands which represent 546 ac of pool area	Forested uplands which represent 1,538, 1,394, 1,182, & 875 ac of pool area for KWR- I, II, III, & IV, respectively Contains 17 nest Great Blue Heron rookery
SANCTUARIES/REFUGES	No resources in the immediate vicinity	No resources in the immediate vicinity	No resources in the immediate vicinity
WETLANDS/VEGETATED SHALLOWS	Affects 590 ac of tidal and nontidal wetlands and open water	Affects 285 ac of nontidal wetlands and open water	Affects 653, 574, 511, & 437 ac of nontidal wetlands and open water for KWR- I, II, III, & IV, respectively
MUD FLATS	Mud flat 8,000 feet downstream of intake	Mud flat 8,000 feet downstream of intake	Mud flats 3,500 ft upstream of the intake and 2,200 ft downstream of the intake
CULTURAL RESOURCES			
ARCHAEOLOGICAL AND HISTORICAL SITES	1 prehistoric site within the vicinity of the proposed river pumping station 45 sites identified within the proposed reservoir pool area 5 sites are located in the vicinity of the proposed pipeline Additional survey work recommended	1 prehistoric site within the vicinity of the proposed river pumping station 4 sites identified within the proposed reservoir pool area 2 sites located within the vicinity of the proposed pipelines Additional survey work recommended	5 sites located within the vicinity of the proposed river pumping station 131, 120, 103, & 92 sites identified within the proposed reservoir pool area for KWR- I, II, III, & IV, respectively 19 sites located within the vicinity of the proposed pipeline
SOCIO-ECONOMIC RESOURCES			
MUNICIPAL AND PRIVATE WATER SUPPLIES			
Source Consumption	Year 1990 consumptive use in Pamunkey River basin is 34.2 mgd	Year 1990 consumptive use in Pamunkey River basin is 34.2 mgd	Year 1990 consumptive use in Mattaponi River basin is 3.66 mgd
Supplies in Project Vicinity	No municipal or private supplies in immediate vicinity of alternative	No municipal or private supplies in immediate vicinity of alternative	No municipal or private supplies in immediate vicinity of alternative
RECREATIONAL AND COMMERCIAL FISHERIES			
Commercial Importance	Fish species harvested from Pamunkey River	Fish species harvested from Pamunkey River	Fish species harvested from Mattaponi River
Recreational Importance	Minimal freshwater and estuarine fishing in Ware Creek basin Ware Creek is used by anadromous fish including Striped Bass	Small size of Black Creek contributes to limited recreational fishing Limited access for anadromous fish	Majority of fishing occurs in 15 ac private Cohoke Mill Pond Blocked to anadromous fish
OTHER WATER-RELATED RECREATION	Pamunkey River supports year-round recreational boat activity Several privately owned hunt clubs and duck blinds impacted Includes hunting, fishing, boating, and canoeing	Pamunkey River supports year-round recreational boat activity Several privately owned hunt clubs and duck blinds impacted Primary recreation impacted is hunting	Mattaponi River supports year-round recreational boat activity Several privately owned hunt clubs and duck blinds impacted Primary recreation impacted is hunting
AESTHETICS	144 houses within close proximity to physical features of alternative The value is its predominantly natural, scenic beauty	104 houses within close proximity to physical features of alternative The value is its predominantly natural, scenic beauty	73, 72, 72, & 69 houses within close proximity to physical features of KWR- I, II, III, & IV, respectively The value is its predominantly natural, scenic beauty
PARKS AND PRESERVES	No resources within the immediate vicinity.	No resources within the immediate vicinity.	No resources within the immediate vicinity.
LAND USE			
Residential Development	Large residential community being developed	Residential growth has occurred and continues in watershed	No known residential development planned
Total Land Affected	1,400 ac of disturbed land	1,032 ac of disturbed land	2,381, 2,322, 2,013, & 1,633 ac of forested and wetland areas for KWR- I, II, III, & IV, respectively
Agricultural/Forestal Districts	246 acres within proposed pool area	376 ac within proposed reservoir pool area	None within proposed reservoir pool area
NOISE			
Affected Receptors	Residential areas near alternative features	Residential areas near alternative features	Residential areas near alternative features
Duration of Construction	2- 3 years (estimated)	3 years (estimated)	3 years (estimated)
INFRASTRUCTURE	Roadways affected (including I-64), energy requirements Pamunkey River and Ware Creek channel navigation Ware Creek dam site in navigable waters	Roadways affected, energy requirements Pamunkey River navigation Black Creek Reservoir dam sites in non-navigable waters	Roadways affected, energy requirements Mattaponi River navigation King William Reservoir dam site in non-navigable waters
SOCIO-ECONOMICS			
Affected Municipality	Located within JCC and NKC JCC is changing into an urban and suburban environment NKC is primarily rural but is experiencing growth	Located primarily within NKC NKC is primarily rural but is experiencing growth	Located primarily within KWC KWC remains primarily rural

TABLE 4-65 (Continued)

SUMMARY OF AFFECTED ENVIRONMENT

IMPACT CATEGORY	FRESH GROUNDWATER	GROUNDWATER DESALINATION	ADDITIONAL CONSERVATION MEASURES AND USE RESTRICTIONS	NO ACTION
PHYSICAL RESOURCES				
SUBSTRATE Impacts	Contributes to the quantity and quality of affected aquatic ecosystem	Contributes to the quantity and quality of affected aquatic ecosystem	No impacts anticipated	No iracts anticipated
WATER QUALITY Source Stream/Groundwater Quality	Withdrawal from 8 fresh groundwater wells for reservoir storage pH, chloride, and sulfate concentrations are high in two reservoirs	Withdrawal from 5 brackish groundwater wells for desalination Brackish water has high chloride concentration	No impacts anticipated N/A	Withdwal from existing sources Degration of water quality in existing reservoirs
HYDROLOGY Source Streams/Aquifers	Fresh groundwater withdrawal from new well fields in NKC and JCC To augment capacity of Little Creek and Diascund Creek Reservoirs	Deep brackish groundwater withdrawal to supply four RO facilities Concentrate discharge pipelines terminate at four tidal water bodies	No impacts anticipated Impact to consumers currently serviced by Lower Peninsula purveyors	No ircts anticipated Stress Chickahominy River, Lower Peninsula's main water supply source
GROUNDWATER RESOURCES Aquifer Impact	Seepage recharge to Middle Potomac Aquifers	Seepage recharge to Middle and Lower Potomac aquifers	Reduction in impact to aquifers currently used as water source	Negaily impacts all aquifers currently used as water source
SOIL/MINERAL RESOURCES Predominant Soil Type Prime Agricultural Soils	Well drained soils No impacts anticipated	Well drained soils No impacts anticipated	N/A No impacts anticipated	N/A No imts anticipated
AIR QUALITY Construction Impacts	Residential development near proposed pipeline route may be sensitive	Discharge pipelines cross medium to high density residential areas	No impacts anticipated	No imts anticipated
BIOLOGICAL RESOURCES				
ENDANGERED, THREATENED AND SENSITIVE SPECIES	No impacts anticipated	No impacts anticipated	No impacts anticipated	Impassociated with species utilizing existing reservoirs
FISH AND INVERTEBRATES	Reservoirs are currently stocked and monitored	Fish and invertebrate species impacted by concentrate pipeline outfalls	No impacts anticipated	Fish nvertebrates impacted by reservoir drawdown
OTHER WILDLIFE Primary Habitat	Permanent impacts to forested land which represents 4 ac	Variety of community types	No impacts anticipated	Impassociated with wildlife species within existing reservoirs
SANCTUARIES/REFUGES	No impacts anticipated	No impacts anticipated	No impacts anticipated	No im anticipated
WETLANDS/VEGETATED SHALLOWS Acreage Classification	No impacts anticipated	Less than 1 ac impacted by outfall structures associated with pipelines Estuarine	No impacts anticipated	Affectlands are associated with current reservoirs and areas supplied by grater
MUD FLATS	No impacts anticipated	Mud flats located in vicinity of concentrate discharge pipeline outfalls	No impacts anticipated	Moreınt and severe drawdown of existing reservoirs
CULTURAL RESOURCES				
ARCHAEOLOGICAL AND HISTORICAL SITES	7 sites exist within the vicinity of Little Creek Reservoir well sites	Discharge pipelines may affect a number of sites	No impacts anticipated	No inanticipated
SOCIO-ECONOMIC RESOURCES				
MUNICIPAL AND PRIVATE WATER SUPPLIES Source Consumption	Current Middle Potomac aquifer withdrawal total is 15.9 mgd	Current withdrawal from Middle and Lower Potomac aquifers is 19.4 mgd	Current Lower Peninsula groundwater withdrawal is 3.6 mgd	Impa9 mgd total groundwater withdrawal for York-James Peninsula
RECREATIONAL AND COMMERCIAL FISHERIES Commercial Importance Recreational Importance	N/A Recreational fisheries exist in Diascund and Little Creek reservoirs	No impacts anticipated Concentrate pipeline discharges into water bodies used for recreation	No impacts anticipated No impacts anticipated	No irnticipated Impah species of recreational importance
OTHER WATER-RELATED RECREATION	No impacts anticipated	Two discharge pipelines cross parks	Private and public facilities reliant on non-essential water use	Impareation in current reservoirs
AESTHETICS	9 houses are within 500' of groundwater withdrawal points	224 houses within close proximity to physical features of alternative	Existing reservoirs impacted	Impaing reservoirs
PARKS AND PRESERVES	No impacts anticipated	1 groundwater well and RO facilities located within Newport News Park Pipeline located in York County New Quarter Park Pipeline crosses Colonial National Historic Parkway	Limited impact to irrigation	Impeated with reservoir drawdown
LAND USE Total Land Disturbance Agricultural/Forestal Districts Houses Displaced	Maximum area of disturbance is 8 ac None None	Maximum area of disturbance is less than 70 ac None None	Impacts to parks and recreational areas None None	Impa land use development Non Non
NOISE Affected Receptors Duration of Construction	Residential areas near well sites and pipelines 6 months (estimated)	Residential areas near well sites and pipelines 1 year (estimated)	No impacts anticipated	No icipated
INFRASTRUCTURE	Impacts to existing roadways, energy requirements	Impacts to existing roadways, energy requirements Impacts to water bodies associated with discharge outfalls	No impacts anticipated	No icipated
SOCIO-ECONOMICS Affected Municipality	Financial impact to Lower Peninsula consumers	Financial impact to Lower Peninsula consumers	Financial impact to Lower Peninsula consumers	Impenic growth of Lower Peninsula

5.0 ENVIRONMENTAL CONSEQUENCES

5.1 INTRODUCTION

This section is devoted to the probable direct, indirect, and cumulative impacts of the candidate alternatives and the No Action alternative; and is the scientific and analytic basis for the comparison of alternatives in this document. A general description of the effects of each alternative is presented, but only in as much detail as needed to make meaningful comparisons among them. A more detailed evaluation of potential impacts is contained in Report D (Volume II), ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) which is incorporated herein by reference and is an appendix to this document.

The environmental effects of alternatives identified in Section 3.5 are summarized for each of the following general categories:

- Physical Resources: Describes impacts on substrate, water quality, hydrology, groundwater resources, soil and mineral resources, and air quality. Riffle and pool complexes were also evaluated, but none of these features were identified within the project areas. Therefore, no impacts to these complexes are anticipated.

- Biological Resources: Describes impacts on endangered, threatened or sensitive species; fish and invertebrates; other wildlife; sanctuaries and refuges; wetlands and vegetated shallows; and mud flats.

- Cultural Resources: Describes impacts on archeological and historical sites.

- Socioeconomic Resources: Describes impacts on municipal and private water supplies, recreational and commercial fisheries, other water-related recreation, aesthetics, parks and preserves, land use, noise, infrastructure, and other socioeconomic impacts.

- Unavoidable and Adverse Environmental Impacts.

- Irreversible and Irretrievable Commitments of Resources.

- Relationship Between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity.

A comparative summary of the environmental consequences associated with each alternative is presented in Section 3.8.

5.2 PHYSICAL RESOURCES

This section provides a general description of how the physical environment would be impacted by each of the seven alternatives evaluated. Physical resource categories evaluated are described below.

Substrate

This section addresses the potential impacts of each alternative on aquatic ecosystem substrate. Impacts are assessed according to the acreage of aquatic ecosystem substrate disturbed.

Water Quality

This section evaluates the potential impacts to surface water quality from the seven alternative components. Water quality impacts to groundwater are addressed in Groundwater Resources. In evaluating the water quality impacts to these surface waters, existing water quality conditions were characterized and potential long-term and short-term water quality changes resulting from implementation of each alternative were assessed. Some factors which were used in evaluating the impacts were quality of the existing surface waters, severity of any impacts, magnitude of any water quality changes, and relative probability that there would be an impact (based on available information). Because the amount of surface water quality information for each alternative varies widely, and the types of impacts differ, a quantitative analysis of each alternative was not appropriate. Rather, a more qualitative analysis which considered relative trends and changes was used to evaluate each alternative. In this manner, the assessment between alternative components would not be biased by the amount of information available for each alternative.

Hydrology

Hydrologic impact analyses were conducted to evaluate the potential environmental consequences of each alternative component on surface water or groundwater hydrology. For surface water withdrawals, key hydrologic impact assessment criteria include streamflow duration curves, average annual, average monthly and cumulative withdrawal rates as a fraction of available flow, and flow contravention frequencies. Impacts to affected streams at proposed impoundment sites and pipeline discharge points are also quantified. For groundwater withdrawals, the magnitude of potential aquifer drawdown is evaluated.

Groundwater Resources

This section evaluates the proposed alternatives based on the relative severity of their potential impacts to the respective environmental criteria. Potential impacts to groundwater resources are divided into two broad categories:

- Impacts to Groundwater Quantity
- Impacts to Groundwater Quality

Most of the above impact criteria were developed by the Virginia State Water Control Board (SWCB) in response to the Groundwater Management Act of 1973 (which was repealed and replaced by the Groundwater Management Act of 1992 (Virginia Code § 62.1 -254 through § 62.1 - 270)).

Soil and Mineral Resources

This section describes the potential impacts on soils and mineral resources from each alternative component. Impacts to these resources resulting from implementation of practicable alternatives are addressed in terms of the acreage of disturbance to these resources.

Air Quality

This section discusses the potential impacts of each alternative component on air quality. Impacts are addressed in terms of construction and operation impacts.

5.2.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Substrate

The Ware Creek Reservoir alternative would impact approximately 1.54 acres of substrate. In greater detail, 0.16 acres of substrate would be removed during construction of the intake pipeline at the proposed Northbury intake site, 1.2 acres of substrate would be temporarily disturbed by pipeline construction, and 0.18 acres of substrate would be disturbed, removed or permanently covered by construction of the outfall structures.

In addition, filling the proposed reservoir area to 35 feet msl would result in the inundation of approximately 1,238 acres, of which 54 acres are currently open water and perennial stream areas containing substrate. Because substrates in these areas are presently inundated, adverse effects from further inundation of these perennially wet areas are considered minimal.

Water Quality

Surface waters involved in this alternative are the Pamunkey River, Diascund Creek Reservoir, Ware Creek, and 21 stream/wetland areas along the pipeline route.

The water quality characteristic for the Pamunkey River which is of greatest concern relative to the proposed withdrawal is salinity. Changes in the distribution of salinity in the river are controlling factors in tidal wetland community structure and some anadromous fish spawning grounds. For use as drinking water, the concentration of chlorides, and secondarily sodium, is of concern. An analysis was conducted to estimate the impact of the proposed withdrawal on existing salinity concentrations in the Pamunkey River. Based on this analysis, salinity changes in the Pamunkey River resulting from the proposed withdrawal are not expected to impact existing tidal freshwater vegetative communities. – what about fish etc.

From a drinking water treatment perspective, another concern associated with Pamunkey River water quality is possible intrusion of salinity, and associated chlorides and sodium, as far upstream as the proposed intake site at Northbury. However, based on review of available salinity data, and based on the proposed Minimum Instream Flowby (MIF) which precludes withdrawals during drought conditions, Pamunkey River withdrawals would be avoided or prevented during any periods of detectable salinity near the intake.

The primary long-term impact to the water quality of Diascund Creek Reservoir is the addition of flow from the Pamunkey River. Phosphorus concentrations tend to be higher in the Pamunkey River. Therefore, increased phosphorus loading to the reservoir may result in water quality problems associated with eutrophic conditions. However, the increased flow through the reservoir, as well as its natural assimilative capacity, should help mitigate the higher phosphorus concentrations.

The most noteworthy long-term impacts to Ware Creek water quality would occur in the tidal portions of the creek, primarily downstream of the proposed dam. One impact would be a considerable change in downstream water quality conditions, eliminating the tidal freshwater section and reducing or eliminating oligohaline portions of Ware Creek.

The runoff control measures planned for the Stonehouse development should afford some degree of water quality protection for Ware Creek. However, given the magnitude of the Stonehouse project, there would still be a severe risk of long-term reservoir water quality deterioration due to the extensive nature of planned residential and commercial development in the watershed. For example, this development has the potential to impact reservoir water quality by contributing non-point source runoff from roads, sediment loads from home and road construction activities, and nutrient loads from lawn fertilizer runoff. One of James City County's environmental consultants has also predicted that the proposed Ware Creek Reservoir would be upper mesotrophic/lower eutrophic immediately after construction and ultimately would become eutrophic (James R. Reed & Associates, 1986).

Another impact would be an increase in the phosphorus loading by the pumpover from Diascund Creek which may result in eutrophic conditions in the proposed reservoir. Short-term water quality impacts are also expected from dam and outfall construction, and clearing associated with preparation of the reservoir. These impacts would primarily consist of increased turbidity resulting from increased erosion. Sediment control measures would be maintained during construction of the dam to minimize impacts to downstream water quality.

In addition to the impacts resulting from reservoir development, accidental spills directly into the reservoir could have a great short-term impact on reservoir water quality. This potential impact is important for the Ware Creek project, since Interstate 64 directly crosses over three arms of France Swamp and one arm of Bird Swamp within the normal pool area of the reservoir.

At Outfall Site 1 on Diascund Creek, the existing water quality conditions would be changed to those of the Pamunkey River. Short-term impacts would also occur as a result of increasing the flow in the channel. However, these impacts should dissipate since the channel would reestablish itself.

At Outfall Site 2, the water quality impact would be a change in the existing water quality to a blend of Diascund Creek water and Pamunkey River water in the vicinity of the outfall. Because the Pamunkey River has a higher phosphorus concentration than Diascund Creek Reservoir, this could result in an increased phosphorus loading to the reservoir.

Water quality impacts to streams crossed during pipeline construction would be limited to the period of construction. Therefore, these impacts are considered minimal.

Hydrology

To identify the potential hydrologic impacts of a 120 mgd Pamunkey River withdrawal capacity at Northbury, the results of the safe yield modeling (see Section 3.4.11) for this withdrawal scenario were used to simulate post-withdrawal flow conditions. For each month of the 696-month safe yield analysis, the simulated pre-withdrawal flow, withdrawal volume, and flow past the intake site were tabulated and analyzed.

Figure 5-1 depicts the percentages of time in which simulated flows past the proposed intake occurred under pre- and post-withdrawal conditions. Decreases in flow past the intake under post-withdrawal flow conditions are relatively small at given frequencies of occurrence.

An analysis of annual average withdrawals and flows past the proposed intake site under pre- and post-withdrawal conditions was conducted. The average withdrawal is simulated to be 63.4 mgd. This represents an 8.2 percent decrease in the estimated average flow past the intake. However, it is estimated that an average Pamunkey River withdrawal of only 25 mgd would be required to provide desired safe yield benefits. This represents a 3.2 percent decrease in estimated average flow past the intake.

Monthly average flows past the proposed intake were simulated for pre-withdrawal conditions (see Figure 5-2). Under the assumed Pamunkey River MIF, the proposed maximum withdrawal of 120 mgd could represent a maximum of 40 percent of the total freshwater flow at Northbury. This could occur during the month of October (Assumed MIF for October equals 180 mgd) if flow past the intake was 300 mgd and the maximum proposed withdrawal of 120 mgd was made.

An analysis of contraventions, or periods when flows are less than given threshold levels, was also performed. There is only a small increase in flow contraventions under post-withdrawal conditions.

A cumulative streamflow analysis was conducted to estimate the impact of any future streamflow reductions in addition to the proposed project on streamflow in the Pamunkey River. It is estimated that by the Year 2040, with all currently identified potential uses taken into account, and an estimated average withdrawal of 25 mgd for this alternative, average Pamunkey River streamflow would be reduced by 8.8 percent.

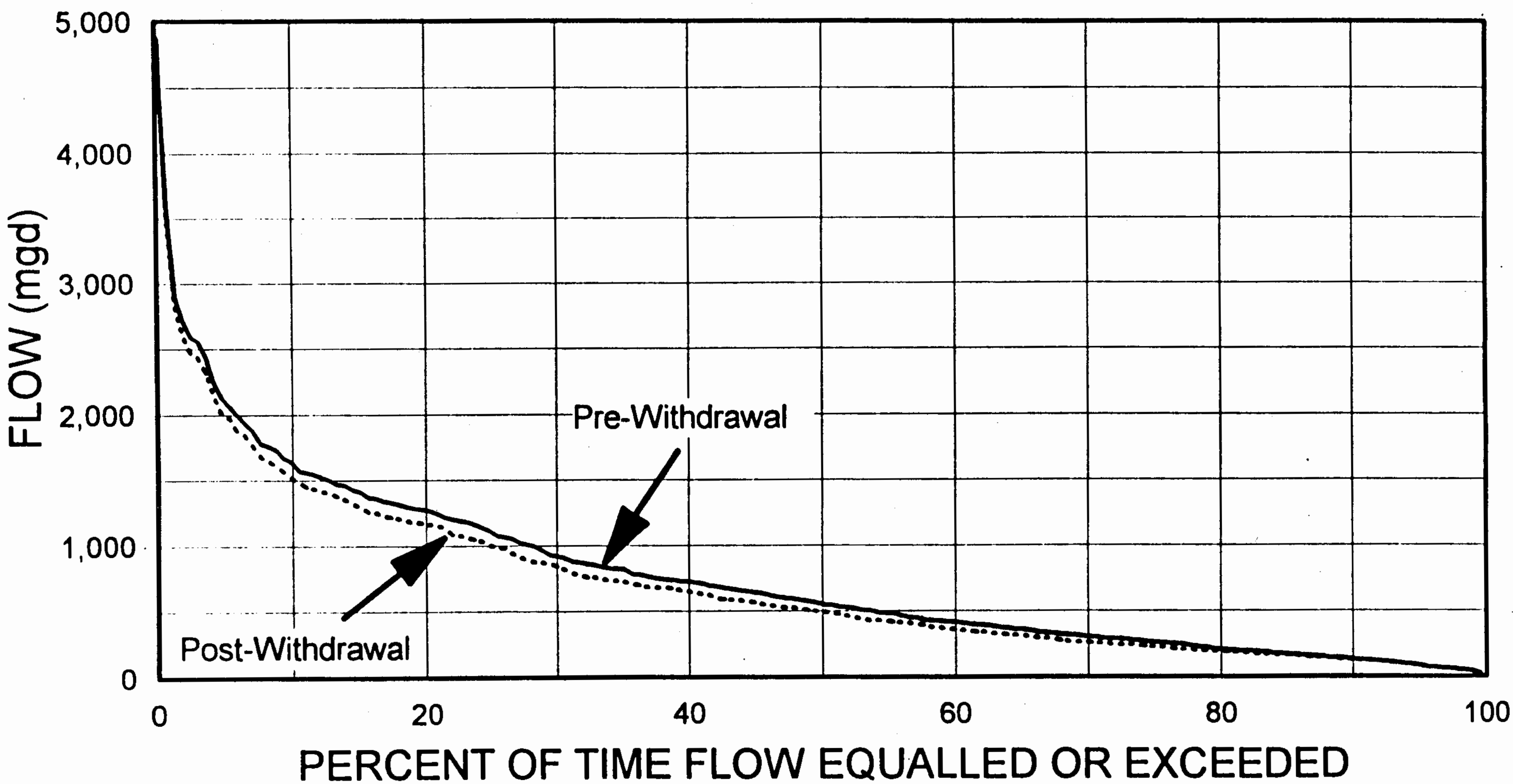
Construction of a dam on Ware Creek would inundate 37.1 miles of tidal and non-tidal perennial and intermittent streams. Streamflows would be restricted to 3.6 percent to 14.4 percent of existing average flow. The net reduction in freshwater discharge at the proposed dam site would be 9.5 to 10.7 mgd.

Water depth in the Pamunkey River would not be measurably impacted by this alternative since the proposed intake site is located in tidal waters.

The pipeline for this alternative would cross 21 stream/wetland areas. Impacts to the hydrology of these streams would be temporary in nature, and are deemed minimal.

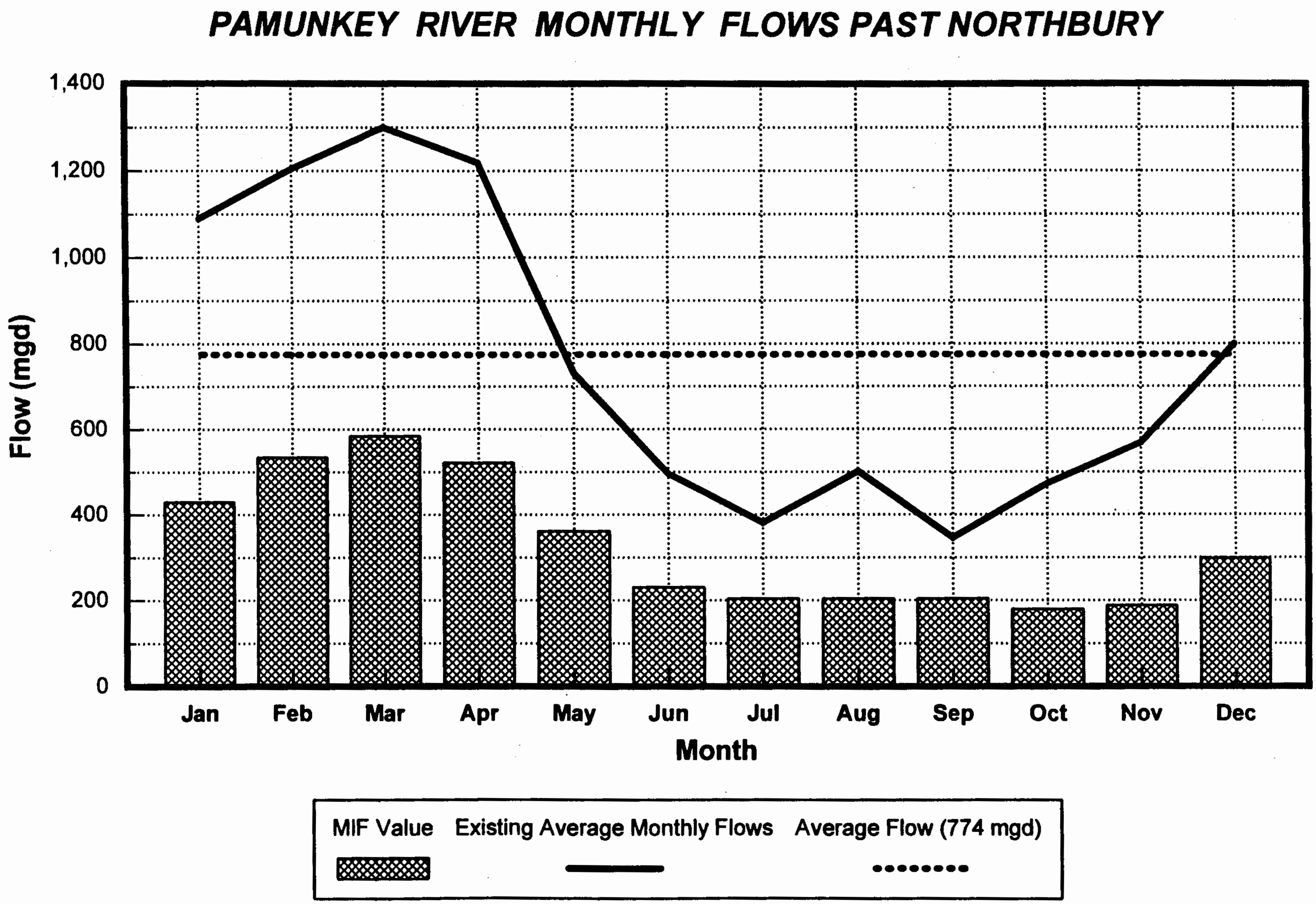
As part of this alternative, Diascund Creek would be used as an inter-reservoir conveyance channel. Based on the field measurements and flow calculations described in Section 4.2.1, the channels at the proposed outfall sites appear capable of accommodating maximum flows during pumpover operations. When reservoirs are near capacity and natural high flow events occur, pumpovers from the Pamunkey River to the Diascund Creek Reservoir would be unnecessary. Therefore, pumpover operations should not increase the frequency at which the banks of Diascund Creek are overtopped by high flow events.

PAMUNKEY RIVER FLOW DURATION CURVES
Ware Creek Reservoir Alternative
(Simulated Flows Past Northbury for 10/29 - 9/87)



* *120 MGD WITHDRAWAL CAPACITY*

Figure 5-1



* 120 mgd withdrawal capacity simulated.

Figure 5-2

The two proposed outfalls on Diascund Creek have the potential to cause physical, chemical and biological changes in the Creek. With a combined maximum raw water discharge capacity of 120 mgd, these outfalls could cause greater meandering of the stream channel and substantially increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels, higher nutrient flushing rates, and greater saturation of the floodplain wetlands through recharge. Potential impacts to Diascund Creek through channel scouring and increased sediment loading are discussed below.

The outfalls to Diascund Creek would be standard U.S. Bureau of Reclamation impact type structures, designed for maximum discharge capacities. Discharge channels would connect the outfall to the main Diascund Creek channel. The outfalls would be designed to dissipate most of the energy associated with the high velocity incoming flow of water before it reaches the stream channel. If erosional problems develop in some portion of Diascund Creek, additional control measures such as check dams or natural deadfall timbers could be placed at strategic locations in the creek channel to dissipate flow velocities and reduce potential bank undercutting. As discussed in Section 4.2.1, pumpover operations should not increase the frequency at which the banks of Diascund Creek are overtopped by high flow events.

Groundwater Resources

A discussion of the potential impacts to groundwater resources related to the operation of a similar freshwater river intake is presented in Section 5.2.3.

When the reservoir becomes operational, changes in the groundwater flow and quality of the Columbia Aquifer may result. An approximate increase of 15 to 30 feet in some areas of the groundwater level, and the resulting increased horizontal flow rate, and an increase in the number of springs located on the valley walls in the watersheds bordering Ware Creek watershed is expected. During construction and operation of the reservoir, the Columbia and Yorktown Aquifers would be afforded recharge by direct and indirect seepage from the reservoir. This would generally be considered a beneficial impact. However, if the water quality in Ware Creek Reservoir deteriorates over the long-term, as expected, then reservoir seepage could have some detrimental impact on groundwater quality.

Impacts to the shallow groundwater system by the Stonehouse planned community is expected to be minimal due to the use of sewer systems. Indirect pumpover from the Pamunkey River to Ware Creek Reservoir via Diascund Creek Reservoir would also not be expected to affect the overall groundwater quality in either watershed.

Implementation of a drinking water reservoir alternative would directly (via recharge) and indirectly (via alternative supply) benefit the groundwater resources of the region.

In general, construction activities related to the reservoir and dam should have little effect on groundwater quality and quantity within the watershed.

Soil and Mineral Resources

Construction of an intake facility at the proposed Northbury intake site would cause the disturbance of approximately 3 acres of Nevarc-Remlik complex and the Pamunkey Fine Sandy Loam; the latter is considered a prime agricultural soil (Hodges et al., 1985).

Construction of Ware Creek Reservoir dam and subsequently filling of the proposed Ware Creek Reservoir would result in the inundation of approximately 1,238 acres of land. However, open water and perennial streams already inundate an estimated 54 acres of this area. Therefore, 1,184 acres of soils would be inundated by the reservoir.

Prime agricultural soils account for 20 of the 1,238 acres to be inundated by the reservoir. However, adverse effects due to the inundation of these soils and dam construction would be minimal since steep side slopes and low land flooding presently make the majority of these soils unsuitable for farming.

Effects to soil due to the construction of the raw water pipelines associated with this alternative would be minimal. After construction, the disturbed soils would be returned to a natural state. A total of 159 acres of soils within the pipeline ROW would be temporarily disturbed.

Air Quality

Although a sizeable portion of this alternative falls within the boundaries of an ozone non-attainment area, the type and amount of pollutants emitted from this operation is minimal and would not prevent reasonable further progress toward attaining the ambient ozone air quality standard.

During the construction phase of the project, it is likely that burning of some unusable cleared vegetation would be conducted on site. Due to the short-term nature of this activity, only a minimal effect on air quality would be expected. In addition, it is expected that clearing, excavation and construction activities would produce fugitive dust emissions in and around the site.

Fuel burning emissions from the use of construction equipment would be released during construction activities. A minimal effect on air quality would be expected due to the small amount of emissions relative to other sources of air pollution in the region and since these activities would be temporary.

5.2.2 Black Creek Reservoir with Pumpover from Pamunkey River

Substrate

The Black Creek Reservoir alternative would impact, at a minimum, an estimated 1.61 acres of existing substrate. This would consist of approximately 0.16 acres of substrate surface area removed at the Northbury intake site, 1.4 acres of substrate being temporarily affected by pipeline construction, and 0.05 acres of substrate at the outfall locations being disturbed, removed, or permanently covered by construction of the outfall structures. An additional 0.6 acres of substrate could be disturbed if conventional cut and fill techniques are used for the Little Creek Reservoir crossing. As with the Ware Creek Reservoir alternative, the majority of affected substrate would only be temporarily impacted.

In addition, filling the proposed reservoir area to 100 feet msl would result in the inundation of approximately 1,146 acres, of which 21 acres are currently open water and perennial stream areas containing substrate. Because substrates in these areas are presently inundated, adverse effects from further inundation of these perennially wet areas are considered minimal.

Water Quality

Surface waters involved in this alternative are the Pamunkey River (new intake source), two tributaries of Black Creek (locations of new reservoirs), the Diascund Creek and Little Creek Reservoirs (existing impoundments), and 34 stream/wetland crossings.

Intake

The water quality characteristic of the Pamunkey River which is of greatest concern relative to the proposed withdrawal is salinity. An analysis was conducted by Malcolm Pirnie to estimate the impact of the proposed withdrawal on salinity concentrations in the Pamunkey River (see Report I, ***Pamunkey River Salinity Intrusion Impact Assessment for Black Creek Reservoir Alternative*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document). This analysis concluded that the salinity regime of the Pamunkey River, and the biological resources existing in that environment, should not be greatly affected by incremental salinity changes due to withdrawals proposed as part of the Black Creek Reservoir Project. Natural Pamunkey River salinity fluctuations greatly exceed any salinity changes that are predicted due to the proposed RRWSG withdrawals. The Pamunkey River salinity modeling results demonstrate that the RRWSG's withdrawals would not affect the upstream limits of detectable salinity intrusion. The proposed withdrawals would, however, cause small increases in the frequency of given levels of salinity intrusion at points which already are periodically exposed to comparable salinity levels.

Malcolm Pirnie also evaluated potential cumulative salinity changes in the Pamunkey River resulting from the proposed RRWSG withdrawal in combination with other existing and projected consumptive water uses in the Pamunkey River Basin (see Report I). Based on this additional analysis, there appears to be some potential that measurable cumulative impacts would result from the combination of all existing and reasonably foreseeable withdrawals. These potential cumulative impacts would most likely be small since potentially affected areas are subject to large natural salinity fluctuations which occur as a result of normal daily, seasonal, and annual variations in streamflow and tidal conditions. Also, these potential impacts would probably occur slowly, over several decades, so that most existing communities may have time to adjust to the changes or possibly to migrate to upstream locations.

From a drinking water treatment perspective, another concern associated with Pamunkey River water quality is possible intrusion of salinity, with its associated concentrations of chlorides and sodium, as far upstream as the proposed intake site at Northbury. This can occur under natural conditions, regardless of any proposed withdrawal. Based on review of available Pamunkey River salinity data, and based on the proposed MIF which precludes withdrawals during low flow conditions, Pamunkey River withdrawals would be avoided or prevented during periods of detectable salinity near the intake.

Reservoir

Long-term water quality changes to the Southern Branch and Eastern Branch of Black Creek would result from filling the impoundment area of the proposed reservoirs with water from the Pamunkey River. Surface water quality records are not available for the Black Creek Reservoir watershed. As presented in the DEIS, water quality data for Crump Creek and Matadequin Creek were used as surrogates for Black Creek water quality conditions because all three creeks have similar drainage areas, topography, and land use within their watersheds. Using these surrogate data, it was found that there are only minor differences in water quality between Crump Creek, Matadequin Creek and the Pamunkey River. Potential water quality changes through altered hydrologic conditions in the Black Creek Reservoir basins are discussed below.

The most notable change at the proposed reservoir sites would result from increasing the depth of the surface water to maximums of 77 feet in the Eastern Branch Black Creek impoundment and 63 feet in the Southern Branch Black Creek impoundment. With these depths, stratification would be expected to occur, principally in the summer months, with possible anoxic conditions and low temperatures in the hypolimnion. Downstream water quality problems would be expected if water were released only from the bottom of the reservoir, resulting from the temperature variations, the low dissolved oxygen, and nutrient enriched water. Mitigative measures such as multi-level releases could be used to regulate the quality of the water released from the reservoir.

The proposed minimum combined reservoir release of 1.2 mgd represents 32 percent of the estimated combined average flow at the two dam sites. Long-term water quality characteristics of Black Creek downstream of the two dams are not expected to be adversely impacted, either by the net reduction in volumes of flow below the impoundments or by the addition of water of similar quality from the Pamunkey River.

Short-term water quality impacts to Black Creek could occur during dam and outfall construction, and from clearing associated with preparation for filling the reservoir. Such impacts would consist largely of increased turbidity as a result of increased erosion in cleared areas. Efforts would be made to control such erosion at the source. Additionally, as the reservoir begins filling, concentrations of nutrients can be expected to temporarily rise from decomposition of leaf litter, stumps, and other organic material left after clearing.

Potential reservoir water quality impacts associated with existing and potential future development in the Black Creek Reservoir watershed could occur as a result of non-point source runoff from roads, sediment loads from home and road construction activities, nutrient loads from lawn fertilizer runoff, and migration of pollutants from septic tanks. There are currently at least four residential subdivisions within the proposed reservoir watershed, including the large Clopton Forest subdivision which borders the western edge of the Southern Branch Black Creek impoundment site.

In general, the water quality of the Pamunkey River is better than the existing water quality in Diascund Creek Reservoir, with the notable exception that the mean total phosphorus concentration is higher in the Pamunkey River than in Diascund Creek Reservoir (0.07 versus 0.04 mg/L). Therefore, there could be periods when eutrophication impacts could occur in Diascund Creek Reservoir due to increased nutrient loading from the addition of water directly from the Pamunkey River.

Much of the water reaching the Diascund Creek Reservoir from the Pamunkey River would first be routed through the Black Creek Reservoir system. A substantial amount of particulate settling would occur within these reservoirs, owing to their large volume and depth. This would reduce concentrations of particulate-borne constituents, such as phosphorus, in the water column, before the water is transferred on to Diascund Creek Reservoir and the rest of the existing Newport News Waterworks raw water supply system. If suspended solids levels in the Pamunkey River occasionally reach unacceptably high levels, the river pump station operators would have the option of discontinuing withdrawals until water quality improves. However, water from the Pamunkey River could sometimes be pumped directly to the headwaters of the Diascund Creek Reservoir, thereby increasing nutrient loading during those periods.

Since raw water can be transferred from Diascund Creek Reservoir to Little Creek Reservoir, water quality can also be affected there, but to a lesser extent. Nutrients would be attenuated in Diascund Creek Reservoir and not all water would be routed through Little Creek Reservoir.

Malcolm Pirnie conducted additional water quality analyses on Pamunkey River water samples in October 1994 and found slightly higher concentrations of organic compounds than in existing raw water sources in the Newport News Waterworks system. The addition of Pamunkey River water, with these higher organic concentrations, is not expected to cause unmanageable water quality problems in Newport News Waterworks reservoirs. However, the treatment process would have to be adjusted to accommodate these generally elevated levels of organic compounds in the raw water supply.

Pipeline

Impacts to the 34 stream/wetland areas along the proposed pipeline routes would be limited to the period of construction. It is also possible that the pipeline would be constructed during the drier months of the year, at which time many of the intermittent streams may not be flowing. Any impacts on the water quality of those streams would be temporary and minimal.

Hydrology

Intake

The potential hydrologic impacts of a maximum 120 mgd withdrawal from the Pamunkey River at Northbury were evaluated under projected Year 2040 demand conditions. The Year 2040 represents the end of the project planning horizon, and presumably the year in which withdrawals would be greatest. Hydrologic impacts in earlier years would be smaller.

From safe yield analyses, data are available on the quantities of water which must be withdrawn to meet the project's yield requirements through the planning period. To evaluate the effects of those withdrawals, it was necessary to examine the 58-year record of streamflow on the Pamunkey River and its principal tributaries, collected at the following gages: for the period 10/29-9/41, North Anna River near Doswell (441 square mile drainage area); for the period 10/41-9/69, Pamunkey River near Hanover (1,081 square mile drainage area); for the period 10/69-9/70, North Anna River near Doswell (441 square mile drainage area); and for the period 10/70-9/87, Pamunkey River near Hanover (1,081 square mile drainage area).

For each month in this historic record, a model was used to predict the flow at the Northbury (1,279 square mile drainage area) intake site (without any withdrawal), the amount required to be withdrawn, and the remaining River flow past the site. The following hydrologic impact assessment techniques were used in that evaluation:

- Streamflow duration curves were developed and compared for the pre- and post-withdrawal conditions.

- Monthly withdrawals for each individual month of the simulation period (Water Years 1930-1987) were summarized graphically.

- Average monthly withdrawals and flows past the proposed intake site were simulated and compared tabularly and graphically for the pre- and post-withdrawal conditions for:

    1. The entire simulation period (Water Years 1930-1987).

    2. Wet years (10 percent exceedance water years).

    3. Average years (45-55 percent exceedance water years).

    4. Dry years (90 percent exceedance water years).

- An analysis was made of those periods when flows are less than nominal threshold levels (i.e., flow contravention analysis). A comparison was made between the number of months in which those levels would not be met, under pre- and post-withdrawal streamflow conditions.

- An analysis of basin-wide consumptive use was conducted to estimate cumulative streamflow reductions with and without the project.

The safe yield model uses simulated Pamunkey River withdrawal records which are based only on MIF conditions and pump station capacity. These simulated withdrawals overestimate the quantity of river withdrawals required to produce a given safe yield, because the model assumes that withdrawals would occur even if the reservoir is already full. To remedy this situation, each of the monthly Pamunkey River withdrawal rates was reduced by the corresponding monthly amount of Black Creek Reservoir water spilling over the top of the dam. In making these corrections, adjusted withdrawal rates were not permitted to go below zero.

Figure 5-2A depicts the percentages of time in which simulated flows past the proposed intake occurred under pre- and post-withdrawal conditions. The decrease in flow past the intake under post-withdrawal flow conditions is small at given recurrence frequencies.

Figures 5-2B through 5-2G show simulated monthly withdrawals for each individual month of the simulation period (Water Years 1930-1987). The 58-year simulation period was divided into six sequential time periods to better portray these data. These six graphs show that the amount withdrawn would be very small relative to total river flow. During particularly low flow months, when the proposed MIF would severely limit or preclude withdrawals, the amount withdrawn would be very limited or there would be no withdrawals.

Under the proposed Pamunkey River MIF (i.e., Modified 80 Percent Monthly Exceedance Flows described in Section 3.3.3), the proposed maximum withdrawal of 120 mgd could represent a maximum of 40 percent of the total flow on a single day at Northbury. This could occur during the month of October (MIF value of 180 mgd is the lowest monthly MIF value), if a daily flow past the intake was 300 mgd and the maximum withdrawal of 120 mgd was made (300 - 180 = 120). This would not be a frequent occurrence since, in October, flows at Northbury exceeding 300 mgd occur only 28.5 percent of the time. In fact, during 48 percent of the time in October, flows are less than 180 mgd and no withdrawals would be allowed.

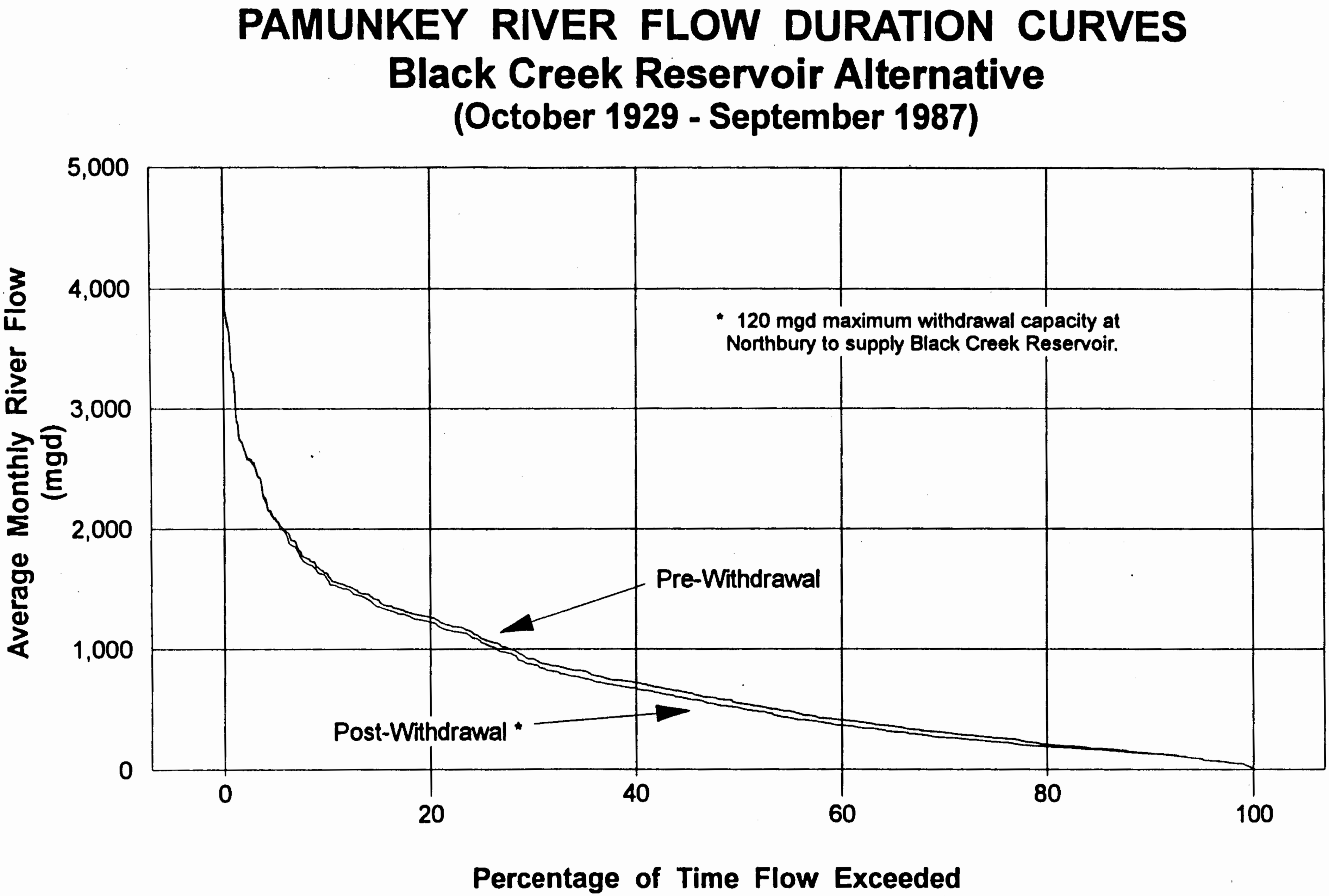
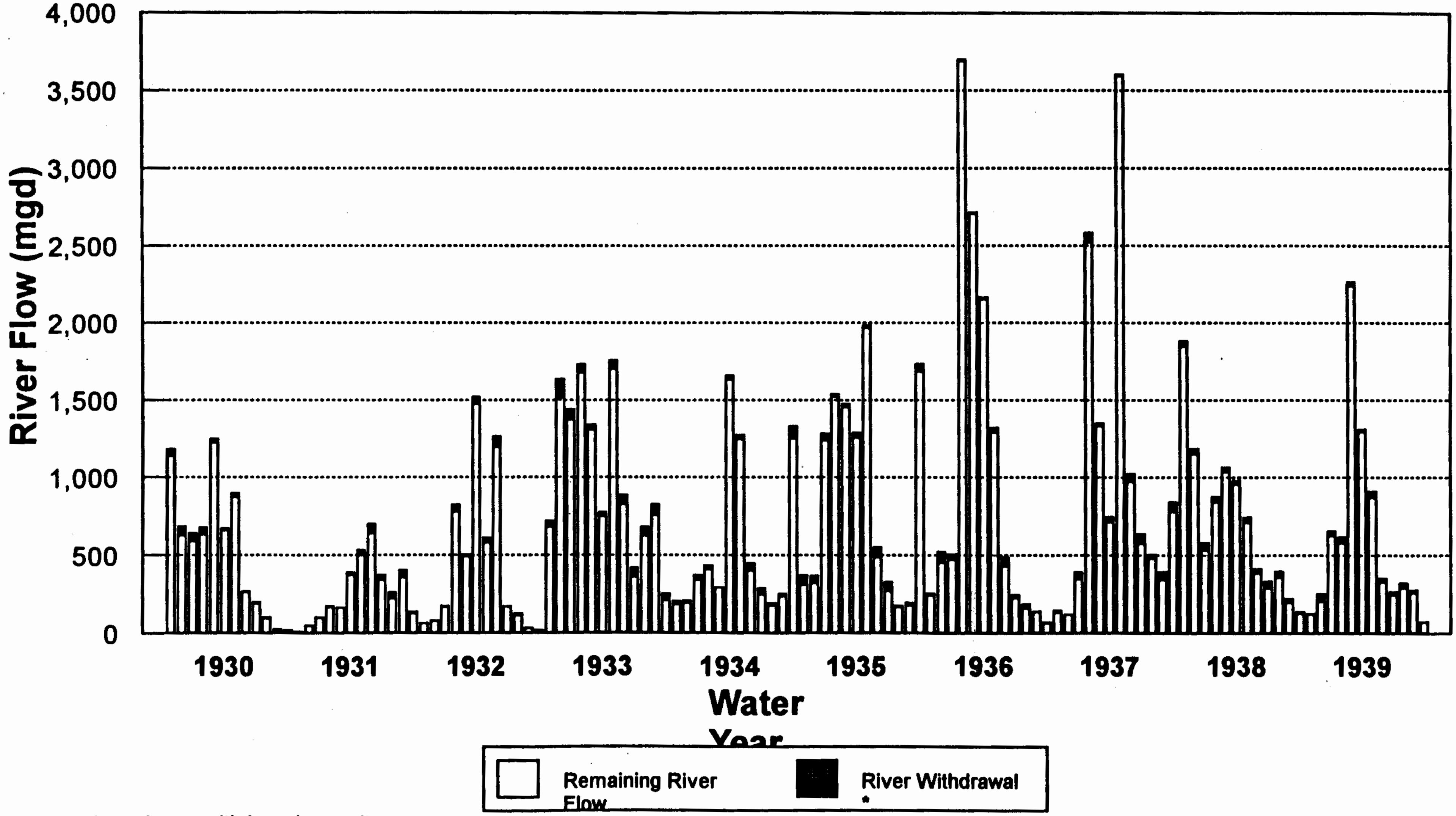

PAMUNKEY RIVER FLOW DURATION CURVES
Black Creek Reservoir Alternative
(October 1929 - September 1987)
Average Monthly River Flow (mgd)
5,000
4,000
3,000
2,000
1,000
0
0
20
40
60
80
100
Percentage of Time Flow Exceeded
* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.
Pre-Withdrawal
Post-Withdrawal *

Figure 5-2A

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS
Black Creek Reservoir Alternative
(OCTOBER 1929 - SEPTEMBER 1939)



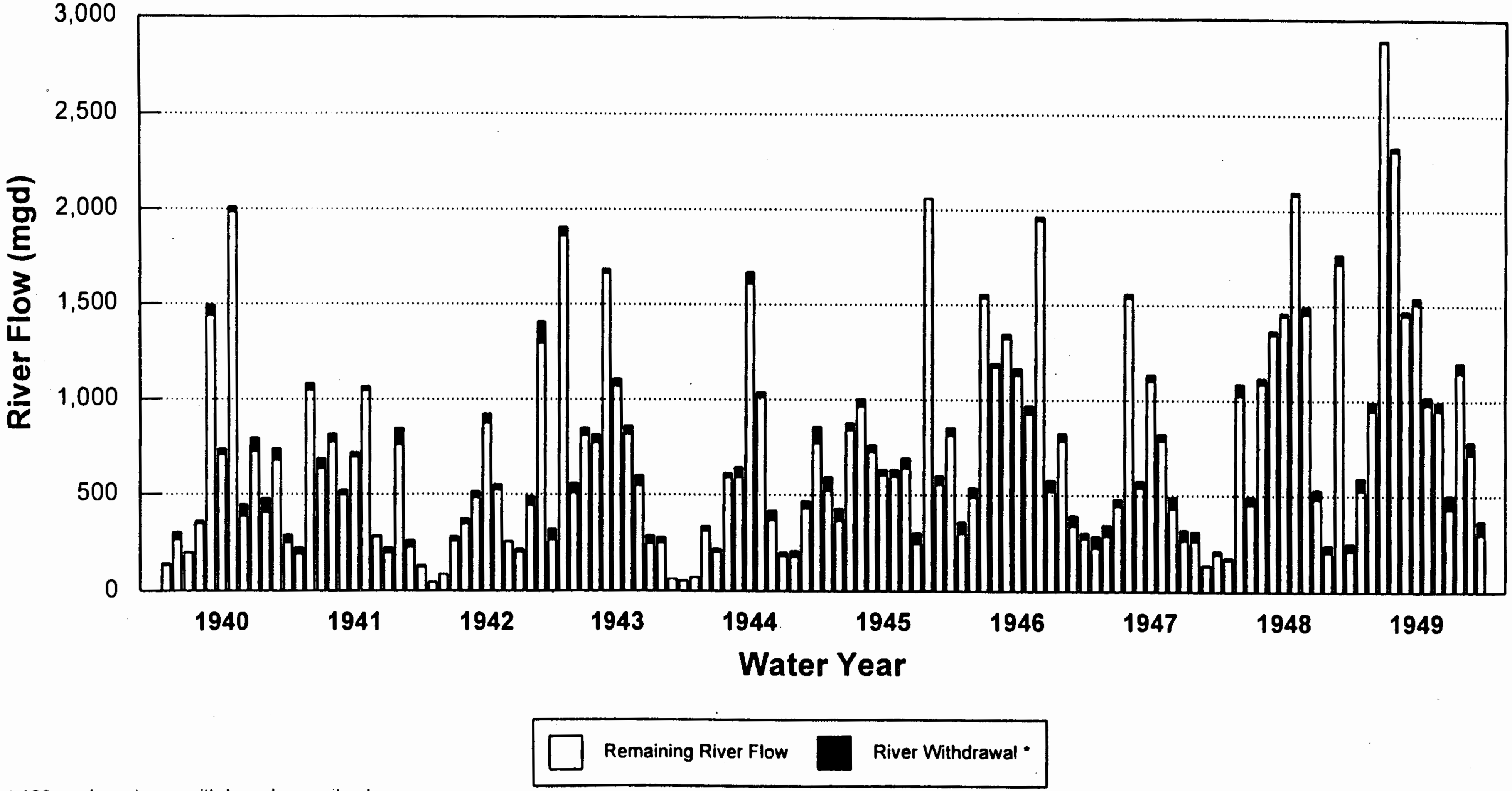
* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

Figure 5-2B

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS

Black Creek Reservoir Alternative

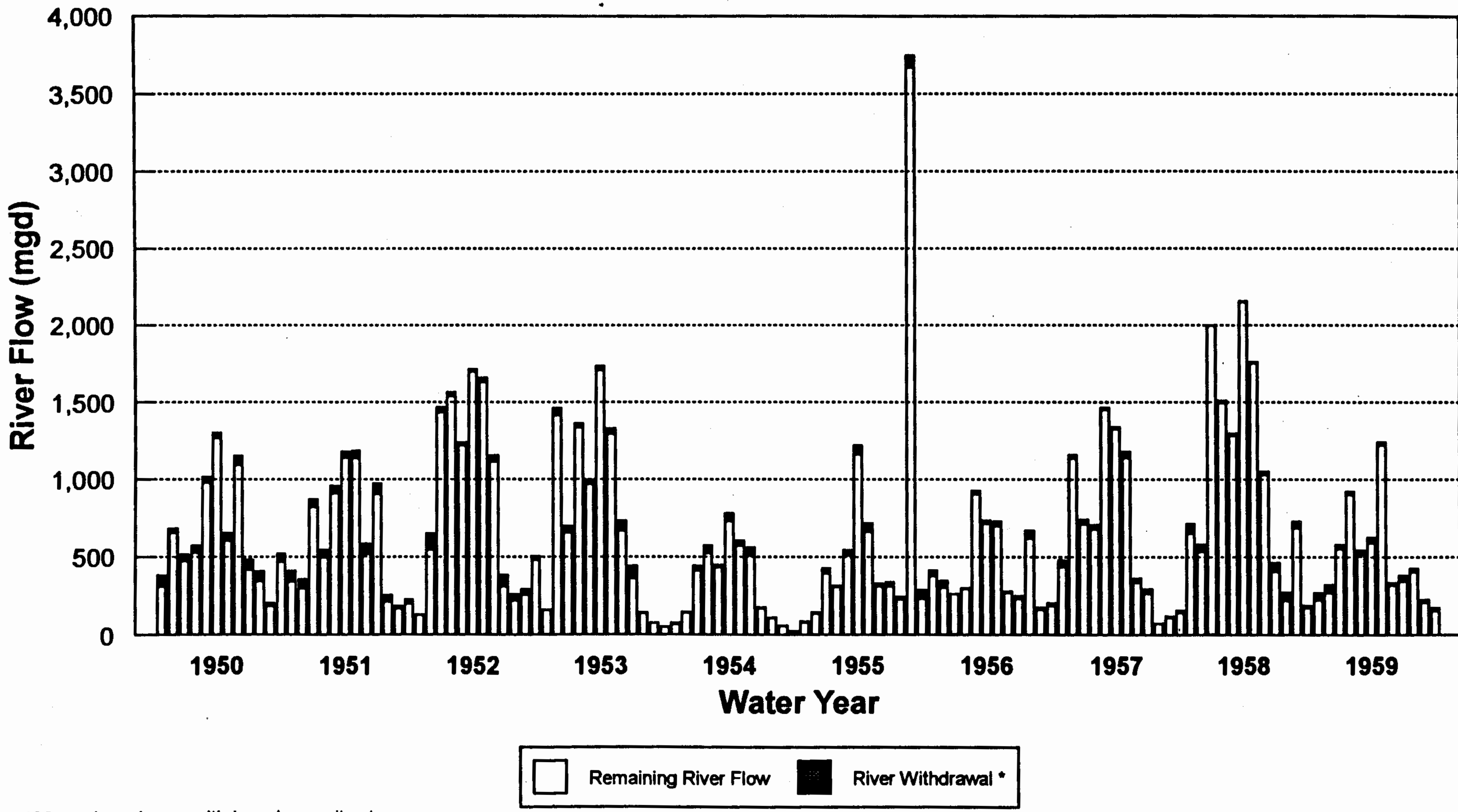
(OCTOBER 1939 - SEPTEMBER 1949)



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

Figure 5-2C

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS
Black Creek Reservoir Alternative
(OCTOBER 1949 - SEPTEMBER 1959)



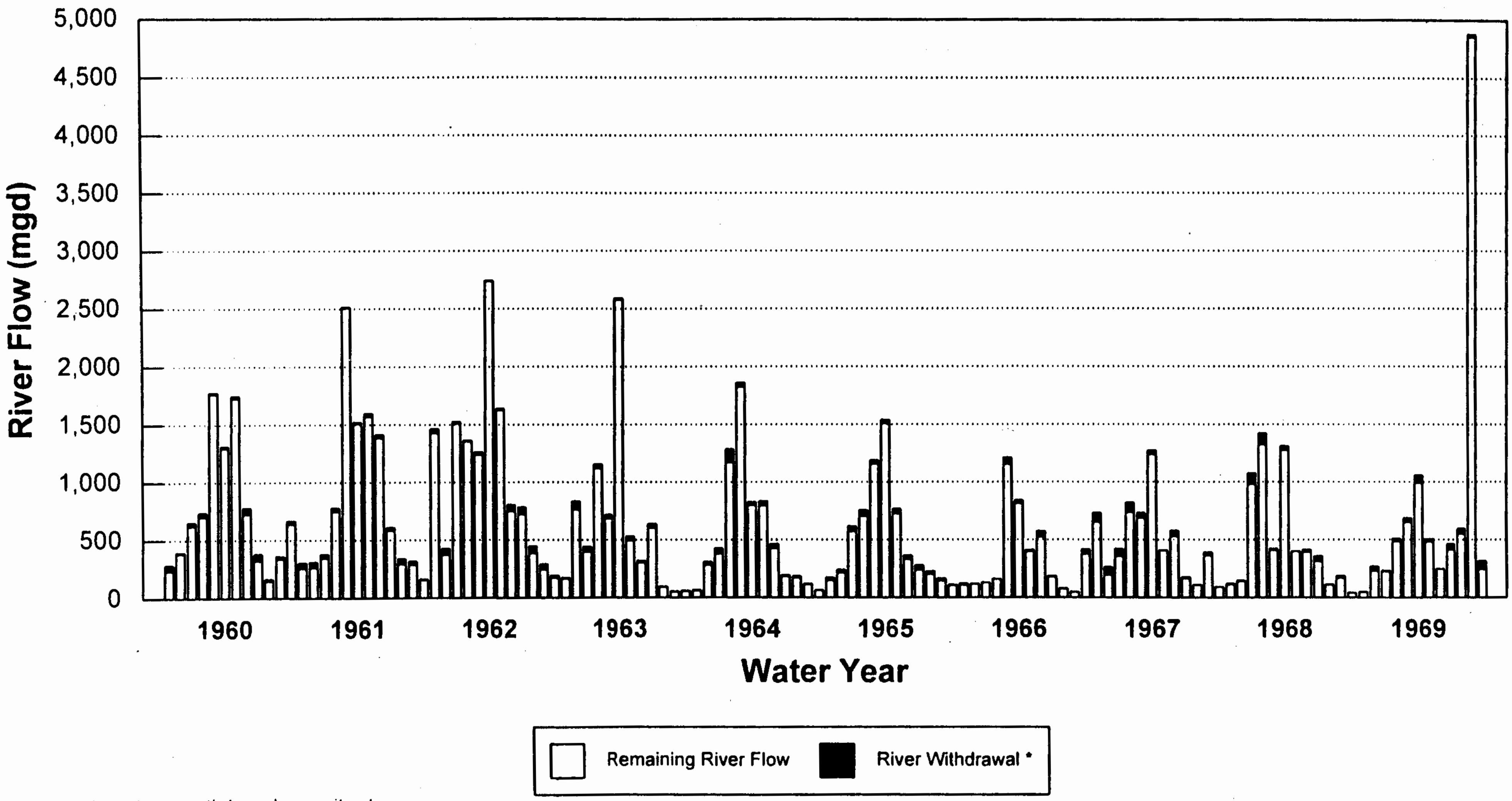
* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

Figure 5-2 D

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS

Black Creek Reservoir Alternative

(OCTOBER 1959 - SEPTEMBER 1969)



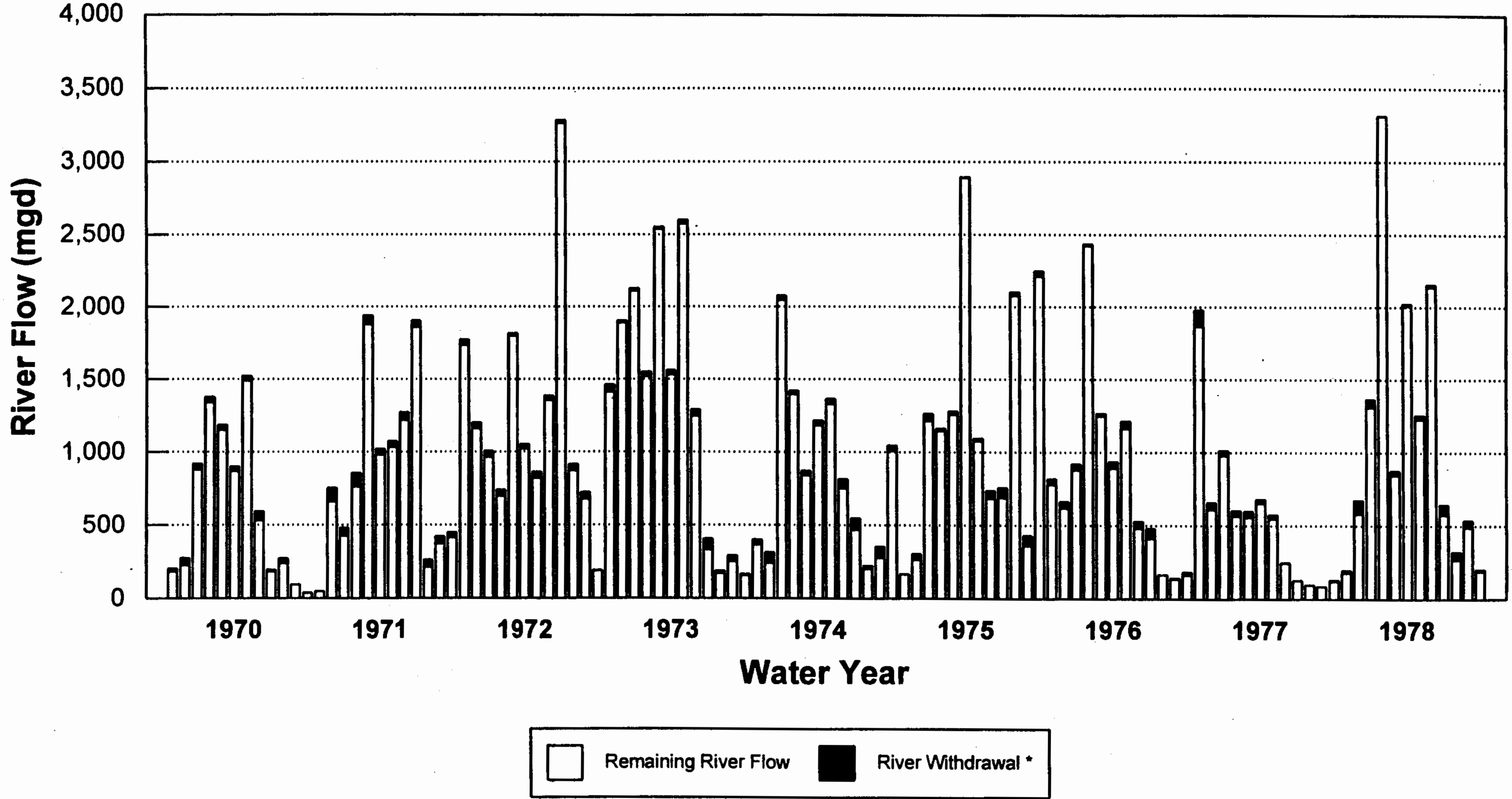
* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir

Figure 5-2E

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS

Black Creek Reservoir Alternative

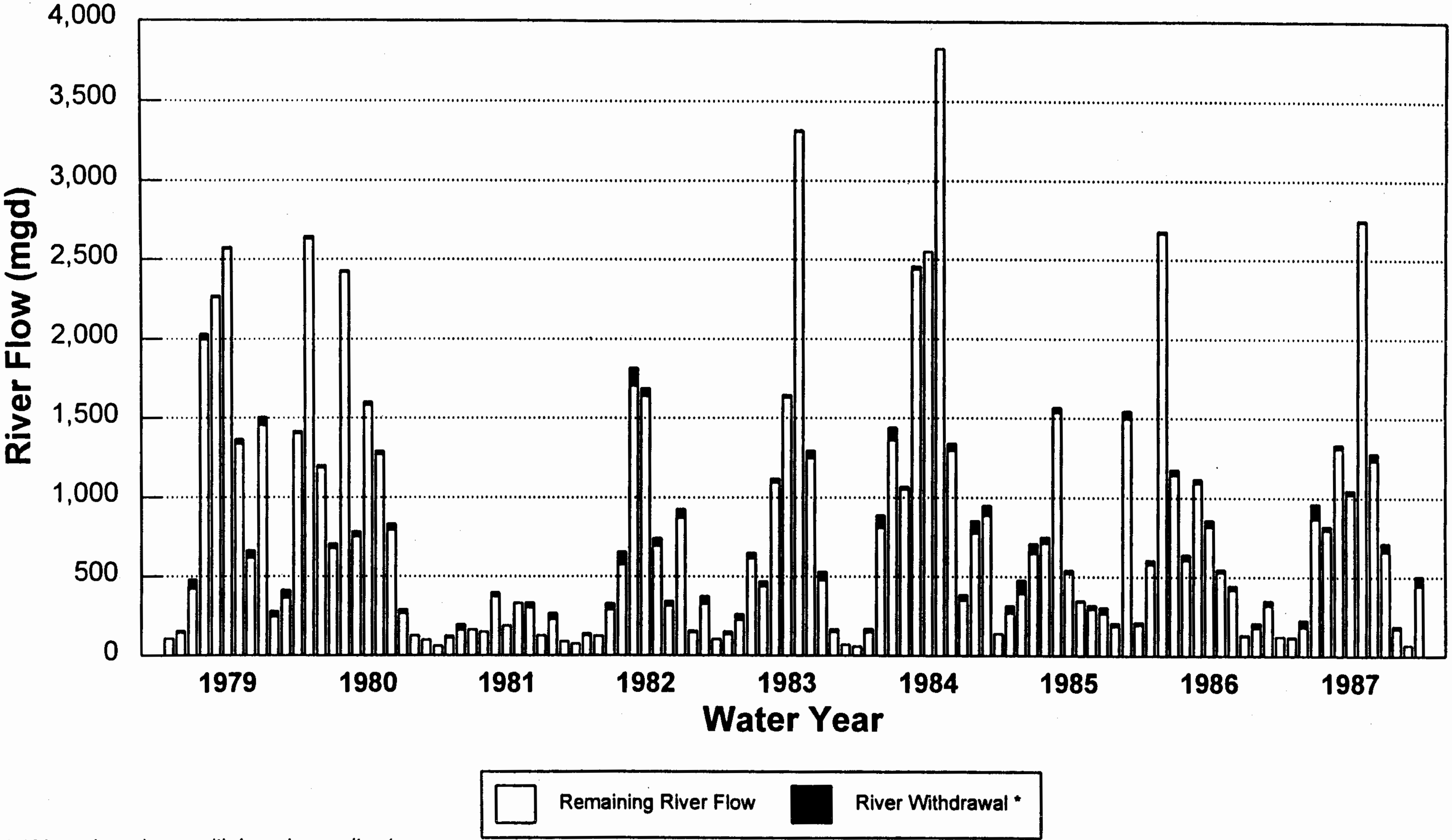
(OCTOBER 1969 - SEPTEMBER 1978)



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

Figure 5-2F

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS
Black Creek Reservoir Alternative
(OCTOBER 1978 - SEPTEMBER 1987)



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

Figure 5-2G

Table 5-1 and Figure 5-2H contain summaries of the simulated average withdrawals and flows past the intake site under pre- and post-withdrawal conditions over the entire simulation period (Water Years 1930-1987). The average simulated withdrawal was 33.3 mgd and represents a 4.4 percent decrease in the estimated average flow past the intake. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was an 8.6 percent reduction in mean flow for the month of June.

An analysis also was conducted of selected wet, average, and dry years to distinguish among the quantities that could be withdrawn under these ranges of flow conditions. Tables 5-2 through 5-4 and Figures 5-2I through 5-2K contain summaries of the simulated average withdrawals and flows past the intake site under pre- and post-withdrawal conditions for wet, average, and dry years.

Wet years were defined as 10 percent exceedance water years, which are the six wettest water years during the 58-year simulation period. The average simulated withdrawal was 36.9 mgd and represented a 3.0 percent decrease in the estimated average flow past the intake for those years. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 9.1 percent reduction in mean flow for the month of August.

Average years were defined as 45 to 55 percent exceedance water year, which are the six average water years during the 58-year simulation period. The average simulated withdrawal was 30.4 mgd and represented a 4.2 percent decrease in the estimated average flow past the intake for those years. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 13.3 percent reduction in mean flow for the month of June.

Dry years were defined as 90 percent exceedance water years, which are the six driest water years during the 58-year simulation period. The average simulated withdrawal was 19.3 mgd and represented a 5.6 percent decrease in the estimated average flow past the intake for those years. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 9.5 percent reduction in mean flow for the month of July. As Figure 5-2K shows, some withdrawals would occur during months in which the average baseline river flow was less than the monthly MIF value. The withdrawals are simulated on a daily basis. Streamflows usually exceed the MIF condition on some days during low flow months; therefore, withdrawals can be made on those days without violating the MIF requirement.

Table 5-5 shows when Pamunkey River flows would not meet nominal threshold levels (i.e., flow contravention analysis), under both pre- and post-withdrawal conditions. This table shows that the withdrawals would have little effect on streamflows under the proposed MIF conditions. The greatest percentage change from pre-withdrawal conditions would be a 4.2 percent increase in the number of months in which streamflows were less than or equal to the 50 Tennant flow level (i.e., 50 percent of mean historical flow). The small (3.3%) incremental increase in months when average streamflows would not meet stated threshold levels occurs in dry years when some daily withdrawals would be allowed even during low flow months (i.e., average monthly flow below monthly MIF value), but only on days on which the streamflow rises above the monthly MIF condition. These daily withdrawals during low flow months would not violate the proposed MIF.

The preceding discussion describes the potential individual impacts of a withdrawal from the Pamunkey River in the vicinity of Northbury. An analysis of the potential cumulative streamflow reductions in the entire Pamunkey River Basin was also conducted, which required the identification of additional withdrawals which could affect future streamflows in the Pamunkey River. Table 5-6 contains a summary of estimated cumulative streamflow reductions in relation to total Pamunkey

TABLE 5-1

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS (1)
BLACK CREEK RESERVOIR ALTERNATIVE

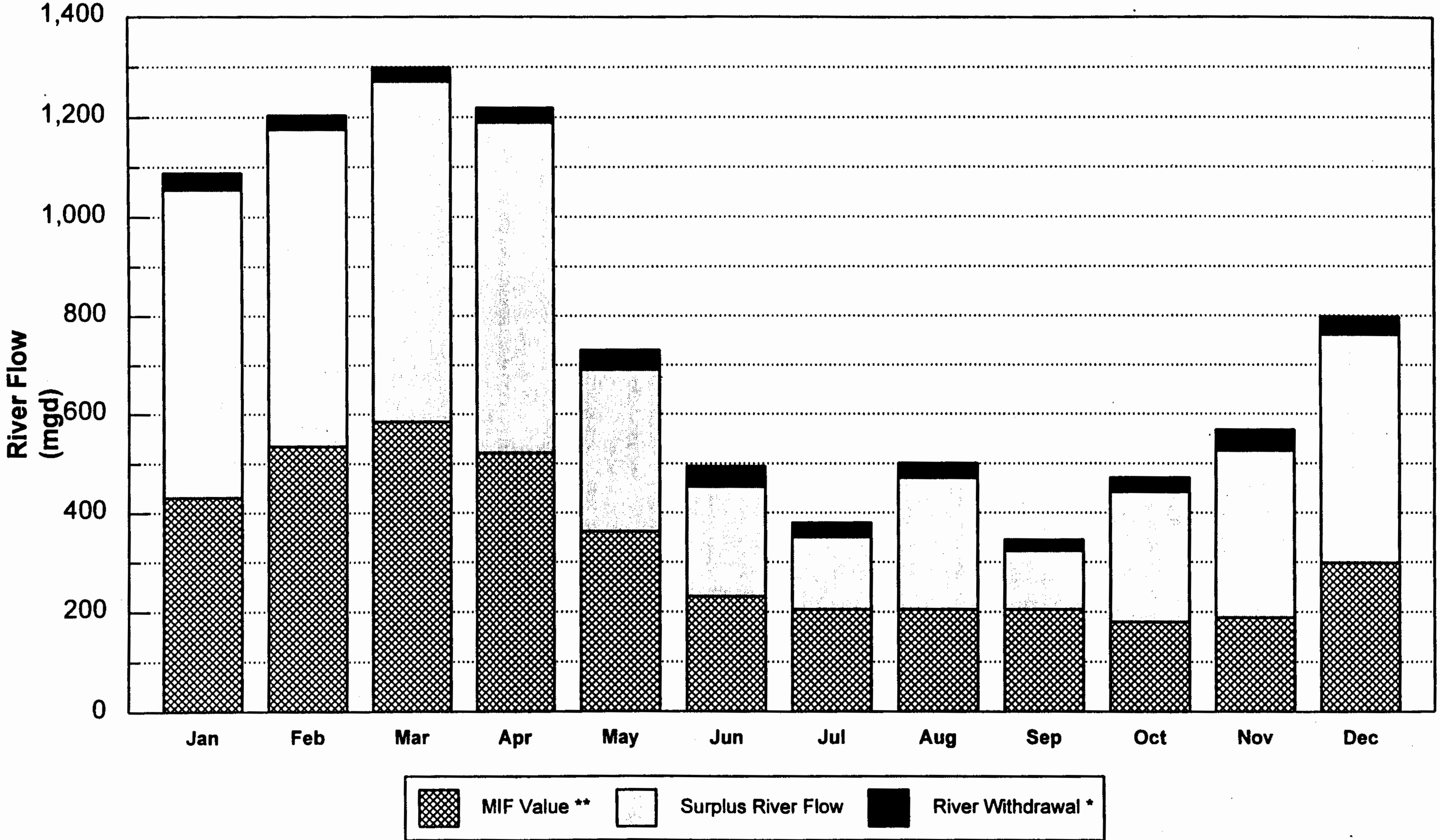
Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	1,089.1	34.6	3.2	1,054.5	430.8
Feb	1,204.3	28.8	2.4	1,175.5	534.9
Mar	1,299.4	28.3	2.2	1,271.1	584.5
Apr	1,218.7	29.1	2.4	1,189.6	521.6
May	730.9	40.7	5.6	690.2	361.7
Jun	495.3	42.8	8.6	452.5	231.0
Jul	380.9	30.4	8.0	350.5	205.0
Aug	501.0	30.6	6.1	470.4	205.0
Sep	345.8	23.5	6.8	322.3	205.0
Oct	472.0	29.9	6.3	442.1	180.0
Nov	568.5	42.9	7.5	525.6	188.4
Dec	799.5	37.9	4.7	761.6	299.3
Averages	**758.8**	**33.3**	**4.4**	**725.5**	**328.9**

(1) Analysis based on average monthly streamflow and withdrawal values over a 696–month simulation period (October 1929 through September 1987).

(2) 120 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Northbury to supply Black Creek Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated Black Creek Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value.

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS
Black Creek Reservoir Alternative



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.
** Modified 80% Monthly Exceedance Flows.

Figure 5-2H

TABLE 5–2

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS FOR WET YEARS (10% EXCEEDANCE WATER YEARS) (1) BLACK CREEK RESERVOIR ALTERNATIVE

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	1,695.1	22.2	1.3	1,672.9	430.8
Feb	1,742.6	21.6	1.2	1,721.0	534.9
Mar	1,937.4	19.7	1.0	1,917.7	584.5
Apr	1,777.7	26.8	1.5	1,751.0	521.6
May	1,316.9	39.9	3.0	1,277.0	361.7
Jun	996.5	58.0	5.8	938.4	231.0
Jul	929.7	46.1	5.0	883.7	205.0
Aug	618.6	56.4	9.1	562.2	205.0
Sep	553.2	23.2	4.2	530.0	205.0
Oct	727.0	33.0	4.5	694.0	180.0
Nov	994.2	53.7	5.4	940.5	188.4
Dec	1,682.4	42.2	2.5	1,640.3	299.3
Averages	**1,247.6**	**36.9**	**3.0**	**1,210.7**	**328.9**

(1) Analysis based on average monthly streamflow and withdrawal values for six wettest water years (1973, 1984, 1972, 1949, 1975, and 1978) out of a 58–year simulation period (Water Years 1930 through 1987).

(2) 120 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Northbury to supply Black Creek Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated Black Creek Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value.

TABLE 5–3

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS FOR AVERAGE YEARS (45–55% EXCEEDANCE WATER YEARS) (1) BLACK CREEK RESERVOIR ALTERNATIVE

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	785.8	30.7	3.9	755.1	430.8
Feb	1,144.8	26.0	2.3	1,118.8	534.9
Mar	1,205.9	34.5	2.9	1,171.4	584.5
Apr	896.0	38.8	4.3	857.2	521.6
May	480.4	38.1	7.9	442.3	361.7
Jun	305.2	40.6	13.3	264.6	231.0
Jul	223.3	21.0	9.4	202.3	205.0
Aug	762.9	24.1	3.2	738.7	205.0
Sep	135.6	15.1	11.2	120.5	205.0
Oct	852.3	27.7	3.3	824.6	180.0
Nov	1,197.6	29.7	2.5	1,167.9	188.4
Dec	745.4	38.5	5.2	706.8	299.3
Averages	**727.9**	**30.4**	**4.2**	**697.5**	**328.9**

(1) Analysis based on average monthly streamflow and withdrawal values for six average water years (1953, 1943, 1986, 1938, 1955, and 1957) out of a 58–year simulation period (Water Years 1930 through 1987).

(2) 120 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Northbury to supply Black Creek Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated Black Creek Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value. Some daily withdrawals would be allowed during low flow months (ie; average monthly flow below monthly MIF value), but only on days on which the streamflow rises above the monthly MIF value. Those daily withdrawals during low flow months would not violate the proposed MIF policy.

TABLE 5-4

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS FOR DRY YEARS (90% EXCEEDANCE WATER YEARS) (1) BLACK CREEK RESERVOIR ALTERNATIVE

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	362.7	18.5	5.1	344.2	430.8
Feb	607.9	22.3	3.7	585.6	534.9
Mar	742.0	27.4	3.7	714.6	584.5
Apr	536.2	24.5	4.6	511.7	521.6
May	617.9	45.9	7.4	572.0	361.7
Jun	213.5	12.4	5.8	201.1	231.0
Jul	251.7	23.9	9.5	227.8	205.0
Aug	134.1	10.9	8.1	123.2	205.0
Sep	145.1	12.1	8.3	133.1	205.0
Oct	134.4	12.4	9.2	122.0	180.0
2	154.9	14.6	9.4	140.3	188.4
Dec	211.5	6.9	3.3	204.6	299.3
Averages	**342.6**	**19.3**	**5.6**	**323.3**	**328.9**

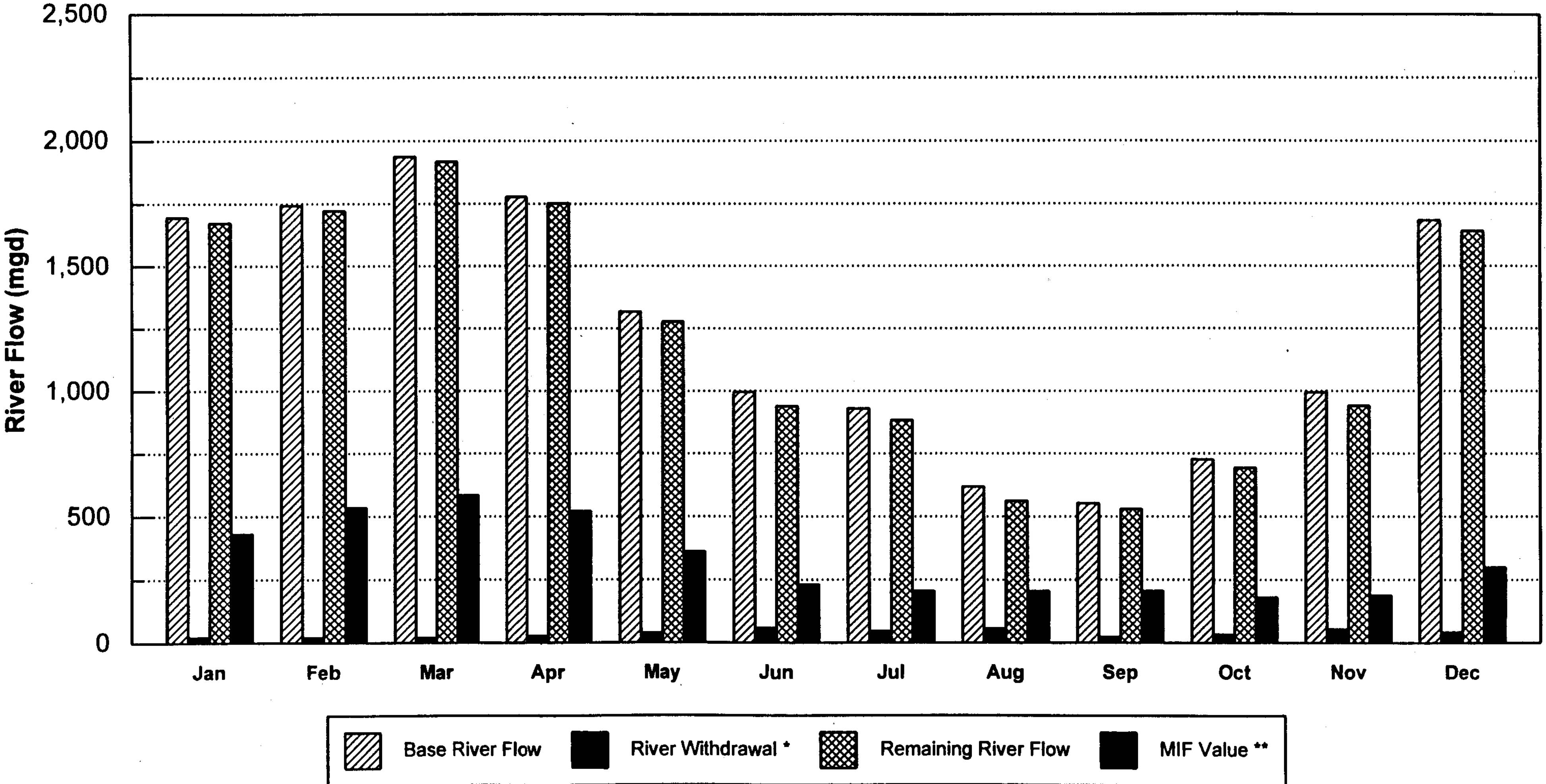
(1) Analysis based on average monthly streamflow and withdrawal values for six driest water years (1981, 1931, 1954, 1966, 1956, and 1932) out of a 58-year simulation period (Water Years 1930 through 1987).

(2) 120 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Northbury to supply Black Creek Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated Black Creek Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value. Some daily withdrawals would be allowed during low flow months (ie; average monthly flow below monthly MIF value), but only on days on which the streamflow rises above the monthly MIF value. Those daily withdrawals during low flow months would not violate the proposed MIF policy.

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS FOR WET YEARS (10% EXCEEDANCE WATER YEARS)

Black Creek Reservoir Alternative



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

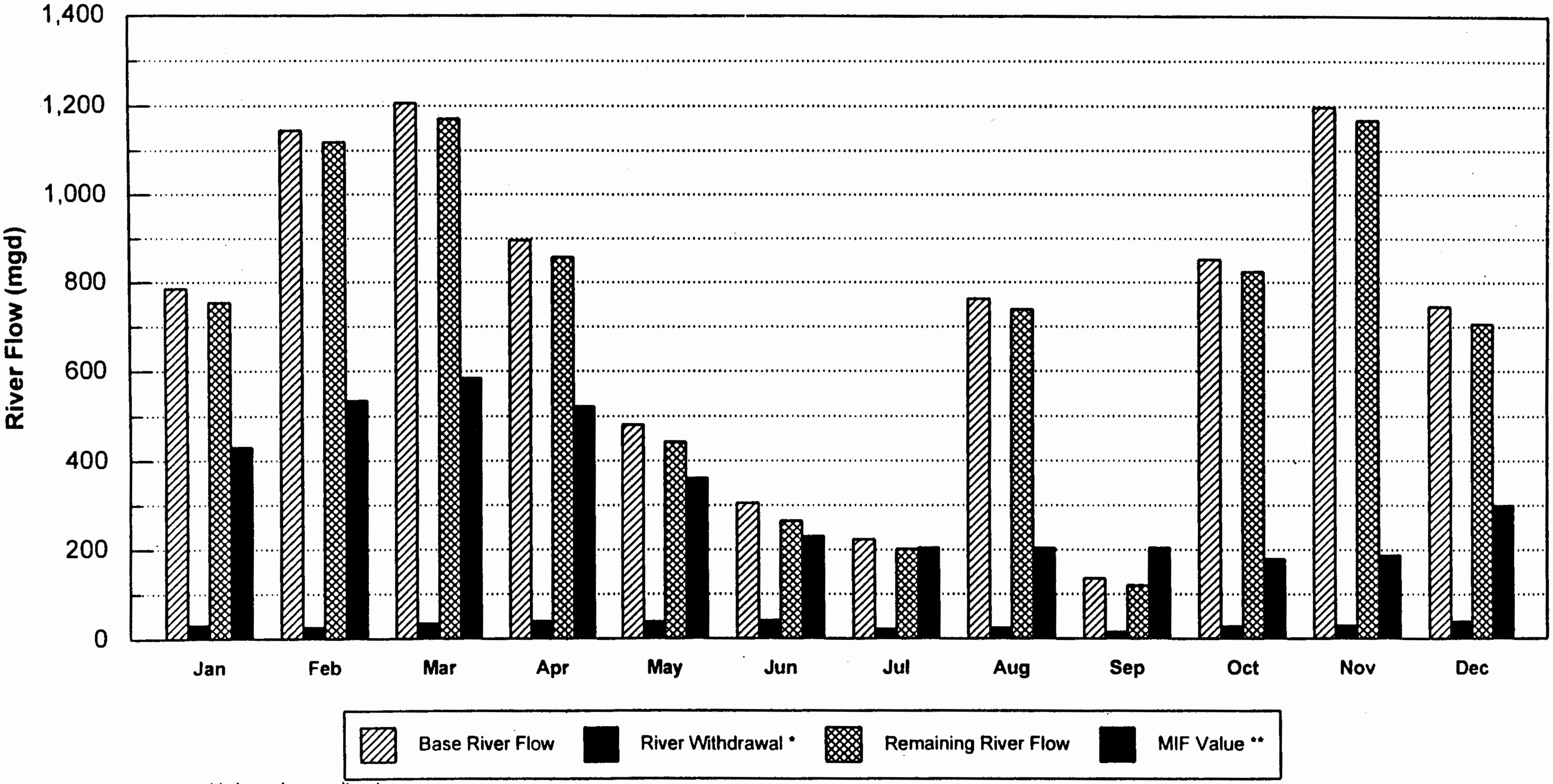
** Modified 80% Monthly Exceedance Flows.

Figure 5-2I

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS

For Average Years (45-55% Exc. Water Yrs.)

Black Creek Reservoir Alternative



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

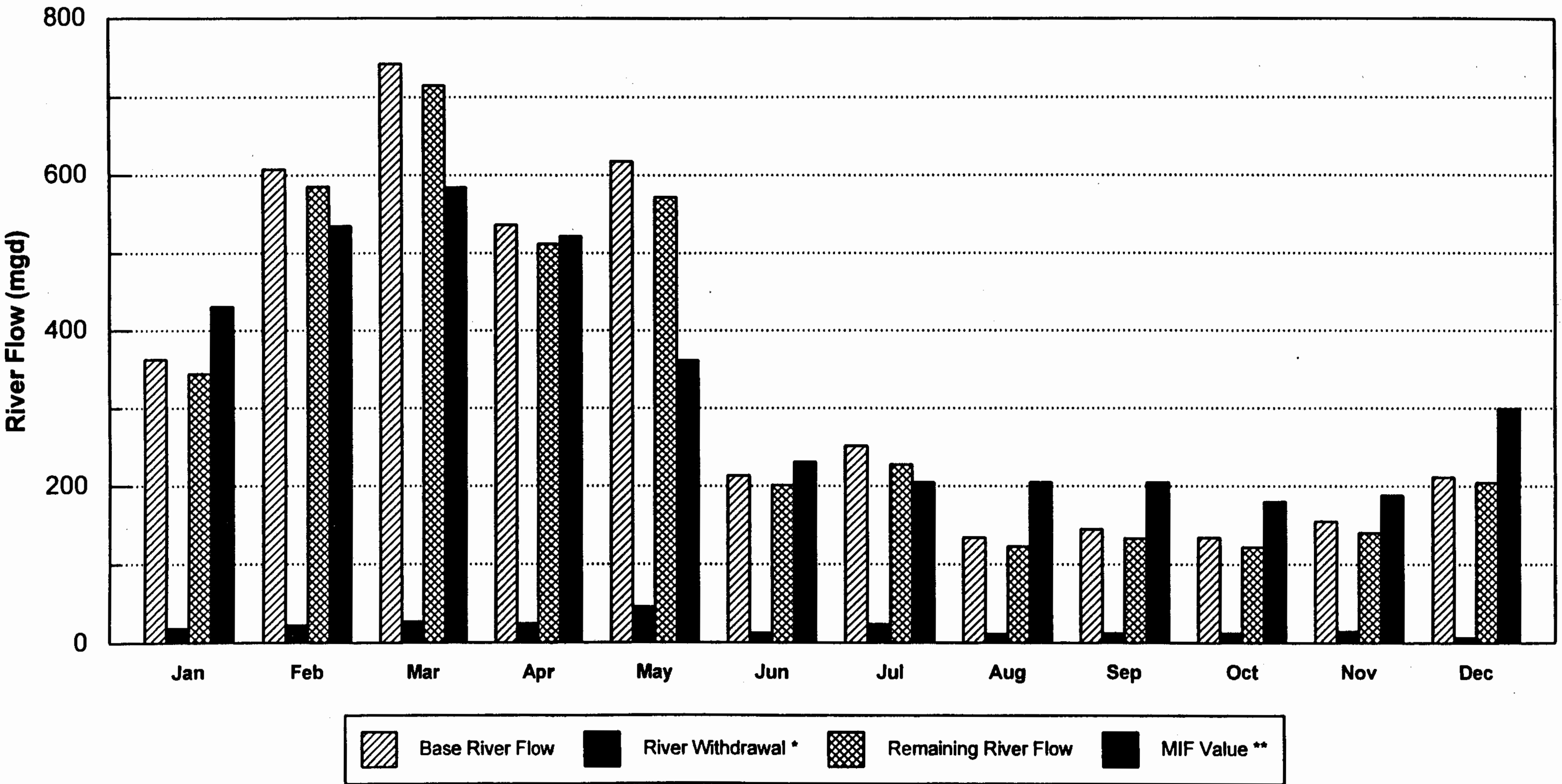
** Modified 80% Monthly Exceedance Flows.

Figure 5-2J

PAMUNKEY RIVER AVERAGE MONTHLY WITHDRAWALS

For Dry Years (90% Exceedance Water Years)

Black Creek Reservoir Alternative



* 120 mgd maximum withdrawal capacity at Northbury to supply Black Creek Reservoir.

** Modified 80% Monthly Exceedance Flows.

Figure 5-2K

TABLE 5-5

CONTRAVENTIONS OF SELECTED PAMUNKEY RIVER FLOW LEVELS
(IN PERCENTAGES OF TIME AT OR BELOW SPECIFIED FLOW LEVELS) (1)

Flow Levels	Contraventions of Flow Levels (% of time)		
	Baseline Streamflow Conditions	Post-Withdrawal (2) Streamflow Conditions	Incremental Increase
76.3 mgd (10 Tennant) (3)	4.7	4.7	0.0
152.6 mgd (20 Tennant) (3)	12.5	13.6	1.1
228.9 mgd (30 Tennant) (3)	22.3	25.4	3.1
305.2 mgd (40 Tennant) (3)	30.0	33.9	3.9
381.5 mgd (50 Tennant) (3)	37.2	41.4	4.2
Proposed MIF Policy (4)	24.9	28.2	3.3 (5)

(1) Analysis based on average monthly streamflow and withdrawal values over a 696-month simulation period (October 1929 through September 1987).

(2) 120 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Northbury to supply Black Creek Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated Black Creek Reservoir spillage for corresponding month.

(3) Tennant refers to a percentage of the mean historical streamflow. Mean historical streamflow at Northbury was estimated at 763 mgd based on the 52-year gaged streamflow record available for the Pamunkey River near Hanover (Water Years 1942-1993) which was adjusted to the 1,279 square mile contributing drainage area at Northbury.

(4) Modified 80% Monthly Exceedance Flows.

(5) Some daily withdrawals would be allowed during low flow months (ie; average monthly flow below monthly MIF value), but only on days on which the stream rises above the monthly MIF value. Those daily withrawals during low flow months would not violate the proposed MIF.

TABLE 5-6

PAMUNKEY RIVER CUMULATIVE STREAMFLOW REDUCTIONS FOR BLACK CREEK RESERVOIR ALTERNATIVE

Flow Condition	Estimated Flows (mgd)	Net Flow Reduction (mgd)	Percentage Change
Historical flows (1)	883.0	n/a	n/a
Year 1990 flows (2)	848.8	34.2	-3.9
Year 2030 flows without RRWSG project (3)	831.9	51.1	-5.9
Year 2040 flows with RRWSG project (4)	796.0	87.0	-9.9

(1) Mean historical freshwater discharge at the mouth of the Pamunkey River was estimated at 883.0 mgd based on a 53-year gaged streamflow record for the Pamunkey River near Hanover (Water Years 1942 through 1994) which was adjusted to the 1,460 square mile Pamunkey River Basin drainage area.

(2) Derivation of the Year 1990 consumptive use estimate for the Pamunkey River Basin is similar to that described in Section 4.5.1, except that estimated Virginia Power use has recently been refined.

(3) The 51.1 mgd Year 2030 consumptive use projection for the Pamunkey River Basin is based on the following consumptive use components:

- 5.0 mgd irrigation use. The SWCB (1988) projected Year 2030 irrigation demand of 8.2 mgd for the Pamunkey River Basin. The USGS (Solley et al., 1983) reported that 61% of irrigation withdrawals in Virginia are consumptive.

- 10.0 mgd remaining SWCB projected use. The SWCB (1988) projected Year 2030 demand of 25.6 mgd (excluding irrigation and power use) for the Pamunkey River Basin. The SWCB also developed an estimated Pamunkey Basin consumptive use factor of 0.44 based on consumptive use data published by Solley et al. (1983). Separating out irrigation use reduces the estimated Pamunkey Basin consumptive use factor to 0.39 for remaining demands.

- 10.8 mgd allowance for additional Hanover County/Richmond region use. Additional Pamunkey River withdrawals of up to 80 mgd are assumed for the Hanover County/Richmond region. Using pumping regime data presented by J. K. Timmons & Associates (1992), an average Pamunkey River withdrawal of 23.0 mgd was calculated for a 100 cfs (64.6 mgd) maximum withdrawal capacity. The ratio of 23.0/64.6 mgd was used to estimate a 28.5 mgd average Pamunkey River withdrawal for an 80 mgd maximum withdrawal capacity. An estimated overall consumptive use factor of 0.38 was applied to these demands. This assumes that 5 mgd of the demand would be by Henrico County and would be removed from the Pamunkey Basin. It is assumed that 75% of the remaining 23.5 mgd demand (in the James River Basin) is returned to the Pamunkey River as treated wastewater effluent.

- 1.2 mgd Diamond Energy use. This is a maximum consumptive use allowance for Diamond Energy's new cogeneration plant on the North Anna River (R. Barrows, Hanover County, personal communication, 1992).

- 24.1 mgd Virginia Power use. The derivation of this consumptive use estimate for Virginia Power's North Anna Nuclear Power Plant is described in Section 2.3.2 of the RRWSG's Pamunkey River Salinity Intrusion Impact Assessment (Malcolm Pirnie, 1995).

(4) The 87.0 mgd average Year 2040 flow reduction is based on a 33.3 mgd average Year 2040 Pamunkey River withdrawal with a 120 mgd pump station at Northbury, a 2.6 mgd average flow reduction at the Black Creek dam sites, and the 51.1 mgd projected Year 2030 flow reduction without a RRWSG project.

River flows through the Year 2040. It is projected that by the Year 2040, with all currently identified potential uses taken into account, the average Pamunkey River streamflow would be reduced by 9.9 percent. The basis for this basin-wide consumptive use projection is described in Table 5-6. (This projection includes the average 2.6 mgd reduction in flows from the Black Creek watershed to the Pamunkey River that would result from operation of the Black Creek Reservoirs.)

Water depth in the Pamunkey River would not be affected by this alternative, because the proposed intake is located in tidal waters.

Reservoir

Construction of dams on the Southern Branch Black Creek and the Eastern Branch of Black Creek would inundate 13.7 miles of free-flowing perennial and intermittent streams. Streamflows would be restricted to 32 percent of existing average flows. The net reduction in average combined freshwater discharge at the two proposed Black Creek dam sites would be 2.6 mgd.

Pipeline

The pipeline for this alternative would cross 34 stream/wetland areas. These minor crossings would be accomplished using conventional cut and fill techniques. It is possible that the pipeline would be constructed during the drier months of the year, at which time many of the intermittent streams may not be flowing. Flowing streams could be temporarily diverted with cofferdams, which would be removed following pipeline construction. Any impacts to the hydrology of those streams would be temporary and minimal.

The pipeline would also cross an arm of the Little Creek Reservoir using either conventional cut and fill techniques, directional drilling techniques, or an elevated crossing.

As part of this alternative, Diascund Creek would be used as an inter-reservoir conveyance channel. The proposed outfall on Diascund Creek has the potential to create physical, chemical, and biological changes in the creek. With a maximum raw water discharge capacity of 40 mgd, this outfall could cause greater meandering of the stream channel and increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels, higher nutrient flushing rates, and greater saturation of the floodplain wetlands through recharge.

Potential impacts to Diascund Creek through channel scouring and increased sediment loading are discussed below.

Much of the water reaching Diascund Creek from the Pamunkey River would first be routed through the Black Creek Reservoirs. (The project configuration would also allow water to be moved from the Pamunkey River to Diascund Creek Reservoir without going through Black Creek Reservoir.) Maximum Black Creek Reservoir withdrawals pumped to Diascund Creek (about 40 mgd) would be much less than maximum Pamunkey River withdrawals (120 mgd). In addition, Black Creek Reservoir withdrawals would be much less variable than Pamunkey River withdrawals which would be subject to the high natural variability of River flows. This flow attenuation would reduce the intensity of changes in hydrologic regime in Diascund Creek.

The outfall to Diascund Creek would be a standard U.S. Bureau of Reclamation impact type structure, designed for a maximum discharge capacity of 40 mgd. A discharge channel would connect the outfall to the main Diascund Creek channel. The outfall would be designed to dissipate most of the energy associated with the high velocity incoming flow of water before it reaches the stream channel.

After reaching Diascund Creek at elevation 60 feet msl, the reduced velocity flow would travel 5.7 miles downstream to the open waters of the Diascund Creek Reservoir at elevation 26 feet msl. The average water surface slope along this path is only 0.11 percent. This very gradual slope would minimize potential erosional effects from the increased flow level in Diascund Creek.

Based on the field measurements and flow calculations described in Section 4.2.1, the channel at the proposed Diascund Creek Outfall Site 1 should be capable of accommodating an estimated maximum flow of at least 53 mgd without overtopping its banks. (Pamunkey River pumpover to Black Creek Reservoir could be up to 120 mgd, but not more than about 40 mgd to Diascund Creek.) When reservoirs are near capacity and natural high flow events occur, pumpovers from the Black Creek Reservoirs to the Diascund Creek Reservoir would be unnecessary. Therefore, pumpover operations should not increase the frequency at which the banks of Diascund Creek are overtopped by high flow events.

If erosional problems develop in some portion of Diascund Creek, additional control measures such as check dams or natural deadfall timbers could be placed at strategic locations in the creek channel to dissipate flow velocities and reduce potential bank undercutting.

Groundwater Resources

A discussion of the potential impacts to groundwater resources related to operation of a similar freshwater river intake is presented in Section 5.2.3.

A maximum increase in the water table elevation of 40 feet is predicted in those areas directly adjacent to the reservoir. This would result in increased horizontal flow velocity and an increase in the number of seeps and springs in adjacent watersheds.

During construction and operation of the reservoir, the Yorktown Aquifer would be afforded recharge by direct seepage from the reservoir. Black Creek Reservoir seepage losses were estimated at 2 mgd.

Implementation of a drinking water reservoir alternative would directly (via recharge) and indirectly (via alternative supply) benefit the groundwater resources of the region.

In general, construction activities related to the reservoir and dam should have little effect on groundwater quality and quantity within the watershed.

Soil and Mineral Resources

Potential effects to soils due to construction of a raw water intake facility at the Northbury site on the Pamunkey River are discussed in Section 5.2.1.

Filling the proposed Black Creek Reservoir would result in the inundation of approximately 1,146 acres of land. However, open water and perennial streams already inundate an estimated 21 acres of this area. Therefore, 1,125 acres of soil would be inundated by the reservoir. Prime agricultural soils account for 17 of the 1,146 acres. However, adverse effects due to the inundation of these soils and dam construction would be minimal since steep side slopes and lowland flooding presently make the majority of these soils unsuitable for farming.

Construction of four reservoir outfall structures would disturb a combined total of 10,500 square feet of soil. In addition, the construction of a pump station on the eastern branch of the proposed reservoir would disturb approximately 4 acres of soil. After construction, the two dams, emergency spillways, access roads, and associated structures would cover a combined total area of 48.5 acres.

Effects to soil due to the construction of the raw water pipelines associated with this alternative would be minimal. After construction, the disturbed soils would be restored to a more natural state. A total of 119 acres of soils within the pipeline ROW would be temporarily disturbed.

Air Quality

Only a small portion of this alternative falls within the boundaries of an ozone non-attainment area. Based on the preliminary layout, none of the air emissions resulting from this operation occur in the non-attainment area and therefore would not affect ambient ozone air quality levels.

During the construction phase of the project, it is likely that burning of some cleared unusable vegetation would be conducted on site. Due to the short-term nature of this activity, only a minimal effect on air quality would be expected. In addition, it is expected that clearing, excavation and construction activities would produce fugitive dust emissions in and around the site.

Fuel burning emissions from the use of construction equipment would be released during construction activities. A minimal effect on air quality would be expected due to the small amount of emissions relative to other sources of air pollution in the region and since these activities would be temporary.

5.2.3 King William Reservoir with Pumpover from Mattaponi River

Four dam configurations are being presented with the King William Reservoir with pumpover from the Mattaponi River alternative: KWR I, KWR II, KWR III, and KWR IV. The intake site and the majority of the pipeline route for all four dam configurations are the same; only the dam location and reservoir pool elevation vary. The normal pool elevation for the KWR I project configuration is 90 feet msl, and the normal pool elevation for all other project configurations is 96 feet msl. Unless otherwise specified, physical resources are the same for all dam configurations of the King William Reservoir alternative. The river water pipeline between the river pumping station and the reservoir, and the portion of the pipeline route from the directional drill under the Pamunkey River to Diascund Reservoir, then from Diascund Reservoir to Little Creek Reservoir, remains as proposed in the DEIS for all configurations. The entire pipeline for KWR I remains a gravity pipeline with the route as proposed in the DEIS.

The KWR II, III, and IV configurations will include pumped pipelines with new portions of pipeline routes identified from each proposed pump station to the Pamunkey River directional drill location. In addition, the outfall location into Diascund Reservoir for KWR II, III, and IV has been extended downstream of that proposed in the DEIS for KWR I.

<u>Substrate</u>

The King William Reservoir alternative would impact, at a minimum, an estimated 1.7, 3.2, 3.1, and 3.2 acres of aquatic ecosystem substrate for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively. Approximately 0.16 acres of substrate would be disturbed at the Scotland Landing intake site for all configurations; 1.5, 3.0, 2.9, and 3.0 acres of substrate would be disturbed as a result of pipeline construction for each respective configuration; and 0.05 acres of substrate would be disturbed, removed, or permanently covered by construction of outfall structures for all configurations. An additional 0.6 acres of substrate could be disturbed if conventional cut and fill techniques are used for the Little Creek Reservoir crossing. The majority of the impacts would be temporary.

In addition, filling the proposed reservoir area to 90 feet msl for the KWR I configuration, and 96 feet msl for the remainder of configurations, would result in the inundation of approximately 2,234, 2,222, 1,894, and 1,587 acres, of which 106, 98, 93, and 88 acres are currently open water and perennial stream areas containing substrate for the KWR I, KWR II, KWR III, and KWR IV, respectively. Because substrates in these areas are presently inundated, adverse effects from further inundation of these perennially wet areas are considered minimal.

<u>Water Quality</u>

Surface waters involved in this alternative are the Mattaponi River (new intake source), Cohoke Creek (location of new reservoir), the Diascund Creek and Little Creek Reservoirs (existing impoundments), and the Pamunkey River and 65, 60, 58, and 60 stream/wetland crossings for the KWR-I, KWR-II, KWR-III, and KWR-IV configurations (pipeline).

Intake

As with the Pamunkey River, the water quality characteristic of the Mattaponi River which is of greatest concern relative to the proposed withdrawal is salinity. An analysis was conducted by the VIMS to estimate the impacts of the proposed withdrawal on salinity concentrations in the Mattaponi River (see Report J, ***Tidal Wetlands on the Mattaponi River: Potential Responses of the Vegetative Community to Increased Salinity as a Result of Freshwater Withdrawal*** (Hershner et al., 1991) which is incorporated herein by reference and is an appendix to this document). The VIMS salinity model is based on the assumption that the Mattaponi River is completely mixed from top to bottom and side to side. Therefore, the salinity value predicted for each transect represents an average of the salinity levels across the river's cross-section. Salinity has been reported to increase with depth along the lower 19.6 miles of the Mattaponi River (***Mattaponi River Slack Water Data Report - Temperature, Salinity, Dissolved Oxygen 1970-1978*** (Brooks, 1983). The average salinity levels used in the model will tend to slightly overestimate near surface salinity levels. Model predictions are, therefore, considered conservative because the aquatic species that are the most sensitive to salinity variation (i.e., plants) persist in the surface waters.

Natural Mattaponi River salinity fluctuations greatly exceed any salinity changes that are predicted due to the proposed withdrawals. The VIMS salinity modeling results demonstrate that the RRWSG's withdrawals, and other existing and reasonably foreseeable consumptive Mattaponi River Basin water uses, would not affect the upstream limits of detectable salinity intrusion. The proposed withdrawals, in combination with other existing and reasonably foreseeable consumptive Mattaponi River Basin water uses, would, however, cause small increases in the frequency of given levels of salinity intrusion at points which already are periodically exposed to comparable salinity levels. The magnitude of predicted salinity change is far smaller in the Mattaponi Basin than in the Pamunkey Basin (as evaluated for Black Creek Reservoir) owing to much less intensive use of Mattaponi Basin waters.

From a drinking water treatment perspective, a concern associated with Mattaponi River water quality is possible intrusion of salinity, with its associated concentrations of chlorides and sodium, as far upstream as the proposed intake site at Scotland Landing. This can occur under natural conditions, regardless of any proposed withdrawals. Based on review of available Mattaponi River salinity data, and based on the proposed MIF which precludes withdrawals during low flow conditions, Mattaponi River withdrawals would be avoided or prevented during periods of detectable salinity near the intake.

Reservoir

Long-term water quality changes to Cohoke Creek would occur from filling the impoundment area of the proposed reservoir with water from the Mattaponi River. Surface water quality records are not available for the Cohoke Creek watershed. As presented in the DEIS, water quality data for Crump Creek and Matadequin Creek were used as surrogates for Cohoke Creek water quality conditions because all three creeks have similar drainage areas, topography, and land use within their watersheds.

Using these surrogate data, it was found that the most notable differences in water quality between Crump Creek, Matadequin Creek, and the Mattaponi River are the concentrations of phosphorus and chlorides, which are higher in the Mattaponi River. Mean total phosphorus levels at Scotland Landing and Crump Creek area 0.11 and 0.07 mg/L, respectively. Mean chloride levels at Scotland Landing and Crump Creek are 22 and 9 mg/L, respectively. It is likely that the discharge of water from the Mattaponi River into the King William Reservoir would result in increases in phosphorus concentrations in the Reservoir to levels higher than those that would occur if there were no pumpover. Chloride levels in the reservoir would probably not be as greatly affected since Mattapponi River withdrawals would be avoided or prevented when River chloride levels are elevated at the intake (i.e., during low flow periods).

The most notable change at the proposed reservoir site would result from increasing the depth of the surface water to a maximum of approximately 82, 82, 73 and 68 feet for KWR-I, KWR-II, KWR-III, and KWR-IV, respectively. With this depth, stratification would be expected to occur, principally in the summer months, with possible anoxic conditions and low temperatures in the hypolimnion. Downstream water quality problems would be expected if water were released only from the bottom of the reservoir, resulting from the temperature variations, the low dissolved oxygen, and nutrient enriched water. Mitigative measures such as multi-level releases could be used to regulate the quality of the water released from the reservoir.

The normal reservoir releases, which would average 3 mgd and 2 mgd, respectively, for the KWR-II and KWR-IV configurations, represent one-third or more of the estimated average flow at the dam sites. Long-term water quality characteristics of Cohoke Creek downstream of the dam are not expected to be adversely impacted by the net reduction in volumes of flow below the impoundment. Particulate settling processes during reservoir retention of Mattaponi River withdrawals would substantially reduce concentrations of particulate-borne phosphorus in the water column, thereby reducing potential nutrient loading impacts below the dam from reservoir releases.

Short-term water quality impacts to Cohoke Creek and Cohoke Millpond could occur during dam and outfall construction, and from clearing associated with preparation for filling the reservoir. Such impacts would consist largely of increased turbidity as a result of increased erosion in cleared areas. Efforts would be made to control such erosion at the source. Additionally, as the reservoir begins filling, concentrations of nutrients can be expected to temporarily rise from decomposition of leaf litter, stumps, and other organic material left after clearing.

There is minimal existing and planned development within the Cohoke Creek watershed. However, there are some concerns regarding groundwater quality and surface water runoff quality because the King William County Landfill is located within the reservoir drainage area. The 85-acre landfill is located above the revised normal pool elevation, along the south side of State Route 30 near the intersection of State Routes 30 and 640.

It was determined several years ago that, once closed, the landfill would not pose an unmanageable threat to water quality in the proposed reservoir. Since that time, the landfill has been closed; however, the proposed reservoir pool elevation has been raised from 90 to 96 feet msl. Potential water quality problems, plans for monitoring of potential reservoir contamination, and contingency plans for isolating the landfill from the reservoir in the event of a contaminant release have been reevaluated in light of these changed conditions.

Municipal solid waste (MSW) was deposited in the King William County Landfill from 1988 to 1994. In addition, Chesapeake Corporation disposed of a small quantity of pulp waste in the landfill. This type of waste is not known to pose any greater threat to the public health and environment than MSW.

The landfill consists of three waste disposal cells designated Al, A2, and A3. The disposal cells were operated as trench and area fills with waste disposed below and above grade within the limits of each cell. The bottom liner configuration varies among the cells. The Cell Al and A3 liner systems consist of 2 feet of clay with a specified permeability of 1×10^{-7} cm/sec, overlain by a 1-foot thick layer of sand. The Cell A2 liner consists of a single 60-mil thickness high density polyethylene (HDPE) flexible membrane. The landfill base extends to about elevation 113 feet msl, approximately 7 to 10 feet below existing grade, and varies between disposal cells. Disposal cells appear to be located within an upper sand unit underlying the surficial silty clay soils. Leachate is collected via gravity in each of the disposal cells and temporarily stored on-site in two 4-foot diameter buried manholes which provide a total storage capacity of 1,500 gallons. The collected leachate is trucked to a wastewater treatment plant for disposal.

Closure construction began in the spring of 1994 and was completed in April 1995. As part of the closure, a final cap system was placed over the entire limits of the waste disposal area. The final grade is provided with vegetative cover to minimize erosion and infiltration. The final cap system should effectively limit surface water infiltration and minimize leachate generation through the post-closure period.

The groundwater table aquifer is contained within the upper sand unit underlying the surficial silty clay soils, approximately between elevations 104 and 108 feet msl, and flows in a southwesterly direction toward Cohoke Creek. Therefore, any leachate leaving the landfill site would flow toward the reservoir. However, the quantities of such leachate would likely be small, due to the small size of the existing landfill cells.

Evaluation of existing groundwater quality data for the period December 1989 to September 1994 is inconclusive. There appears to be some variability in pH and specific conductivity, which may be attributable either to the presence of leachate in the groundwater or to natural variability. To monitor for potential reservoir contamination, two additional downgradient monitoring wells could be installed between the approximate limits of waste deposit and the nearest reach of the reservoir normal pool area. Well screens for the monitoring wells would be located within the upper sand unit which comprises the major groundwater source in the water table aquifer. These new monitoring wells would be added to the existing groundwater monitoring well network and monitored in accordance with regularly scheduled monitoring events. Monitoring of both inorganic and organic constituents in the groundwater would be useful in examining potential reservoir water quality impacts.

Several alternatives exist for corrective action in the event of a release of leachate constituents from the landfill and confirmed impacts on water quality. Corrective action, if necessary, would only be selected after thorough consideration of existing site conditions, State requirements, engineering feasibility, and costs. Corrective action alternatives are as follows:

(1) Isolation: Contaminated groundwater movement toward the reservoir could be minimized by construction of a perimeter slurry wall around the limits of the waste deposits, extending from the ground surface through the water table aquifer, and keying the bottom of the wall into the low permeability confining layer present at about 30-foot depth. The slurry wall would be constructed with a low permeability soil-bentonite backfill with a permeability not exceeding 1×10^{-7} cm/sec. The wall would effectively isolate buried waste materials from the water table aquifer.

Potential leachate migration to the reservoir from deeper aquifers is not expected to occur since only a small fraction of groundwater in the water table aquifer would reach deeper aquifers through vertical leakage. Furthermore, available soil boring data indicate that deeper aquifers (i.e., below the water table aquifer) would not be major contributors of groundwater discharge to the reservoir.

(2) Source Removal: Existing waste materials could be exhumed and disposed off-site at another MSW landfill.

(3) Mitigation: Water quality impacts resulting from any release of leachate constituents could be mitigated by installation of a series of groundwater recovery wells located down-gradient of the limits of the waste deposits. Groundwater recovered from the wells would require pre-treatment prior to discharge, or it might possibly be trucked off-site to a wastewater treatment plant.

Impacts from the proposed transfer of water from King William Reservoir to Diascund Creek Reservoir are expected to be similar to the impacts that would result from the corresponding pumpover from the Black Creek Reservoirs. Phosphorus concentrations in the Mattaponi River appear higher than in the Pamunkey River; however, all of the water reaching Diascund Creek

Reservoir from the Mattaponi River would first be routed through King William Reservoir. This is unlike the Black Creek Reservoir Project, which would allow Pamunkey River water to be pumped directly to the headwaters of the Diascund Creek Reservoir.

A high degree of particulate settling would occur within the King William Reservoir, owing to its very large volume and depth. The King William Reservoir volume would be more than three times that of Black Creek Reservoir and would provide a much longer hydraulic retention time for incoming river water. The result would be a substantial reduction in concentrations of particulate-borne constituents, such as phosphorus, in the water column, before the water is transferred on to Diascund Creek Reservoir and the rest of the existing Newport News Waterworks raw water supply system. If suspended solids levels in the Mattaponi River occasionally reach unacceptably high levels, the river pump station operators would have the option of discontinuing withdrawals until water quality improves. Given these offsetting factors, average nutrient levels in raw water reaching Diascund Creek Reservoir from King William Reservoir would likely be similar to those in raw water reaching Diascund Creek Reservoir from the proposed Black Creek Reservoirs.

Since raw water can be transferred from Diascund Creek Reservoir to Little Creek Reservoir, water quality can also be affected there, but to a lesser extent. Nutrients would be attenuated in Diascund Creek Reservoir and not all water would be routed through Little Creek Reservoir.

Malcolm Pirnie conducted additional water quality analyses on Mattaponi River water samples in October 1994 and found slightly higher concentrations of organic compounds than in existing raw water sources in the Newport News Waterworks system and in Pamunkey River samples taken during the same time period. The addition of Mattaponi River water, with these slightly higher organic concentrations, is not expected to cause unmanageable water quality problems in Newport News Waterworks reservoirs. However, the treatment process would have to be adjusted to accommodate these generally elevated levels of organic compounds in the raw water supply.

Pipeline

Impacts to the 65, 60, 58 and 60 stream/wetland crossings for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively, along the proposed pipeline routes would be limited to the period of construction. It is also possible that the pipelines would be constructed during the drier months of the year, at which time many of the intermittent streams may not be flowing. The Little Creek Reservoir crossing would be accomplished using conventional cut and fill techniques, directional drilling techniques, or an elevated crossing. Regardless of the crossing technique, appropriate environmental controls would be used. Any impacts on the water quality of these water bodies would be temporary and minimal. The pipeline crossing of the Pamunkey River would be completed using directional drilling techniques. Therefore, no impact on Pamunkey River water quality should occur.

<u>Hydrology</u>

Intake

The potential hydrologic impacts of a maximum 75 mgd withdrawal from the Mattaponi River at Scotland Landing were evaluated under projected Year 2040 demand conditions. The Year 2040 represents the end of the project planning horizon, and presumably the year in which withdrawals would be greatest. Hydrologic impacts in earlier years would be smaller.

From safe yield analyses, data are available on the quantities of water which must be withdrawn to meet the project's yield requirements through the planning period. To evaluate the effects of those withdrawals, it was necessary to examine a 58-year record of streamflow on the Mattaponi River simulated using data collected at the following gages: for the period 10/41 - 9/87, gage on Mattaponi River near Beulahville (built in 1941; 601 square mile drainage area); and for the period 10/29 - 9/41 (before Beulahville gage was built), gage on North Anna River near Doswell (441 square mile drainage area).

For each month in this historic record, a model was used to predict the flow at the Scotland Landing (781 square mile drainage area) intake site (without any withdrawal), the amount required to be withdrawn, and the remaining River flow past the site. The following hydrologic impact assessment techniques were used in that evaluation:

- Streamflow duration curves were developed and compared for the pre- and post-withdrawal conditions.

- Monthly withdrawals for each individual month of the simulation period (Water Years 1930-1987) were summarized graphically.

- Average monthly withdrawals and flows past the proposed intake site were simulated and compared tabularly and graphically for the pre- and post-withdrawal conditions for:

    1. The entire simulation period (Water Years 1930-1987).

    2. Wet years (10 percent exceedance water years).

    3. Average years (45-55 percent exceedance water years).

    4. Dry years (90 percent exceedance water years).

- An analysis was made of those periods when flows are less than nominal threshold levels (i.e., flow contravention analysis). A comparison was made between the number of months in which those levels would not be met, under pre- and post-withdrawal streamflow conditions.

- An analysis of basin-wide consumptive use was conducted to estimate cumulative streamflow reductions with and without the project.

The safe yield model uses simulated Mattaponi River withdrawal records which are based only on MIF conditions and pump station capacity. These simulated withdrawals overestimate the quantity of river withdrawals required to produce a given safe yield, because the model assumes that withdrawals would occur even if the reservoir is already full. To remedy this situation, each of the monthly Mattaponi River withdrawal rates was reduced by the corresponding monthly amount of King William Reservoir water spilling over the top of the dam. In making these corrections, adjusted withdrawal rates were not permitted to go below zero.

The originally proposed KWR I safe yield benefits were derived from Mattaponi River withdrawal simulations using a 40/20 Tennant MIF. Hydrologic impacts from this configuration are presented in Section 6.3.3 of Report D, ***Alternatives Assement, Volume II - Environmental Analysis***

(Malcolm Pirnie, 1994), which is incorporated herein by reference and is an appendix to this document.

A Modified 80 Percent Monthly Exceedance Flows MIF was assumed for the RRWSG's preferred KWR II configuration to provide a more balanced comparison of potential safe yield benefits associated with the use of either the Pamunkey or Mattaponi River as pumpover sources for new reservoirs. Potential Mattaponi River hydrologic impacts from the KWR III project configuration are not reported. It was assumed that the KWR II project configuration would withdraw greater daily quantities of water from the Mattaponi River than the KWR III project configuration under the same MIF (Modified 80 Percent Monthly Exceedance Flows) because of the larger modeled safe yield benefits. Figure 5-3 depicts the percentages of time in which simulated flows past the proposed intake occurred under pre- and post-withdrawal conditions for the KWR-II configuration. The decrease in flow past the intake under post-withdrawal flow conditions is small at given recurrence frequencies.

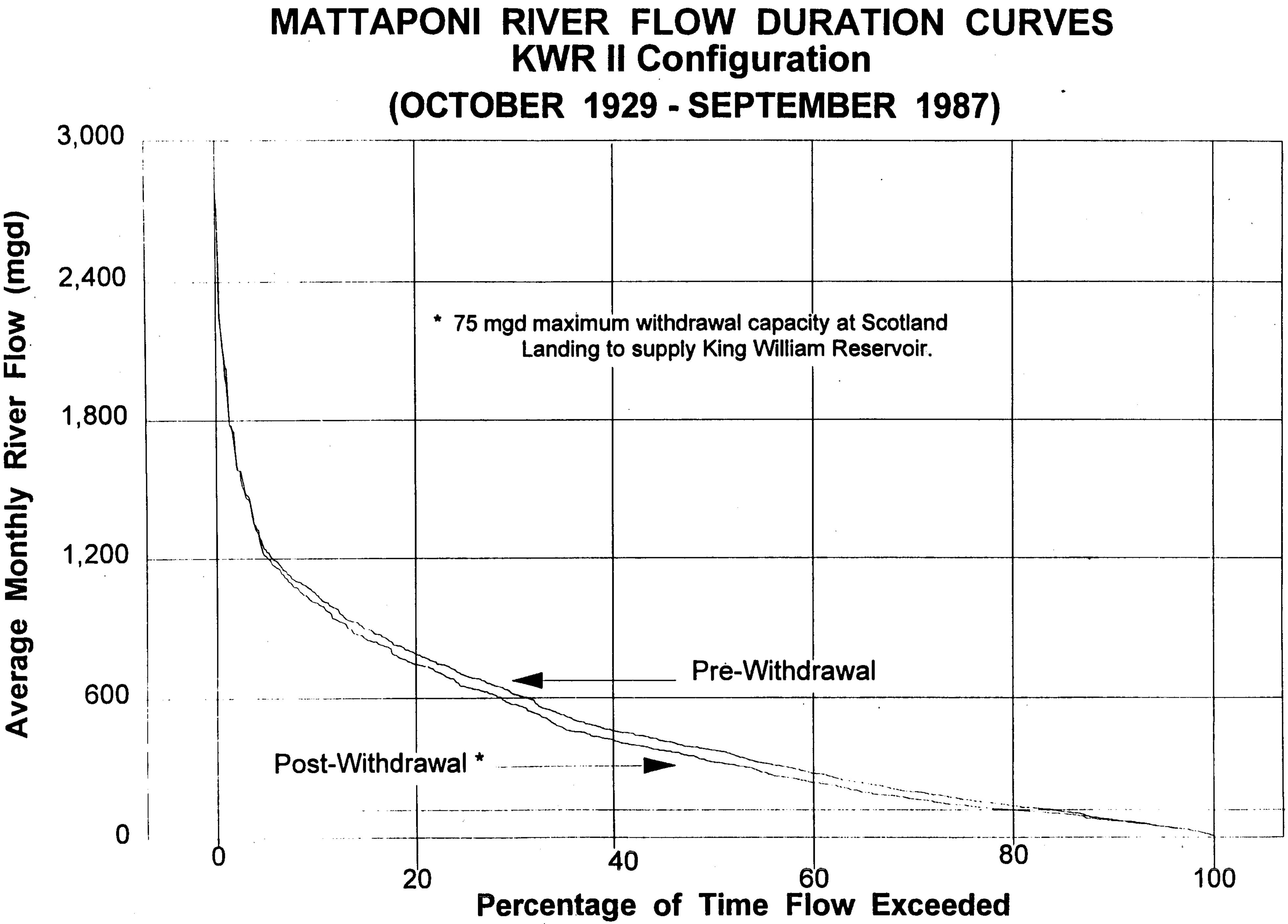
Figures 5-3A through 5-3F show simulated monthly KWR II withdrawals for each individual month of the simulation period (Water Years 1930-1987). The 58-year simulation period was divided into six sequential time periods to better portray these data. These six graphs show that the amount withdrawn would be very small relative to total river flow. During particularly low flow months, when the proposed MIF would severely limit or preclude withdrawals, the amount withdrawn would be very limited or there would be no withdrawals.

Under the Modified 80 Percent Monthly Exceedance Flows MIF described in Section 3.3.3 for the KWR II configuration, the proposed maximum withdrawal of 75 mgd could represent a maximum of 39.7 percent of the total flow on a single day at Scotland Landing. This could occur during the months of August, September, or October (MIF values for all three months are approximately 114 mgd which are the lowest monthly MIF values) if a daily flow past the intake was 189 mgd and the maximum withdrawal of 75 mgd was made. This would not be a frequent occurrence since, in September, for example, flows at Scotland Landing exceeding 189 mgd occur only 30 percent of the time. In fact, during 48.4 percent of the time in September, flows are less than 114 mgd and no withdrawals would be allowed.

Table 5-7 and Figure 5-3G contain summaries of the simulated average withdrawals and flows past the intake site (for the KWR-II configuration) under pre- and post-withdrawal conditions over the entire simulation period (Water Years 1930-1987). The average simulated withdrawal was 31.6 mgd and represents a 6.5 percent decrease in the estimated average flow past the intake. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 12.6 percent reduction in mean flow for the month of June.

An analysis of the KWR II configuration also was conducted of selected wet, average, and dry years to distinguish among the quantities that could be withdrawn under those ranges of flow conditions. Tables 5-8 through 5-10 and Figures 5-3H through 5-3J contain summaries of the simulated average withdrawals and flows past the intake site under pre- and post-withdrawal conditions for wet, average, and dry years.

Wet years were defined as 10 percent exceedance water years, which are the six wettest water years during the 58-year simulation period. The average simulated withdrawal was 39.0 mgd and represented a 4.7 percent decrease in the estimated average flow past the intake for those years. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 20.3 percent reduction in mean flow for the month of September.



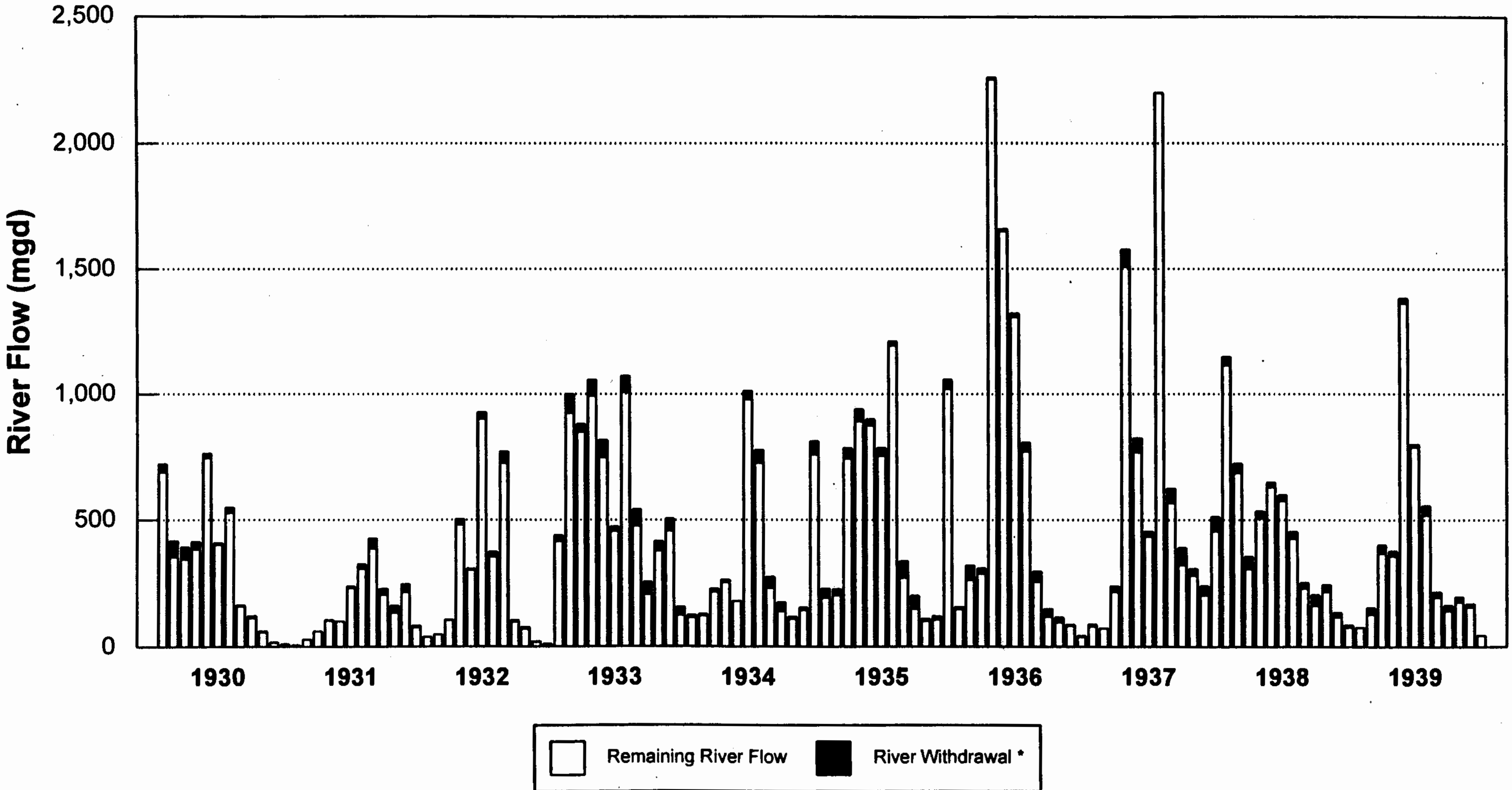
MATTAPONI RIVER FLOW DURATION CURVES
KWR II Configuration
(OCTOBER 1929 - SEPTEMBER 1987)
3,000
2,400
1,800
1,200
600
0
Average Monthly River Flow (mgd)
* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.
Pre-Withdrawal
Post-Withdrawal *
0
20
40
60
80
100
Percentage of Time Flow Exceeded

Figure 5-3

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

(October 1929 - September 1939)



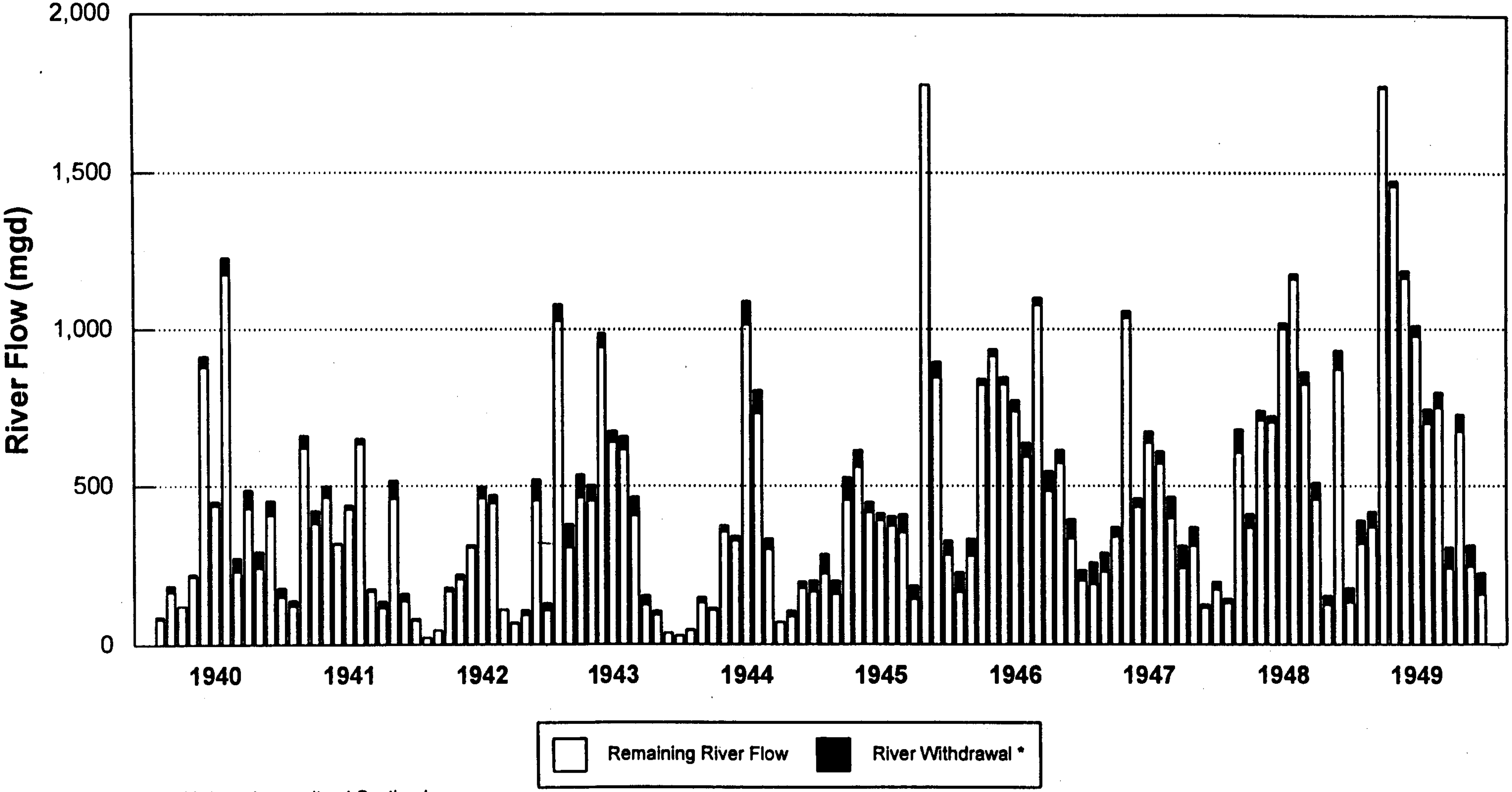
* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.

Figure 5-3A

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

(October 1939 - September 1949)



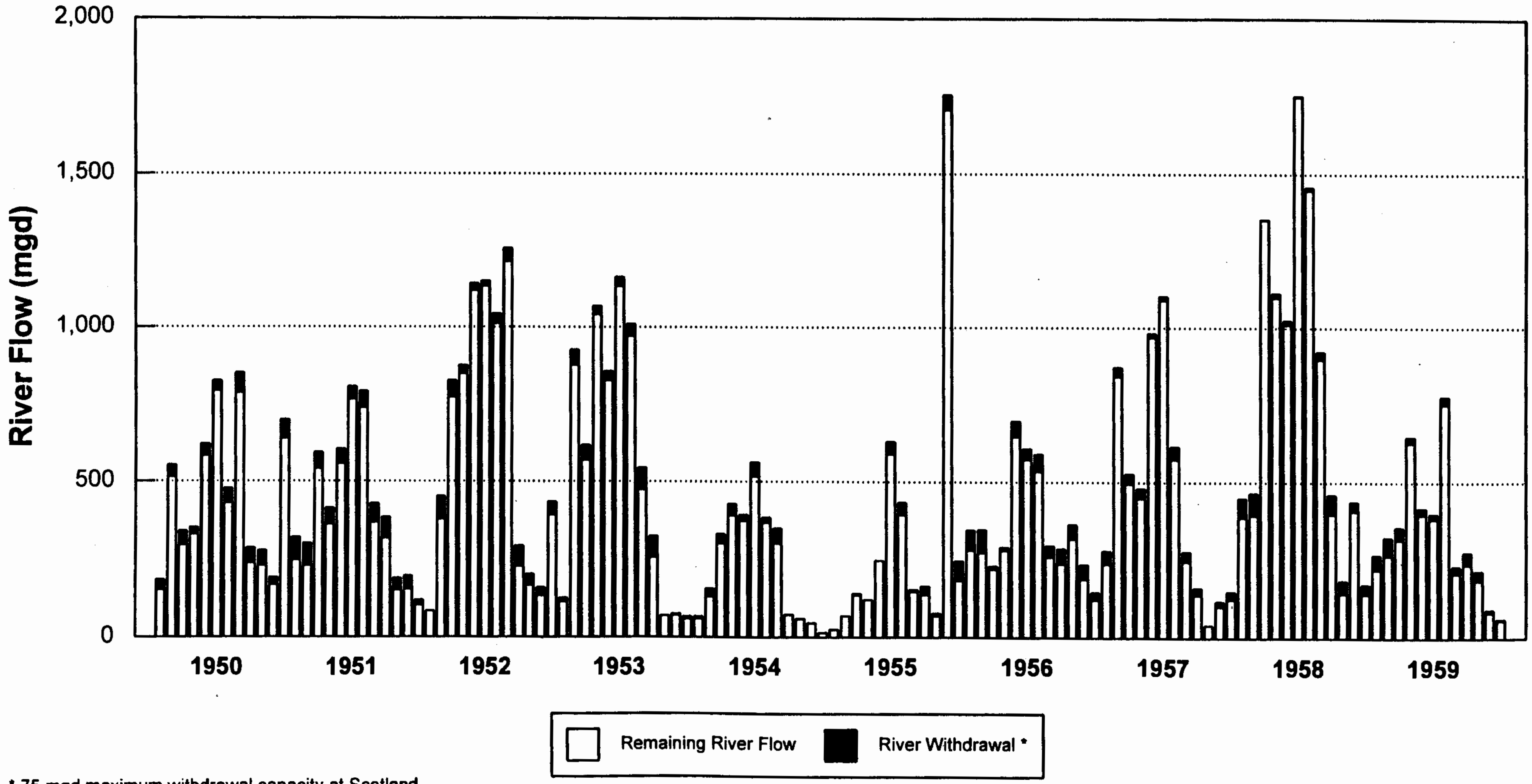
* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.

Figure 5-3B

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

(October 1949 - September 1959)



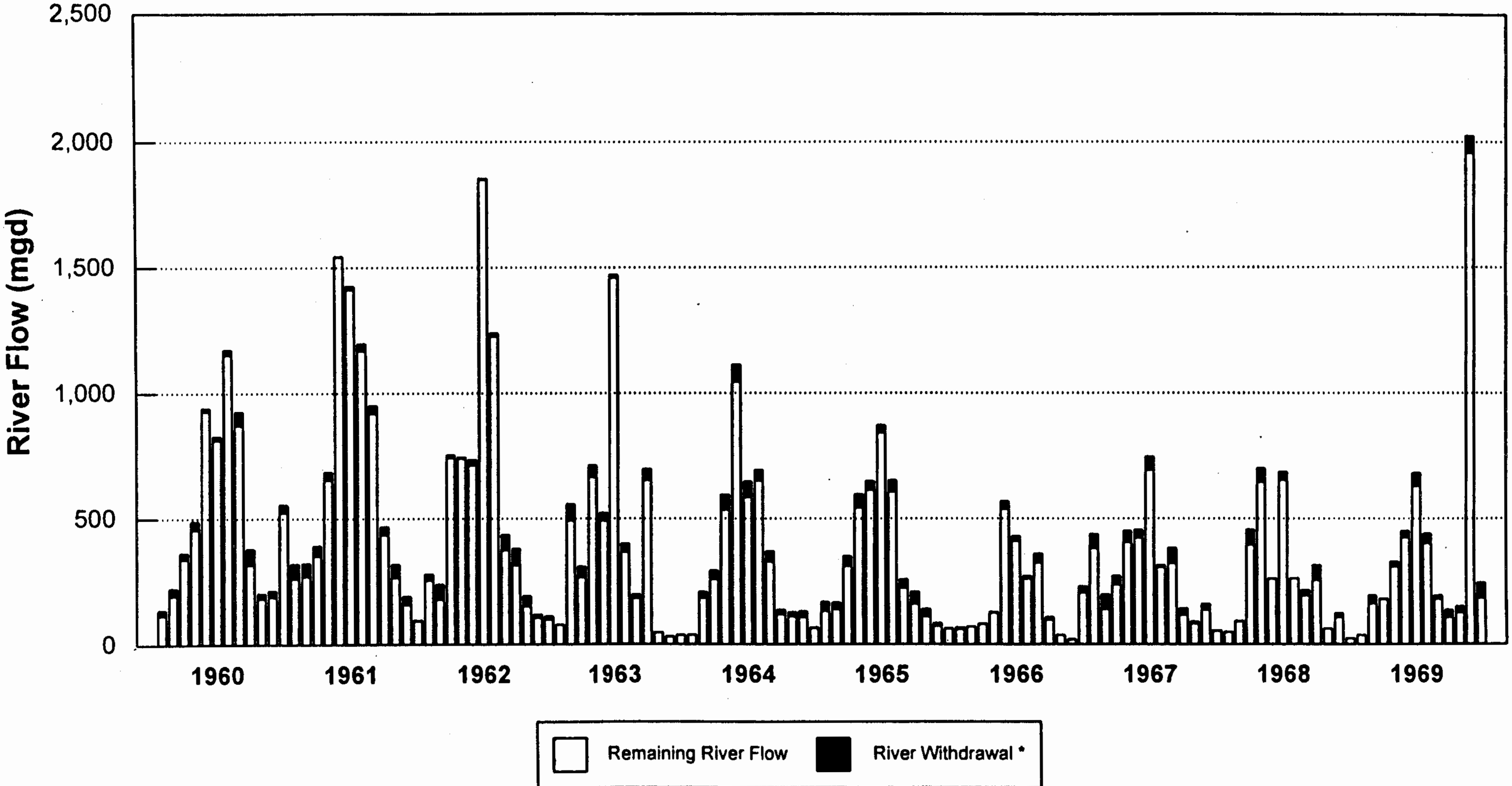
* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.

Figure 5-3C

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

(October 1959 - September 1969)



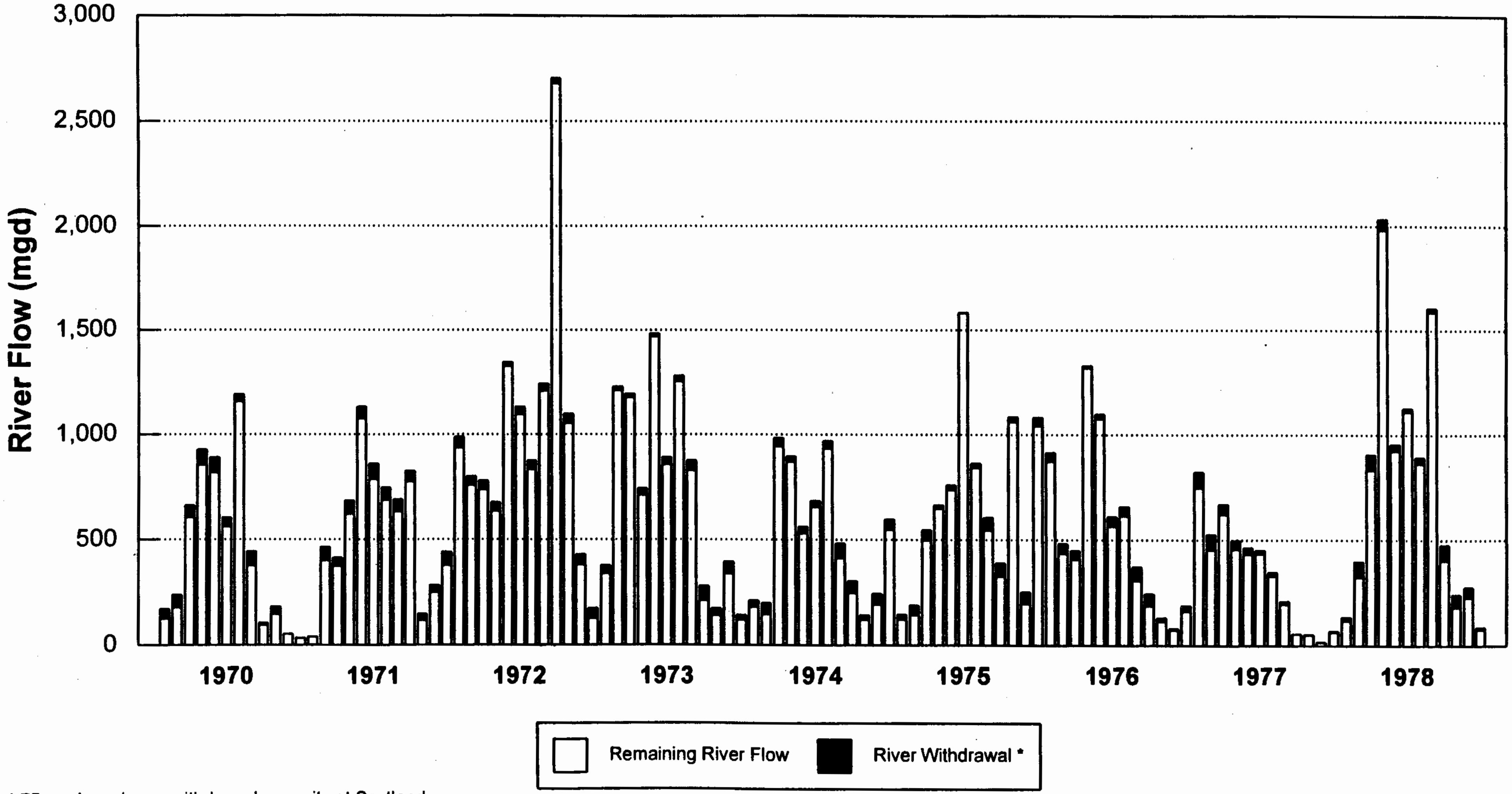
* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.

Figure 5-3D

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

(October 1969 - September 1978)



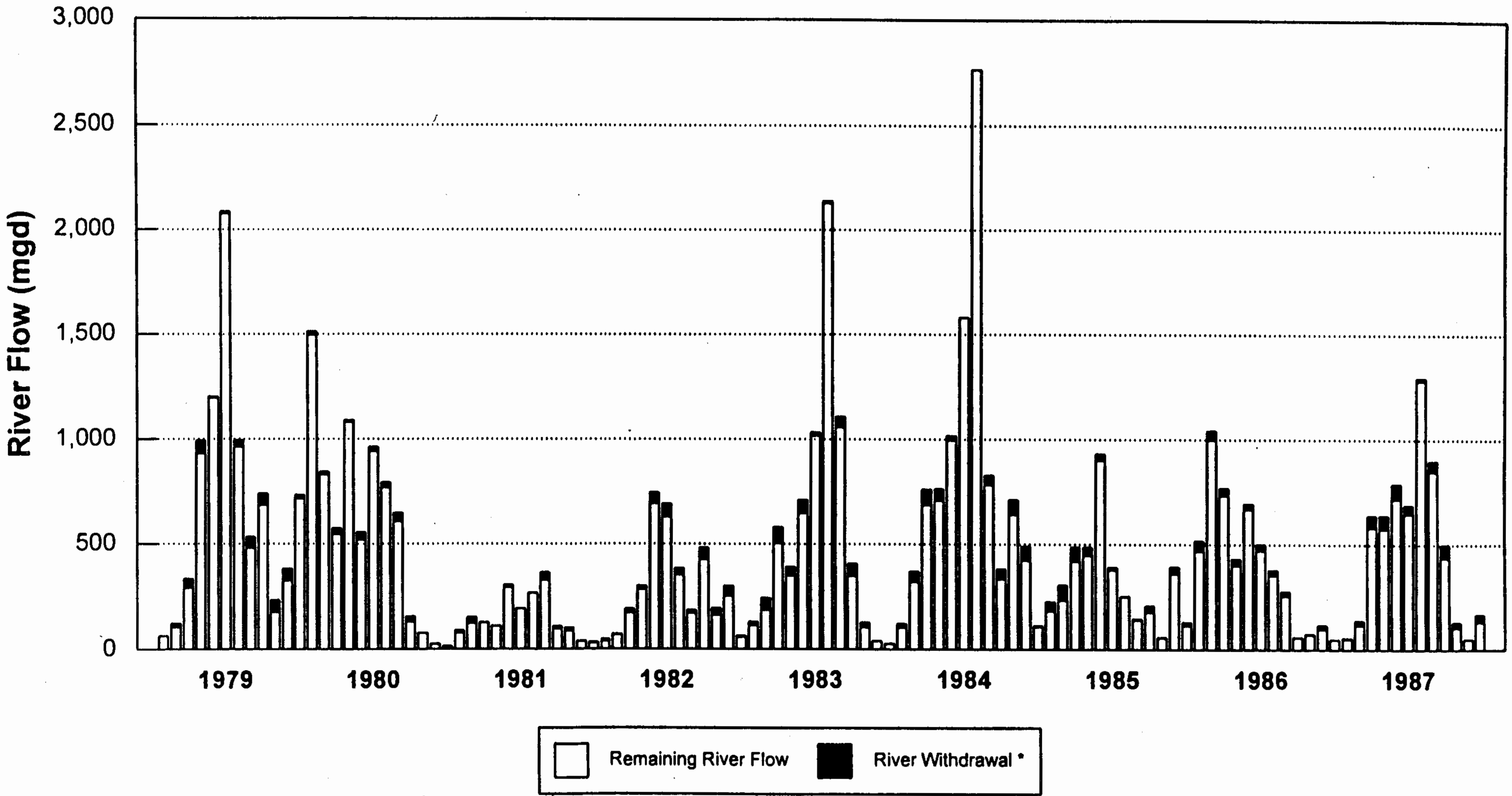
* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.

Figure 5-3E

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

(October 1978 - September 1987)



* 75 mgd maximum withdrawal capacity at Scotland Landing to supply King William Reservoir.

Figure 5-3F

TABLE 5-7

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS (1)
KWR II CONFIGURATION

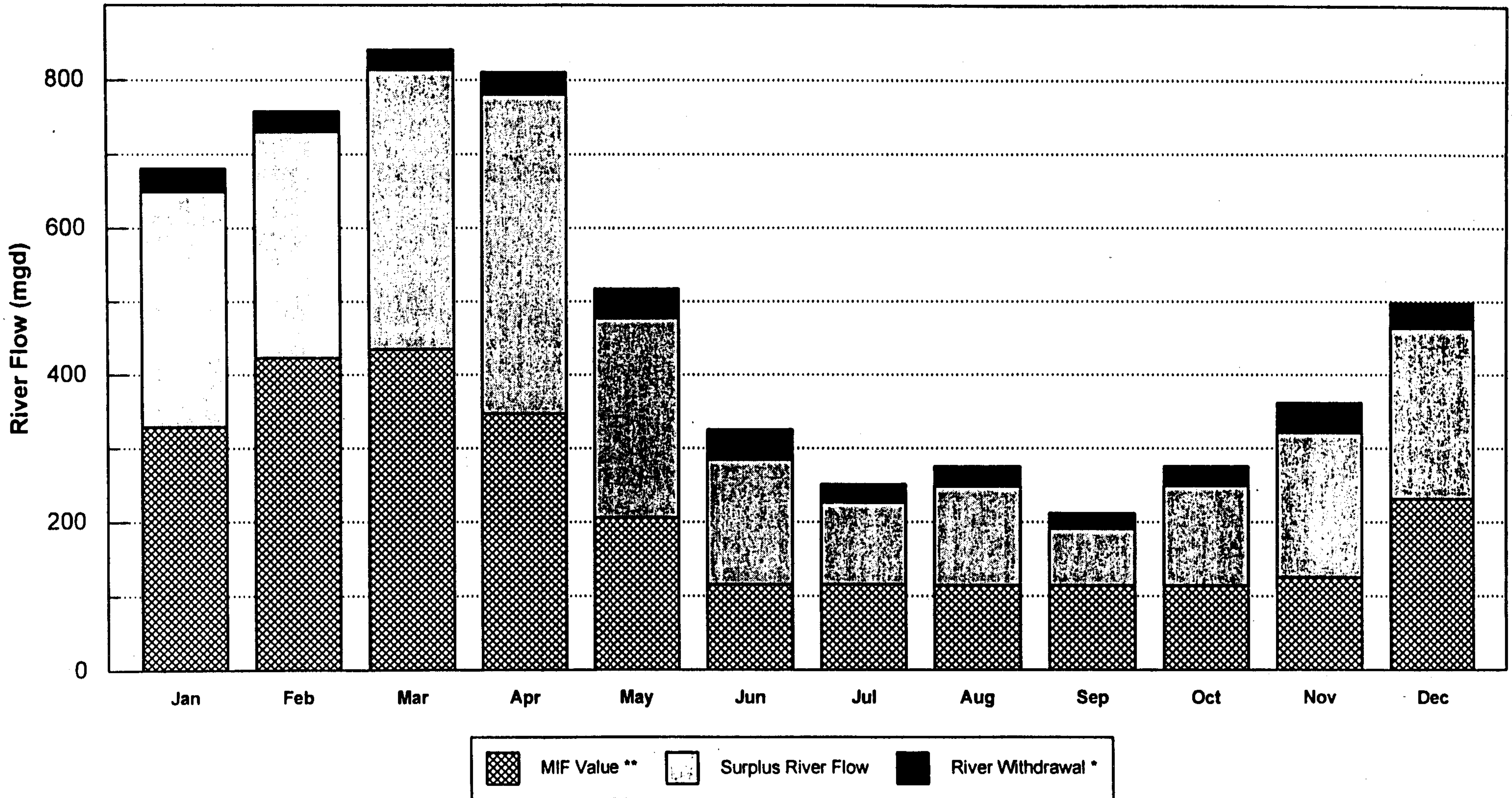
Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	681.6	32.4	4.8	649.2	328.9
Feb	758.3	28.1	3.7	730.2	422.9
Mar	840.8	27.6	3.3	813.2	434.4
Apr	810.8	30.4	3.8	780.4	346.9
May	517.4	40.6	7.9	476.8	205.8
Jun	325.3	41.1	12.6	284.2	115.1
Jul	251.3	25.8	10.2	225.6	115.5
Aug	275.4	27.4	10.0	248.0	114.2
Sep	212.3	22.1	10.4	190.2	113.8
Oct	276.1	27.2	9.8	248.9	113.6
Nov	362.0	41.0	11.3	321.0	125.1
Dec	498.1	35.0	7.0	463.1	231.5
Averages	**484.1**	**31.6**	**6.5**	**452.6**	**222.3**

(1) Analysis based on average monthly streamflow and withdrawal values over a 696-month simulation period (October 1929 through September 1987).

(2) 75 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Scotland Landing to supply King William Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated King William Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value.

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS
KWR II Configuration



* 75 mgd max. withdrawal capacity at Scotland Landing to supply King William Reservoir.

** Modified 80% Monthly Exceedance Flows.

Figure 5-3G

TABLE 5-8

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS FOR WET YEARS (10% EXCEEDANCE WATER YEARS) (1) KWR II CONFIGURATION

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	1,133.5	36.6	3.2	1,096.9	328.9
Feb	1,168.7	21.4	1.8	1,147.4	422.9
Mar	1,248.8	20.3	1.6	1,228.5	434.4
Apr	1,336.3	26.8	2.0	1,309.5	346.9
May	1,045.3	37.2	3.6	1,008.1	205.8
Jun	767.9	58.4	7.6	709.5	115.1
Jul	522.5	51.2	9.8	471.3	115.5
Aug	389.6	53.8	13.8	335.8	114.2
Sep	151.3	30.7	20.3	120.5	113.8
Oct	409.7	44.1	10.8	365.5	113.6
Nov	613.0	51.4	8.4	561.6	125.1
Dec	1,127.9	36.2	3.2	1,091.7	231.5
Averages	**826.2**	**39.0**	**4.7**	**787.2**	**222.3**

(1) Analysis based on average monthly streamflow and withdrawal values for six wettest water years (1972, 1984, 1958, 1949, 1978, and 1973) out of a 58-year simulation period (Water Years 1930 through 1987).

(2) 75 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Scotland Landing to supply King William Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated King William Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value.

TABLE 5-9

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS FOR AVERAGE YEARS (45-55% EXCEEDANCE WATER YEARS) (1) KWR II CONFIGURATION

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	642.3	38.7	6.0	603.6	328.9
Feb	765.5	37.0	4.8	728.5	422.9
Mar	746.6	30.8	4.1	715.8	434.4
Apr	667.6	39.0	5.8	628.6	346.9
May	458.8	52.9	11.5	405.9	205.8
Jun	203.2	38.2	18.8	165.0	115.1
Jul	202.6	30.8	15.2	171.8	115.5
Aug	109.3	11.8	10.8	97.5	114.2
Sep	198.5	20.1	10.1	178.4	113.8
Oct	519.0	46.1	8.9	472.8	113.6
Nov	508.6	50.6	10.0	458.0	125.1
Dec	465.6	49.1	10.5	416.5	231.5
Averages	**457.3**	**37.1**	**8.1**	**420.2**	**222.3**

(1) Analysis based on average monthly streamflow and withdrawal values for six average water years (1950, 1943, 1957, 1970, 1938, and 1947) out of a 58-year simulation period (Water Years 1930 through 1987).

(2) 75 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Scotland Landing to supply King William Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated King William Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value. Some daily withdrawals would be allowed during low flow months (ie; average monthly flow below monthly MIF value), but only on days on which the streamflow rises above the monthly MIF value. Those daily withdrawals during low flow months would not violate the proposed MIF policy.

TABLE 5-10

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS FOR DRY YEARS (90% EXCEEDANCE WATER YEARS) (1) KWR II CONFIGURATION

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	281.6	18.2	6.5	263.4	328.9
Feb	323.5	11.9	3.7	311.5	422.9
Mar	433.9	23.6	5.4	410.3	434.4
Apr	330.7	12.2	3.7	318.4	346.9
May	304.5	30.8	10.1	273.6	205.8
Jun	150.2	18.8	12.5	131.4	115.1
Jul	88.1	10.2	11.5	77.9	115.5
Aug	165.6	19.0	11.5	146.6	114.2
Sep	85.8	9.4	10.9	76.4	113.8
Oct	49.7	4.6	9.2	45.2	113.6
Nov	90.2	8.8	9.8	81.4	125.1
Dec	205.7	17.3	8.4	188.3	231.5
Averages	**209.1**	**15.4**	**7.4**	**193.7**	**222.3**

(1) Analysis based on average monthly streamflow and withdrawal values for six driest water years (1981, 1931, 1966, 1942, 1954, and 1968) out of a 58-year simulation period (Water Years 1930 through 1987).

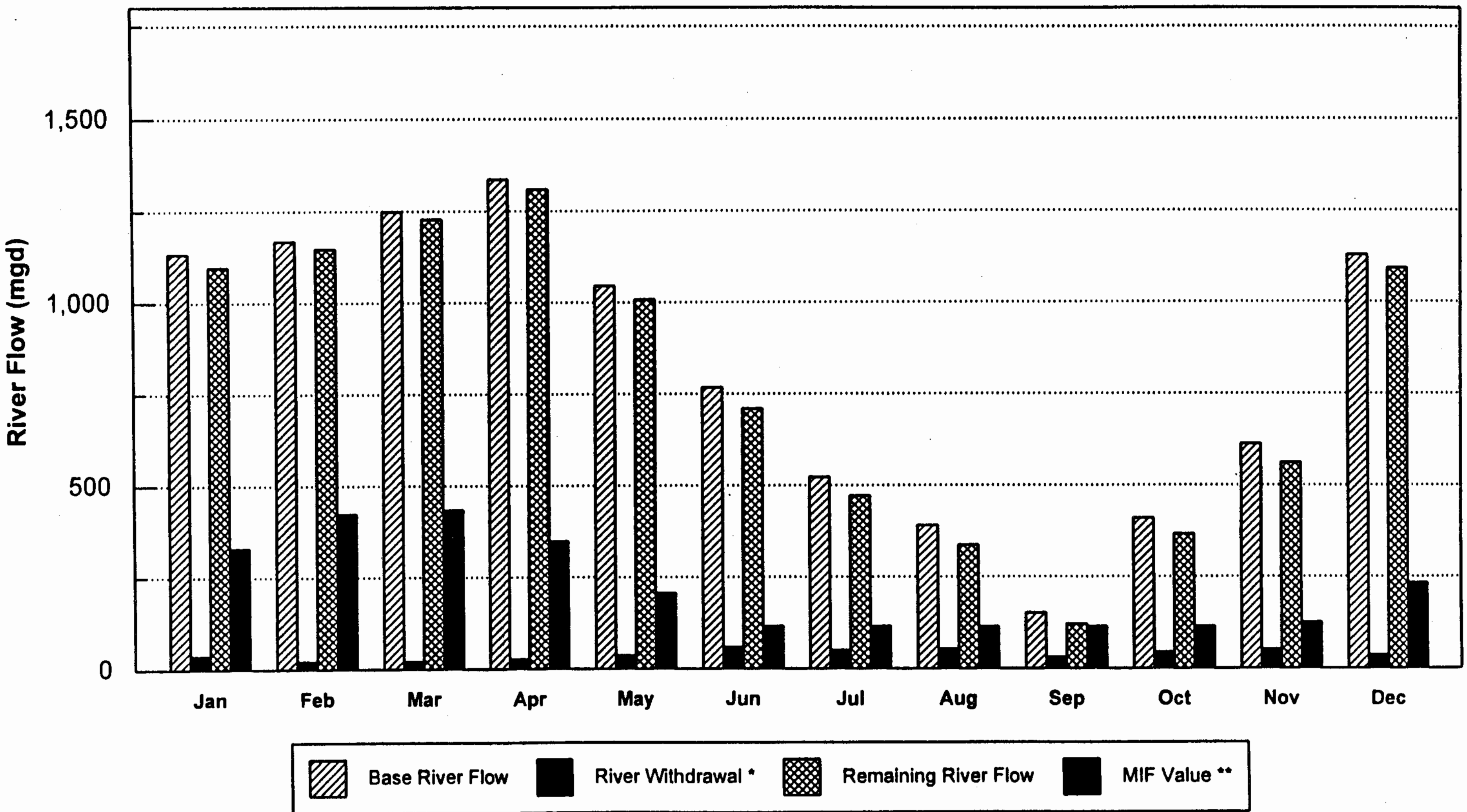
(2) 75 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Scotland Landing to supply King William Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated King William Reservoir spillage for corresponding month.

(3) Modified 80% Monthly Exceedance Flows applied to each daily streamflow value. Some daily withdrawals would be allowed during low flow months (ie; average monthly flow below monthly MIF value), but only on days on which the streamflow rises above the monthly MIF value. Those daily withdrawals during low flow months would not violate the proposed MIF policy.

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

For Wet Years (10% Exceedance Water Years)



* 75 mgd max. withdrawal capacity at Scotland Landing to supply King William Reservoir.

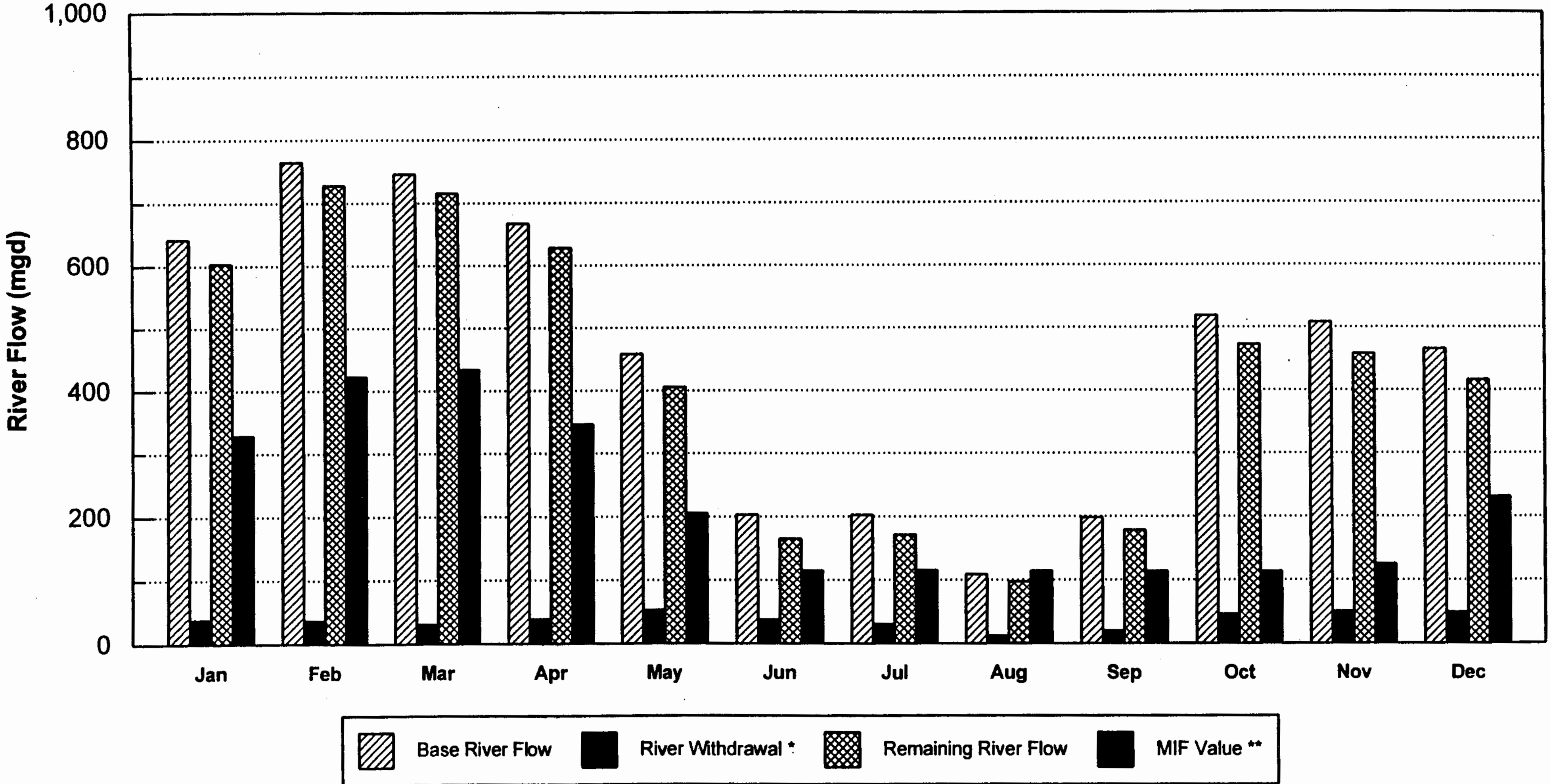
** Modified 80% Monthly Exceedance Flows.

Figure 5-3H

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

For Average Years (45-55% Exceedance Water Years)



* 75 mgd max. withdrawal capacity at Scotland Landing to supply King William Reservoir.

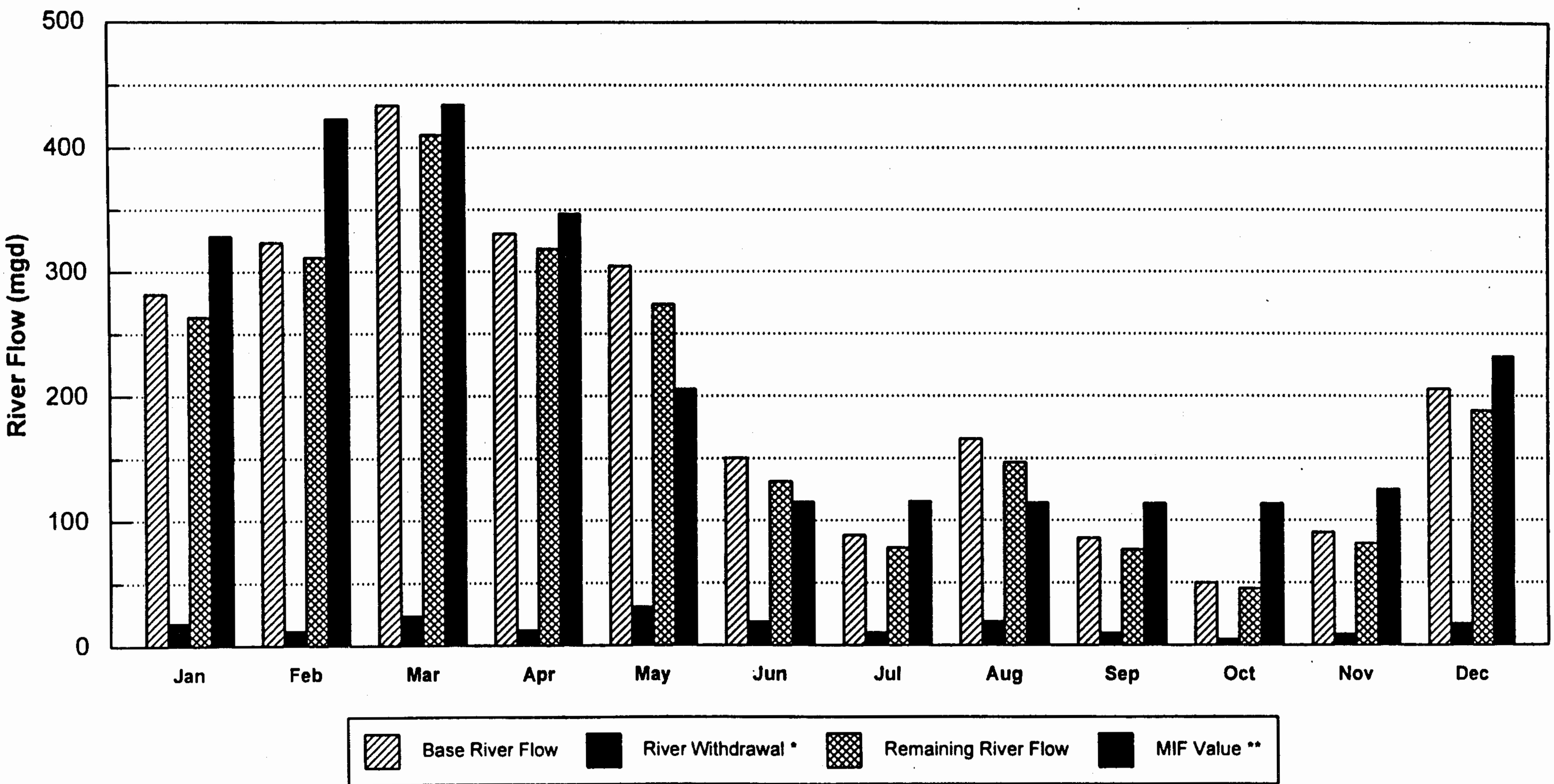
** Modified 80% Monthly Exceedance Flows.

Figure 5-3I

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS

KWR II Configuration

For Dry Years (90% Exceedance Water Years)



* 75 mgd max. withdrawal capacity at Scotland Landing to supply King William Reservoir.

** Modified 80% Monthly Exceedance Flows.

Figure 5-3J

Average years were defined as 45 to 55 percent exceedance water years, which are the six average water years during the 58-year simulation period. The average simulated withdrawal was 37.1 mgd and represented an 8.1 percent decrease in the estimated average flow past the intake for those years. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was an 18.8 percent reduction in mean flow for the month of June.

Dry years were defined as 90 percent exceedance water years, which are the six driest water years during the 58-year simulation period. The average simulated withdrawal was 15.4 mgd and represented a 7.4 percent decrease in the estimated average flow past the intake for those years. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 12.5 percent reduction in mean flow for the month of June. As Figure 5-3J shows, some withdrawals would occur during months in which the average baseline river flow was less than the monthly MIF value. The withdrawals are simulated on a daily basis. Streamflows usually exceed the MIF condition on some days during low flow months; therefore, withdrawals can be made on those days without violating the MIF requirement.

Table 5-11 shows when Mattaponi River flows would not meet nominal threshold levels (i.e., flow contravention analysis), under both pre- and post-withdrawal conditions for the KWR-II configuration. This table shows that the withdrawals would have little effect on streamflows under the proposed MIF conditions. The greatest percentage change from pre-withdrawal conditions would be a 5.4 percent increase in the number of months in which streamflows were less than or equal to the 40 Tennant flow level (i.e., 40 percent of mean historical flow). The small (4.8%) incremental increase in months when average streamflows would not meet stated threshold levels occurs in dry years when some daily withdrawals would be allowed even during low flow months (i.e., average monthly flow below monthly MIF value), but only on days on which the streamflow rises above the monthly MIF condition. These daily withdrawals during low flow months would not violate the proposed MIF.

The preceding discussion describes the potential individual impacts of a withdrawal from the Mattaponi River in the vicinity of Scotland Landing using the KWR II project configuration. An analysis of the potential cumulative streamflow reductions in the entire Mattaponi River Basin was also conducted, which required the identification of additional withdrawals which could affect future streamflows in the Mattaponi River. Table 5-12 contains a summary of estimated cumulative streamflow reductions in relation to total Mattaponi River flows through the Year 2040. It is projected that by the Year 2040, with all currently identified potential uses taken into account, the average Mattaponi River streamflow would be reduced by 6.4 percent. The basis for this basin-wide consumptive use projection is described in Table 5-12. The Virginia Department of Environmental Quality has reviewed these York River Basin consumptive use projections, and confirmed that they represent the most recent published projections (J. Hassell, Virginia Department of Environmental Quality, personal communication, 1996).

To enhance the safe yield benefits of the currently proposed KWR IV project configuration, and minimize reservoir drawdown, the originally proposed 40/20 Tennant MIF was retained. This MIF allows for more frequent withdrawals. Figure 5-3K depicts the percentages of time in which simulated flows past the proposed intake occurred under pre- and post-withdrawal conditions for the KWR-IV configuration. The decrease in flow past the intake under post-withdrawal flow conditions is small at given recurrence frequencies. Table 5-12A and Figure 5-3L contain summaries of the simulated average withdrawals and flows past the intake site under pre- and post-withdrawal conditions over the entire simulation period (Water Years 1930-1987) for the KWR-IV configuration. The average simulated withdrawal was 32.6 mgd and represents a 6.7 percent decrease in the

TABLE 5–11

CONTRAVENTIONS OF SELECTED MATTAPONI RIVER FLOW LEVELS
(IN PERCENTAGES OF TIME AT OR BELOW SPECIFIED FLOW LEVELS) (1)

Flow Levels	Contraventions of Flow Levels (% of time)		
	Baseline Streamflow Conditions	Post–Withdrawal (2) Streamflow Conditions	Incremental Increase
49.0 mgd (10 Tennant) (3)	5.6	5.6	0.0
98.0 mgd (20 Tennant) (3)	13.1	14.4	1.3
147.0 mgd (30 Tennant) (3)	22.1	27.0	4.9
196.0 mgd (40 Tennant) (3)	29.9	35.3	5.4
245.0 mgd (50 Tennant) (3)	36.6	40.8	4.2
Proposed MIF Policy (4)	22.4	27.2	4.8 (5)

(1) Analysis based on average monthly streamflow and withdrawal values over a 696–month simulation period (October 1929 through September 1987).

(2) 75 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Scotland Landing to supply King William Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated King William Reservoir spillage for corresponding month.

(3) Tennant refers to a percentage of the mean historical streamflow. Mean historical streamflow at Scotland Landing was estimated at 490 mgd based on the 50–year gaged streamflow record available for the Mattaponi River near Beulahville (Water Years 1942–1987 and 1990–1993) which was adjusted to the 781 square mile contributing drainage area at Scotland Landing.

(4) Modified 80% Monthly Exceedance Flows.

(5) Some daily withdrawals would be allowed during low flow months (ie; average monthly flow below monthly MIF value), but only on days on which the stream rises above the monthly MIF value. Those daily withrawals during low flow months would not violate the proposed MIF.

TABLE 5-12

MATTAPONI RIVER CUMULATIVE STREAMFLOW REDUCTIONS FOR KING WILLIAM RESERVOIR ALTERNATIVE
KWR II Configuration

Flow Condition	Estimated Flows (mgd)	Net Flow Reduction (mgd)	Percentage Change
Historical flows (1)	581.0	n/a	n/a
Year 1990 flows (2)	577.9	3.1	-0.5
Year 2030 flows without RRWSG project (3)	575.5	5.5	-1.0
Year 2040 flows with RRWSG project (4)	543.9	37.1	-6.4

(1) Mean historical freshwater discharge at the mouth of the Mattaponi River was estimated at 581 mgd based on a 51-year gaged streamflow record for the Mattaponi River near Beulahville (Water Years 1942-1987 and 1990-1994) which was adjusted to the 918 square mile Mattaponi River Basin drainage area.

(2) Derivation of the 3.1 mgd Year 1990 consumptive use estimate for the Mattaponi River Basin is described in Section 4.5.3.

(3) The 5.5 mgd Year 2030 consumptive use projection for the Mattaponi River Basin is based on the SWCB's projected Year 2030 Mattaponi Basin withdrawals of 8.33 mgd and the SWCB's estimated consumptive use factor of 0.66 for the Mattaponi Basin (SWCB, 1988).

(4) The 37.1 mgd average Year 2040 flow reduction is based on a 31.6 mgd average Year 2040 Mattaponi River withdrawal with a 75 mgd pump station at Scotland Landing and the 5.5 mgd projected Year 2030 flow reduction without a RRWSG project.

Figure 5-3K

MATTAPONI RIVER FLOW DURATION CURVES
(OCTOBER 1929 - SEPTEMBER 1987)
KWR IV CONFIGURATION

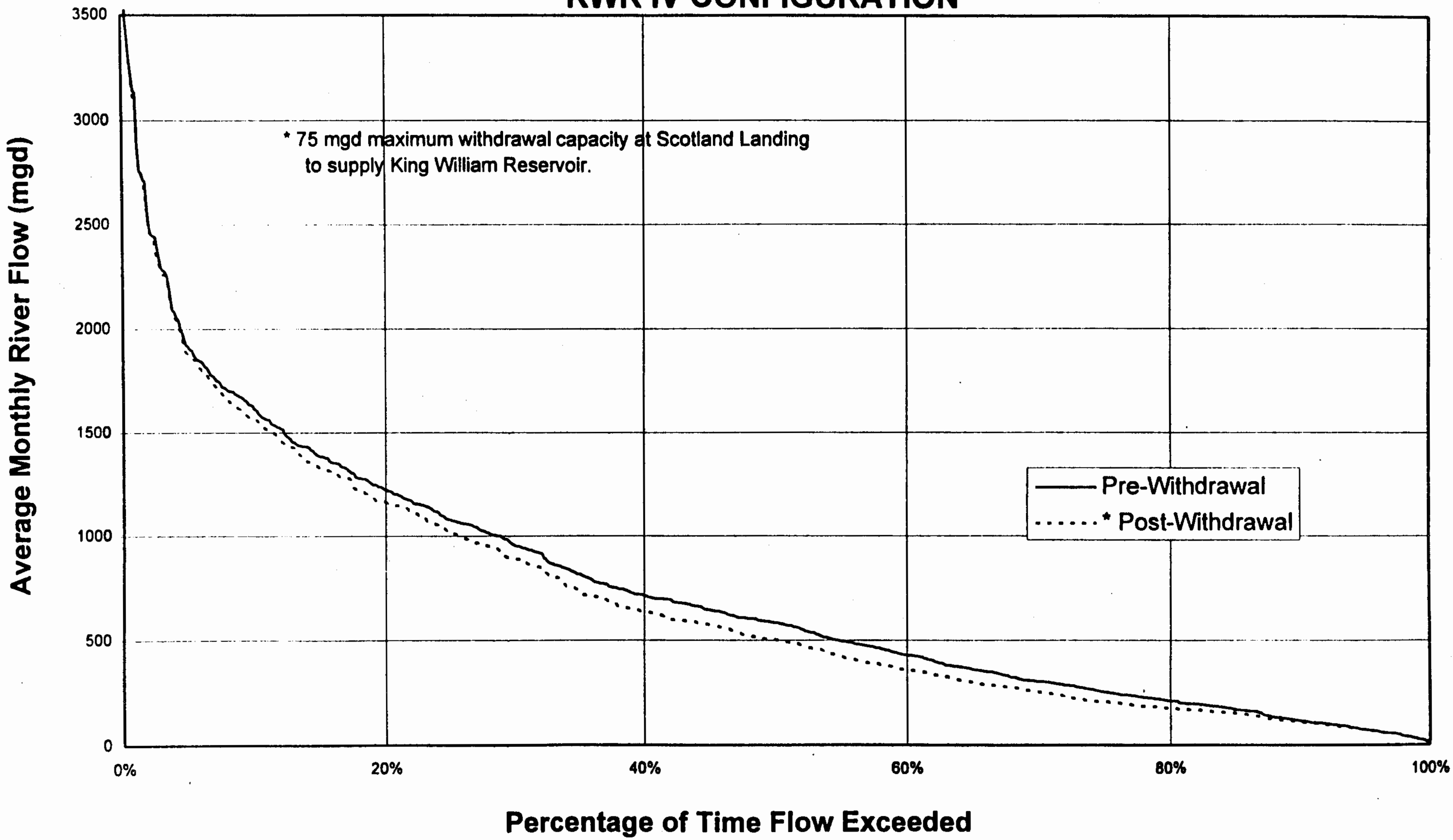


TABLE 5-12A

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWAL ANALYSIS (1) KWR IV CONFIGURATION

Month	Baseline Streamflow (mgd)	Average Withdrawal (2) (mgd)	Average Withdrawal (% of Flow)	Remaining Streamflow (mgd)	MIF Value (3) (mgd)
Jan	681.6	33.9	5.0	647.7	205.0
Feb	758.3	32.1	4.2	726.2	205.0
Mar	840.8	34.9	4.1	805.9	205.0
Apr	810.8	35.6	4.4	775.2	205.0
May	517.4	37.1	7.2	480.4	205.0
Jun	325.3	39.5	12.1	285.8	106.0
Jul	251.3	26.2	10.4	225.1	106.0
Aug	275.4	26.7	9.7	248.7	106.0
Sep	212.3	22.7	10.7	189.6	106.0
Oct	276.1	26.9	9.8	249.1	106.0
Nov	362.0	40.7	11.2	321.3	106.0
Dec	498.1	34.7	7.0	463.4	205.0
Averages	**484.1**	**32.6**	**6.7**	**451.5**	**155.5**

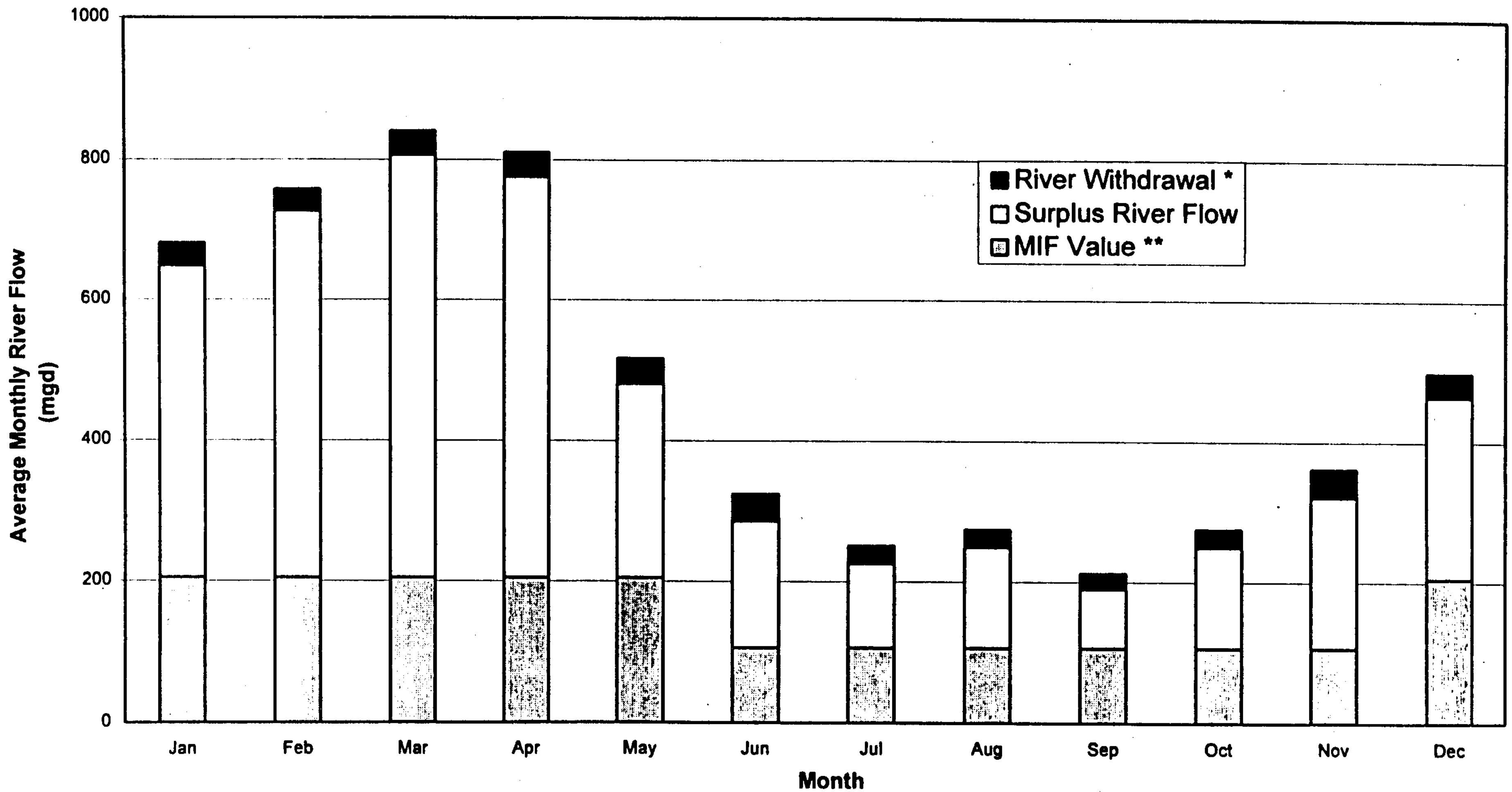
(1) Analysis based on average monthly streamflow and withdrawal values over a 696 - month simulation period (October 1929 through September 1987).

(2) 75 mgd maximum withdrawal capacity (in 10 mgd pumping increments) at Scotland Landing to supply King William Reservoir. Withdrawals were calculated on a daily basis and averaged for each month of simulation period. Calculated withdrawals were then reduced by simulated King William Reservoir spillage for corresponding month.

(3) 40/20 Tennant MIF value applied to each daily streamflow value.

Figure 5-3L

MATTAPONI RIVER AVERAGE MONTHLY WITHDRAWALS
KWR IV CONFIGURATION



*75 mgd max. withdrawal capacity at Scotland Landing to supply King William Reservoir.

**40 / 20 Tennant Flow

estimated average flow past the intake. On a monthly basis, the greatest percentage change from pre-withdrawal conditions was a 12.1 percent reduction in mean flow for the month of June. The results of this KWR IV configuration analysis suggest that the hydrologic impacts to the Mattaponi River from river withdrawals are approximately equivalent to those resulting from the KWR II configuration.

An evaluation of the effects of Mattaponi River withdrawals on the natural streamflow variability was conducted for the RRWSG's preferred KWR II configuration. As depicted in Figures 5-3M through 5-3Q, the comparisons of minimum and maximum monthly flow values demonstrate that the streamflow variability is either unchanged or only slightly reduced as a result of simulated withdrawals. Both of the seasonally varying MIFs evaluated for the Mattaponi River preclude withdrawals during low flow periods. During high flow periods, maximum river withdrawals are far exceeded by natural flow levels. Consequently the peaks and valleys of the natural streamflow hydrograph would be preserved. This conclusion is further supported by the 'high-flow skimming' method of proposed withdrawals and the extremely large magnitude of tidal influence at Scotland Landing. The proposed high flow skimming withdrawals from the Mattaponi River would be made without impoundment of the river to minimize potential impacts when salinity naturally migrates farther upstream during extended dry periods. The estimated mean tidal range at Scotland Landing is 3.56 feet (Basco, 1996). According to the VIMS publication, ***Hydrography and Hydrodynamics of Virginia Estuaries. V. Mathematical Model Studies of Water Quality of the York River System*** (Hyer et al., 1975), the average tidal current at Walkerton, about 5 river miles upstream of Scotland Landing, is 1.5 feet per second and the cross-sectional area is 5,800 square feet. Using these values, the average tidal flow past Walkerton can be estimated as 8,700 cfs or about 5,600 mgd, an order of magnitude greater than the estimated average freshwater discharge at Scotland Landing of 494 mgd.

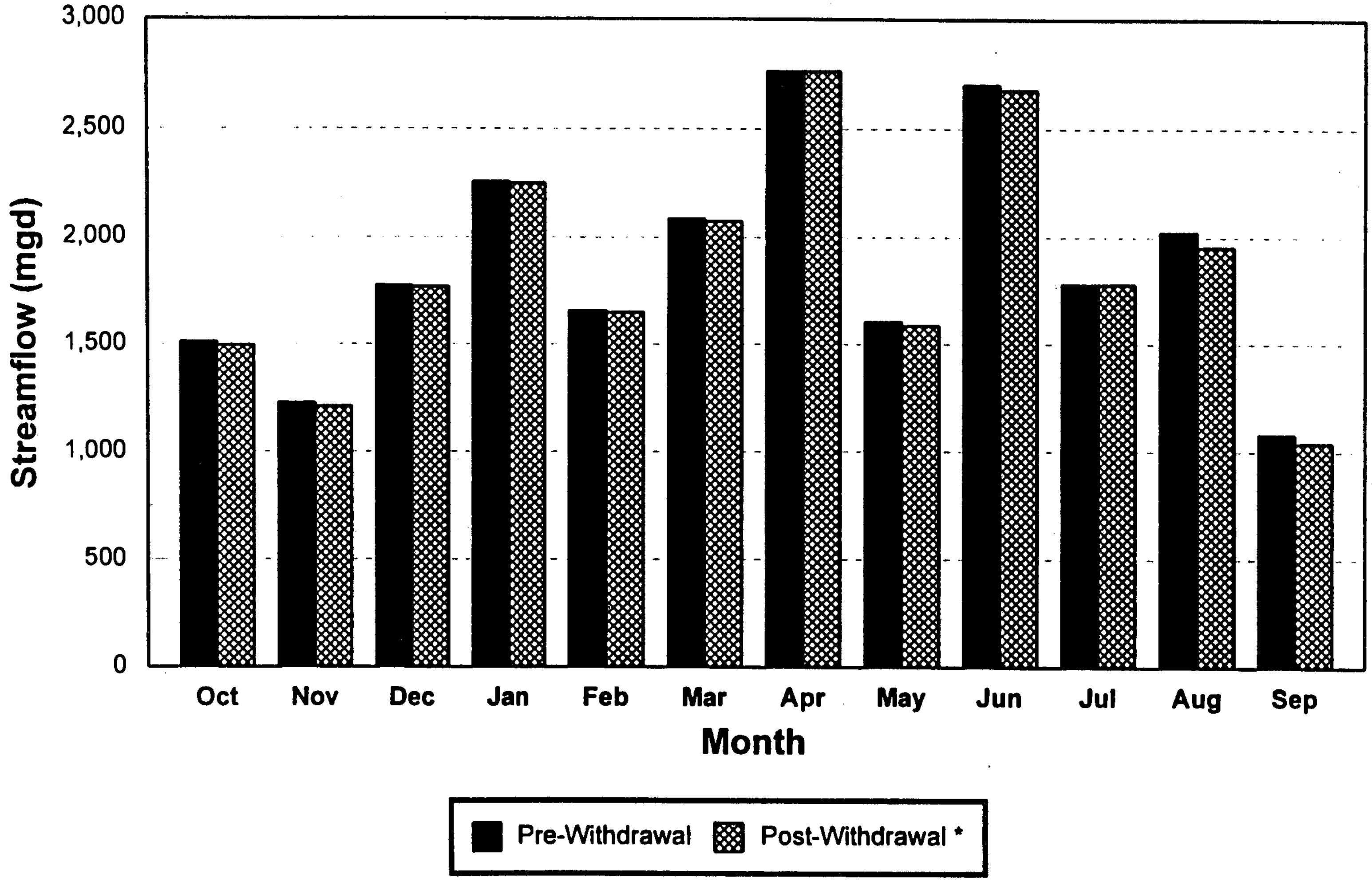
Water depth in the Mattaponi River would not be affected by this alternative, because the proposed intake is located in tidal waters.

An analysis of the water velocities and sediment transport potential at Scotland Landing before and after intake construction was conducted to determine the relative change in sediment transport patterns. It was determined that the increased mean velocities and sediment transport potential caused by the intake structure would be so small that the possibility for erosion of Garnetts Creek marsh and the south side shoreline is minimal to non-existent. Sediment deposition along the north side (inner radius) of the meander bend is expected to continue to increase the size of Garnetts Creek marsh in the future. Natural sediment erosion along the south side (outer radius) of the meander bend is also expected to continue due to high velocities during elevated water level, freshwater flooding events. These findings are documented in Report N, ***Study of Potential Erosional Impact of Scotland Landing, Water Intake Structure on Garnetts Creek Marsh, Mattaponi River, Virginia*** (Basco, 1996), which is incorporated herein by reference and is an appendix to this document.

The King William Reservoir with pumpover from the Mattaponi River alternative also would increase cumulative streamflow reductions in the Pamunkey River, because the King William Reservoir would impound a tributary of the Pamunkey River. The estimated net reduction in average flows from Cohoke Creek to the Pamunkey River would be 5 mgd. This estimate for the RRWSG's preferred KWR-II configuration is based on an estimated average flow of 8 mgd at the KWR-II dam

MATTAPONI STREAMFLOW AT SCOTLAND LANDING

MAXIMUM MONTHLY VALUES

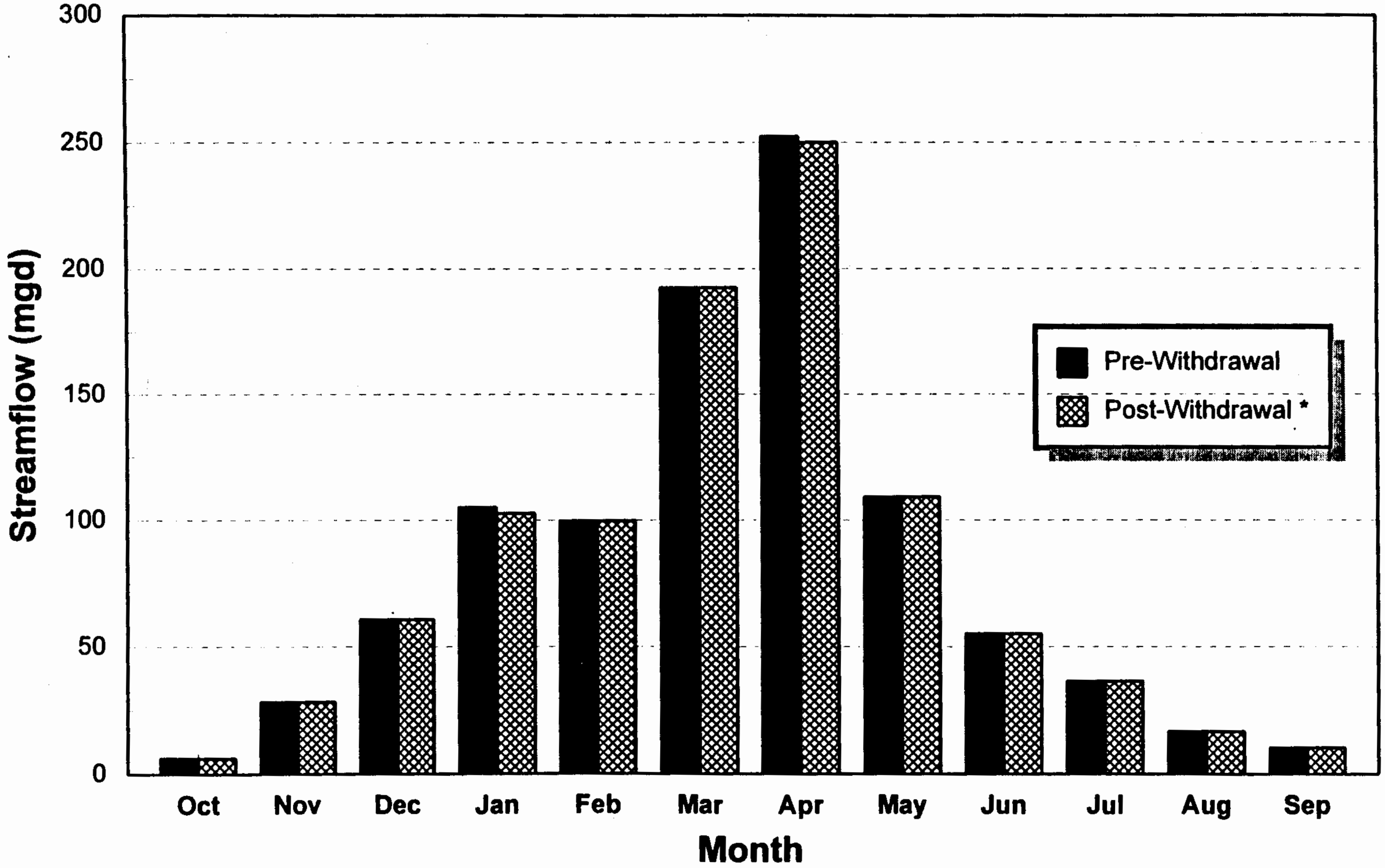


* KWR II Configuration Withdrawals

Figure 5-3M

MATTAPONI STREAMFLOW AT SCOTLAND LANDING

MINIMUM MONTHLY VALUES

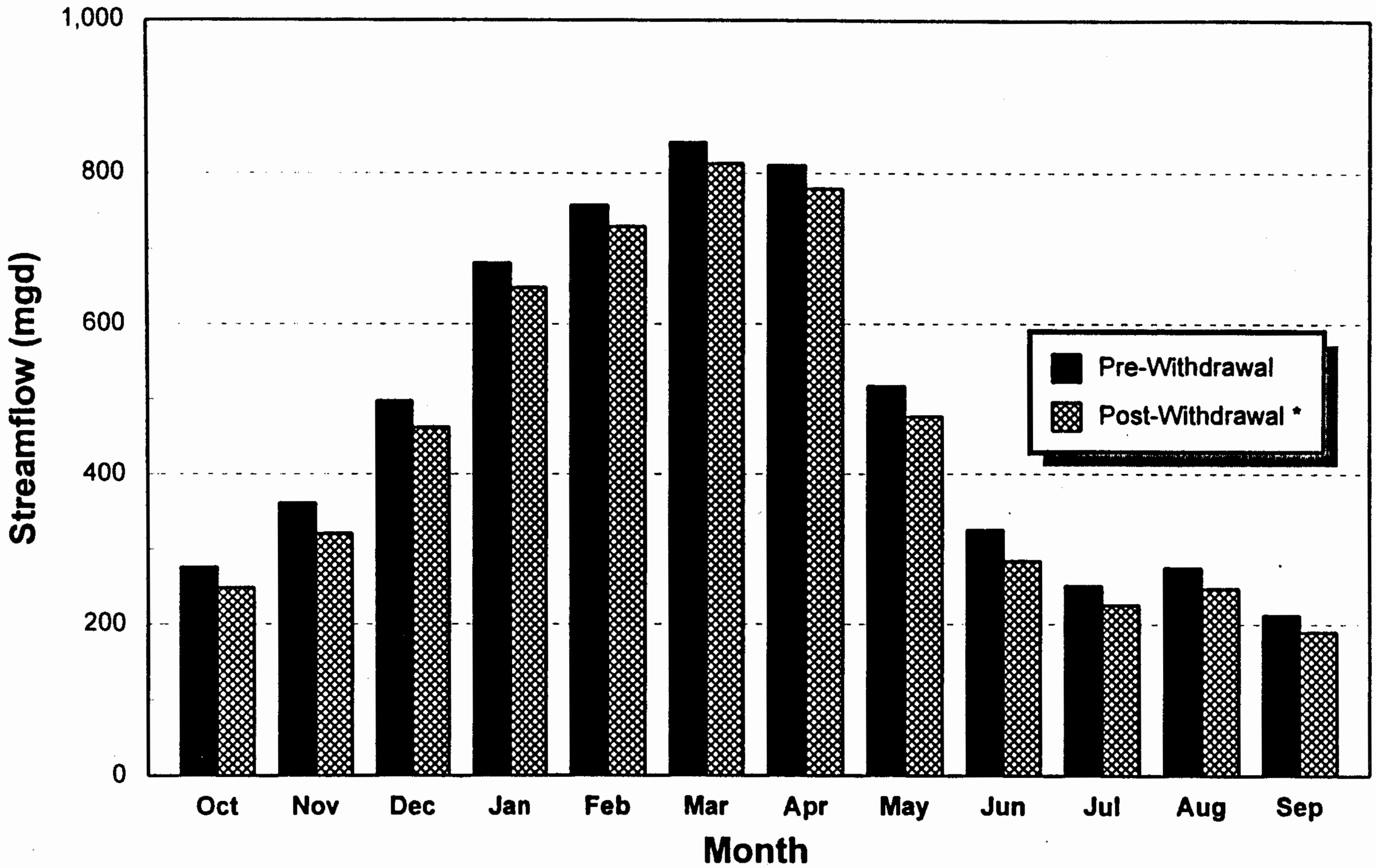


* KWR II Configuration Withdrawals

Figure 5-3N

MATTAPONI STREAMFLOW AT SCOTLAND LANDING

MEAN MONTHLY VALUES

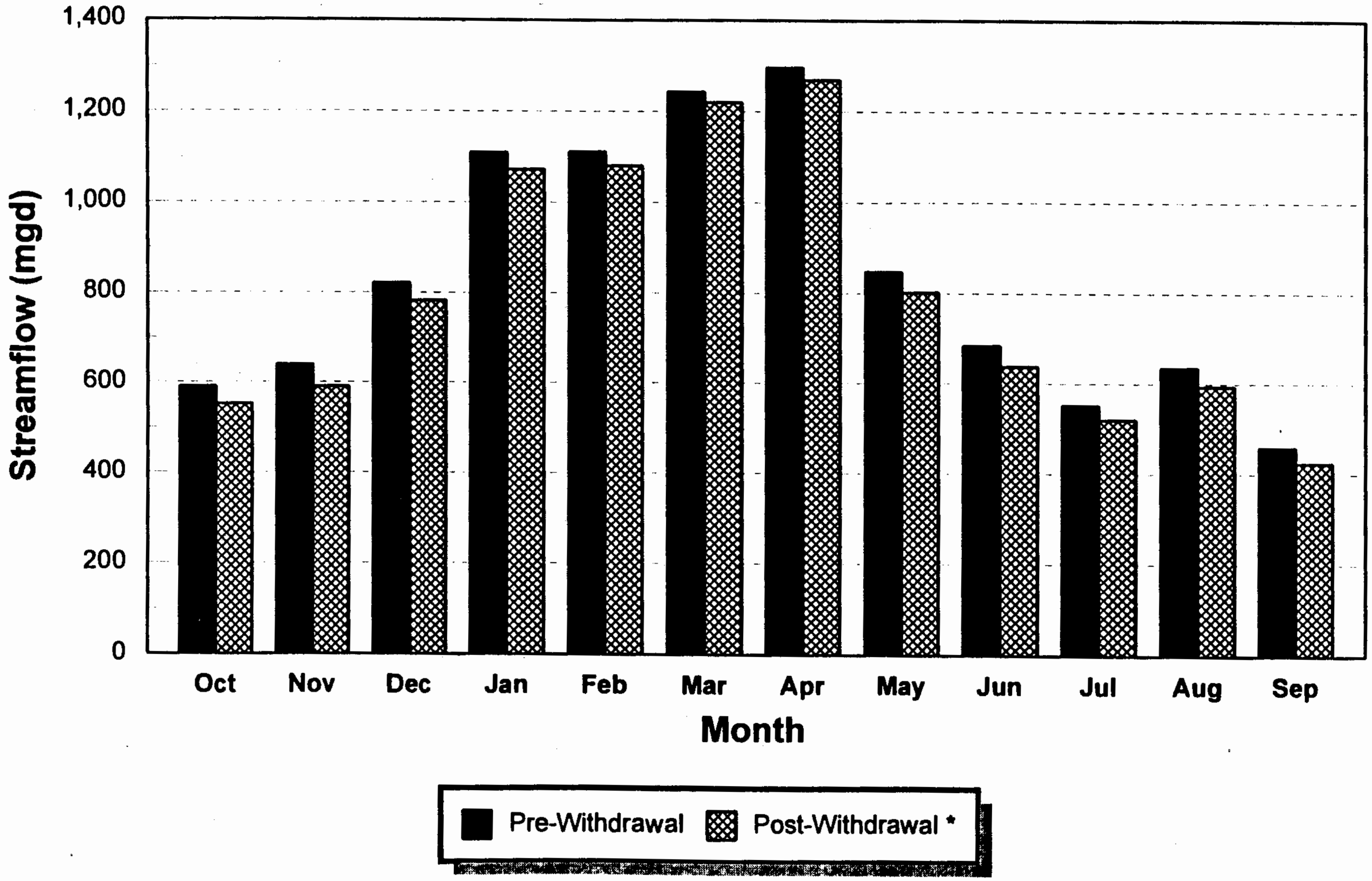


* KWR II Configuration Withdrawals

Figure 5-30

MATTAPONI STREAMFLOW AT SCOTLAND LANDING

MEAN + 1 STANDARD DEVIATION MONTHLY VALUES

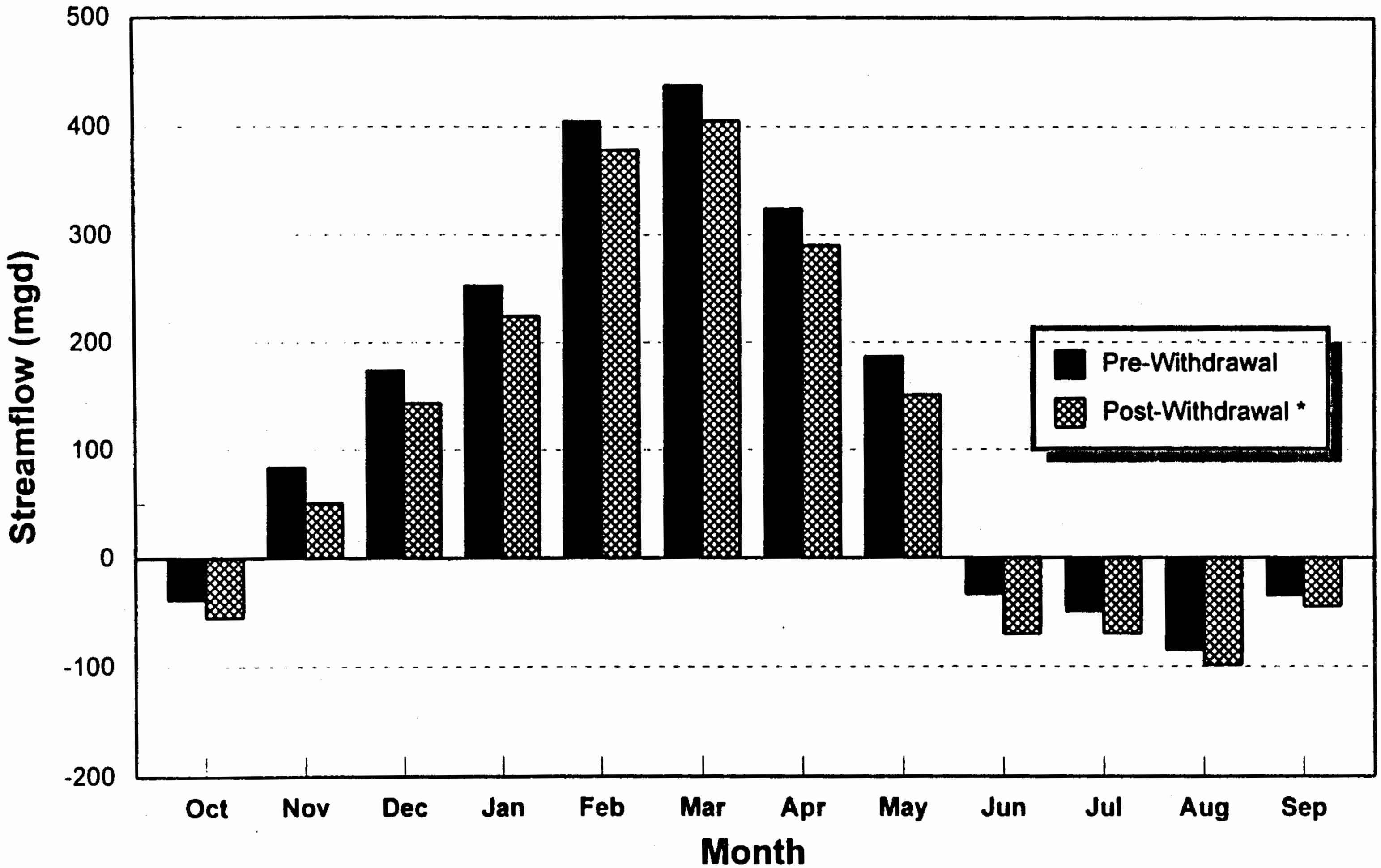


* KWR II Configuration Withdrawals

Figure 5-3P

MATTAPONI STREAMFLOW AT SCOTLAND LANDING

MEAN - 1 STANDARD DEVIATION MONTHLY VALUES



* KWR II Configuration Withdrawals

Figure 5-3Q

site and a normal reservoir release which averages 3 mgd[1]. A 5 mgd net reduction in average Cohoke Creek flow represents a 0.6 percent decrease in the estimated average freshwater discharge in the Pamunkey River Basin (883 mgd). In reality, the net flow reduction would be somewhat less than this, since reservoir seepage losses and spillage would increase average flows below the dam to a level greater than the minimum release.

Reservoir

Construction of a dam on Cohoke Mill Creek would inundate 28.25, 26.50, 24.41, and 20.99 miles of free flowing perennial and intermittent streams for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively. Streamflows would be restricted to 38 percent of existing average flow. The net reduction in freshwater discharge at the proposed dam sites would be 5 mgd.

Pipeline

The pipeline for this alternative would cross 65, 60, 58, and 60 stream/wetland areas for the KWR I, KWR II, KWR III, and KWR IV configurations, respectively. These stream/wetland crossings would be accomplished using conventional cut and fill techniques. It is possible that the pipeline would be constructed during the drier months of the year, at which time many of the intermittent streams may not be flowing. Flowing streams could be temporarily diverted with cofferdams, which would be removed following pipeline construction. Any impacts to the hydrology of those streams would be temporary and minimal.

The Pamunkey River crossing would be completed using directional drilling techniques which can be accomplished from the shore and should not affect the hydrology of the Pamunkey River. The pipeline would also cross an arm of the Little Creek Reservoir using either conventional cut and fill techniques, directional drilling techniques, or an elevated crossing.

As part of this alternative, Beaverdam Creek would be used as an inter-reservoir conveyance channel. The proposed outfall on Beaverdam Creek would have the potential to create physical, chemical, and biological changes in the creek. With a maximum raw water discharge capacity of 50 mgd, this outfall could cause greater meandering of the stream channel and substantially increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels, higher nutrient flushing rates, and greater saturation of the floodplain wetlands through recharge. These latter changes could be beneficial to aquatic life by providing a hydrologic regime that supports a wide assemblage of aquatic organisms.

Potential impacts to Beaverdam Creek through channel scouring and increased sediment loading are discussed below.

All of the water reaching Beaverdam Creek from the Mattaponi River would first be routed through the King William Reservoir which would serve to attenuate flows eventually reaching Beaverdam Creek. Maximum King William Reservoir withdrawals conveyed to Beaverdam Creek (about 50 mgd) would be less than the maximum Mattaponi River withdrawals (75 mgd). In addition, King William Reservoir withdrawals would be much less variable than Mattaponi River

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1 For the currently proposed KWR-IV configuration, the minimum release would average 2 mgd during normal higher reservoir pool conditions and 1 mgd during critical reservoir drawdown periods (see Section 3.3.3).

withdrawals which would be subject to the high natural variability of river flows. This flow attenuation would reduce the intensity of changes in hydrologic regime in Beaverdam Creek.

The outfall to Beaverdam Creek would be a standard U.S. Bureau of Reclamation impact type structure, designed for a maximum discharge capacity of 50 mgd. A short, riprapped discharge channel would connect the outfall to the main Beaverdam Creek channel. The outfall would be designed to dissipate most of the energy associated with the 8 feet per second maximum velocity of water exiting the pipeline. Additional energy would be dissipated and the flow velocity reduced in the short riprapped channel.

After reaching Beaverdam Creek, the reduced velocity flow would travel 0.8 miles downstream to the open waters of the Diascund Creek Reservoir at elevation 26 feet msl. The average water surface slope along this path is only 0.1 percent. This very gradual slope minimizes potential erosional effects from the increased flow level in Beaverdam Creek.

To further evaluate the impact of the pipeline discharge on the 0.8 miles of Beaverdam Creek between the discharge point and the reservoir, daily flows at the discharge point both with and without the discharge were estimated and compared. Daily flows at a USGS gaging station on Beaverdam Swamp near Ark in Gloucester County, Virginia were adjusted to acquire an estimate of the daily flows at the discharge point on Beaverdam Creek. The flows were adjusted in proportion to the respective drainage areas. The drainage area at the USGS gaging station on Beaverdam Swamp is 6.6 square miles. Beaverdam Creek at the pipeline discharge point has a drainage area of 6.4 square miles. The resulting adjusted flow record for the period from October 1949 through September 1987 was combined with the projected monthly average pumpover flows from King William Reservoir to Diascund Creek Reservoir. These pumpover flows were projected for the same period of record using the Newport News Waterworks safe yield model, with the King William Reservoir being utilized to its full safe yield potential for the entire period. With the projected pumpover flows added to the estimated natural stream flows, the projected average daily flow increased to 32.6 mgd, from the estimated natural average daily flow of 4.5 mgd.

To assess the erosion potential of this higher average flow, a profile and cross-section survey and inspection of the channel's physical characteristics was conducted from the downstream discharge site to the open water of Diascund Creek Reservoir. Cross-sections were taken approximately every 500 feet along the stream. At a flow of 32.6 mgd (projected future average daily flow), the maximum calculated flow velocity at any section was 1.2 feet per second (fps) or less. At a flow of 54.5 mgd (50 mgd peak pipeline discharge plus current average daily flow) the maximum calculated flow velocity was 1.3 fps. At a flow of 59.3 mgd (50 mgd peak pipeline discharge plus current 10 percent exceedence flow) the maximum calculated flow velocity was 1.4 fps. The flow velocities are relatively low due to the relatively flat channel bottom slope of 0.1 percent from the pipeline discharge point to the open water of the reservoir.

In order to compare projected flows with the pipeline discharge to existing high flow conditions, the peak flow rates from the 2-Year and smaller storms were estimated using the U.S. Soil Conservation Service TR-55 Graphical Peak Discharge method. The following table presents a summary of estimated existing and future flows at the pipeline discharge point.

Event	Flow (mgd)	Velocity (fps)
Estimated historical average daily flow	4.5	0.70
Estimated future average daily flow at full utilization of King William Reservoir	32.6	1.16
Estimated historical average daily flow plus 50 mgd pipeline discharge	54.5	1.32
Estimated 10 percent exceedance daily flow plus 50 mgd pipeline discharge	59.3	1.35
Estimated 2.0-inch rainfall peak flow	52.0	1.30
Estimated 2.5-inch rainfall peak flow	63.0	1.37
Estimated 3.0-inch rainfall peak flow	163.0	N/A
Estimated 3.5-inch rainfall peak flow (2-Year Storm)	305.0	N/A

*Velocity for 3.0- and 3.5-inch rainfalls not calculated due to out-of-bank flow condition.

Comparison of the estimated future flows with the peak pipeline discharge flow included to the estimated existing peak storm flows shows the future flows to be comparable to or less than the peak flows associated with 2.0-inch and 2.5-inch rainfall events. These types of rainfall events occur relatively frequently and are not generally associated with marked channel erosion or alignment changes in natural stream systems. Stream channel size and characteristics are generally controlled by the 1.5-Year recurrence interval storm (Rosgen, 1994). For the Beaverdam Creek watershed at the pipeline discharge point, these storms are estimated to generate peak storm flows that are 3 to 6 times greater than the majority of flows attributable to the pipeline discharge.

Due to the relatively flat channel bottom slope between the pipeline discharge point and the open water of Diascund Creek Reservoir, and the magnitude of difference between the 1.5-Year storm flows and projected pipeline discharge flows, no marked channel changes are predicted for Beaverdam Creek below the pipeline discharge point. This analysis shows that a flow of 54.5 mgd would be expected to have minimal erosive effects on the natural stream channel from the pipeline discharge point to the open water of Diascund Creek Reservoir. Maximum velocity at the point of discharge is expected to be only 1.3 fps, and the natural Beaverdam Creek stream channel contains stiff clay soils that are resistant to erosion. The stream bed at the discharge point is also periodically disturbed by floodwater from Diascund Reservoir, so this natural lotic system has already been altered by lake inundation.

Groundwater Resources

A possible concern exists over direct freshwater withdrawals from the Mattaponi River of up to 75 mgd, and the possible encroachment of salinity into tidal freshwater reaches of the Mattaponi Watershed. If this were to occur, the potential for saltwater encroachment into the shallow aquifers would be high. However, based on the proposed MIF which precludes withdrawals during drought conditions, and based on salinity intrusion modeling, little change in the water quality of the shallow aquifers beneath and bordering the river is expected.

Alteration of the existing groundwater flow velocity patterns is expected in the Cohoke Mill Creek and adjacent watersheds. A corresponding increase in lateral seepage due to the rise in water table elevation and relationship to the Pamunkey and Mattaponi Rivers has been estimated at 1.5 mgd. Underseepage below the dam has been estimated at 0.5 mgd.

Based on water quality data for the Mattaponi River compiled by Malcolm Pirnie, an initial screening of the proposed King William Reservoir watershed, and a salinity intrusion impact study (Hershner et al., 1991), there should be little effect to overall water quality of the shallow aquifer system.

Implementation of a drinking water reservoir alternative would directly (via recharge) and indirectly (via alternative supply) benefit the groundwater resources of the region.

In general, construction activities related to the reservoir and dam should have little effect on groundwater quality and quantity within the watershed.

Soil and Mineral Resources

Construction of an intake facility at the proposed Scotland Landing intake site would cause the disturbance of approximately 3 acres of Tetotum, Bojac, and Tarboro soils which are considered prime agricultural soils (Hodges et al., 1985). Construction of the access road would cause the disturbance of approximately 10 acres of these soils.

Filling the proposed KWR-II configuration pool area would result in the inundation of approximately 2,222 acres of land. However, open water and perennial streams already inundate an estimated 98 acres of this area. Therefore, 2,124 acres of soil would be inundated by the reservoir. Prime agricultural soils account for 342, 298, 277, and 228 acres for KWR-I, -II, -III, and -IV, respectively, and would be inundated. Presently, a negligible amount of this prime agricultural land is being used for farming purposes, while the remaining land is either wetland or forested land.

A total of approximately 59, 52, 53, and 43 acres of soil would be either removed or covered by the dam, emergency spillway, reservoir pump station, access road and associated structures for the KWR-I, -II, -III, and-IV configurations, respectively.

Effects to soil due to the construction of the raw water pipeline are expected to be temporary. A total of 94, 97, 101, and 104 acres of soils within the pipeline ROW would be temporarily disturbed for the KWR-I,-II,-III,-IV configurations, respectively. After construction, the disturbed soils would be restored to pre-construction conditions.

Air Quality

Only a small portion of this alternative falls within the boundaries of an ozone non-attainment area. Based on the preliminary layout, none of the air emissions resulting from this operation occur in the non-attainment area and therefore would not affect ambient ozone air quality levels.

During the construction phase of the project, it is likely that burning of some unusable cleared vegetation would be conducted on site. Due to the short-term nature of this activity, only a minimal effect on air quality would be expected. In addition, it is expected that clearing, excavation and construction activities would produce fugitive dust emissions in and around the site. Special attention would be given to ensure effective implementation of dust suppression measures, particularly given the close proximity of recreational uses in Cohoke Millpond.

Fuel burning emissions from the use of construction equipment would be released during construction activities. A minimal effect on air quality would be expected due to the small amount of emissions relative to other sources of air pollution in the region and since these activities would be temporary.

5.2.4 Fresh Groundwater Development

Substrate

This alternative would involve the excavation and removal of an estimated 0.18 acres of substrate during construction of the eight pipeline outfalls.

Water Quality

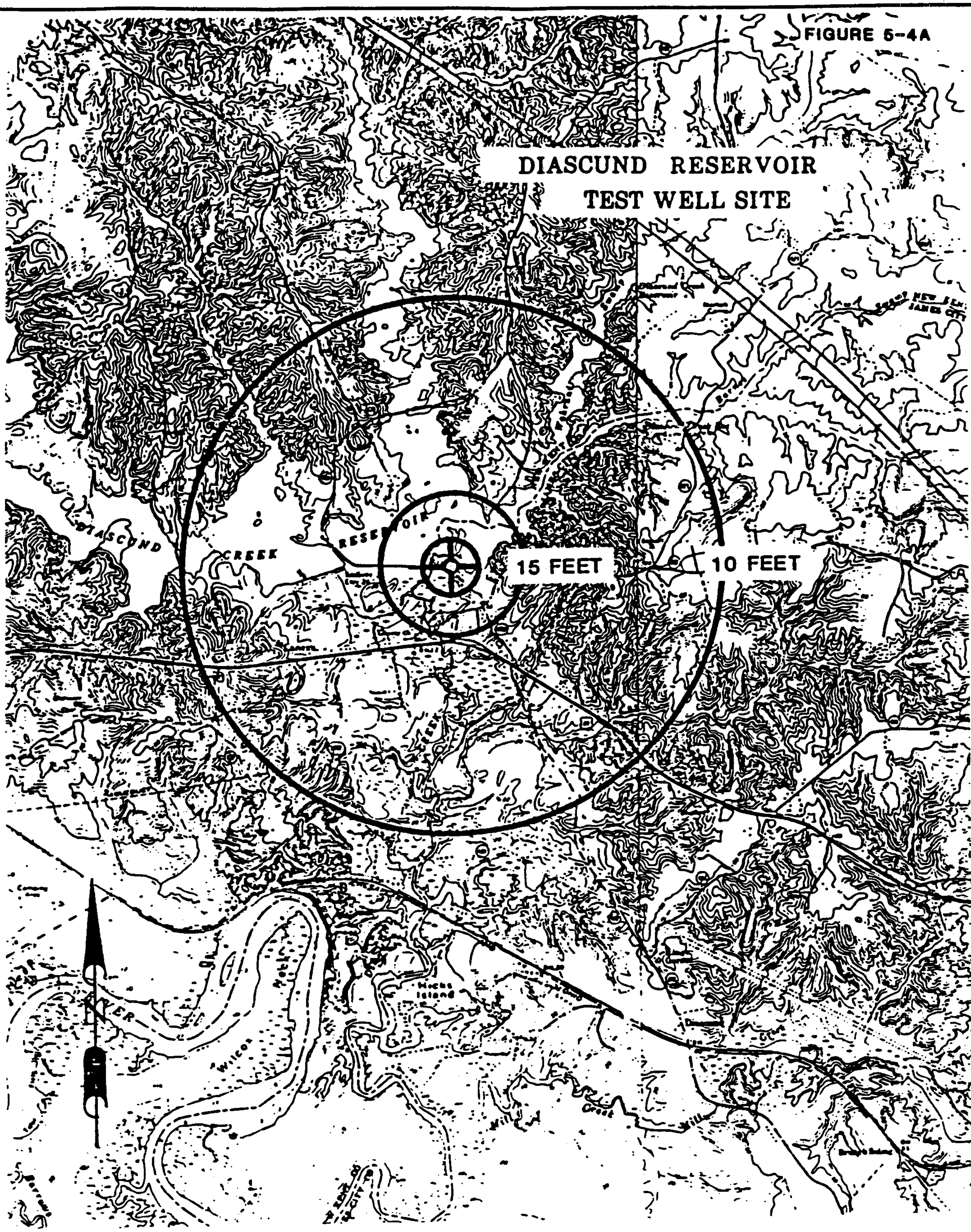
Surface waters involved in this alternative are Diascund Creek Reservoir and Little Creek Reservoir. The principal impact would be to increase chloride, bicarbonate, sodium, sulfate, fluoride, and possibly phosphorus concentration in the two reservoirs. With the exception of phosphorus, water quality conditions for Little Creek Reservoir would be impacted the most. Phosphorus concentrations in the groundwater near Diascund Creek Reservoir are expected to be higher than at Little Creek Reservoir. Concentrations over short periods of time may be sufficient to impact aquatic life in the two reservoirs, and increase treatment requirements at the terminal reservoirs.

Hydrology and Groundwater Resources

In 1988, two test wells were installed by the City of Newport News to evaluate the water quality and yield of the Middle Potomac Aquifer in the vicinity of Diascund Creek and Little Creek reservoirs. Figures 5-4A and 5-4B show the predicted drawdowns after one year of pumping from a single production well located at each of the reservoir sites. The report, prepared by Geraghty & Miller, concluded that development of a 10 mgd supply of fresh groundwater from the Middle Potomac Aquifer was feasible with well yields between 1 and 1.5 mgd (Geraghty & Miller, 1988). Transmissivities reported for the aquifer appeared to be low compared to USGS publications and the USGS Coastal Plain Regional Model, and the predicted drawdown may, therefore, be exaggerated.

In 1992, Malcolm Pirnie conducted several modeling studies using a three-dimensional groundwater flow model developed by the USGS. In these 1992 modeling studies, fresh groundwater withdrawals were simulated in James City and New Kent counties at rates ranging from 2.1 to 10.3 mgd (Malcolm Pirnie, 1992c and 1992d). There was no simulation done for this specific 10 mgd alternative; however, the results of the previous modeling provide insight into the approximate drawdowns anticipated from the two proposed well fields. The following

FIGURE 5-4A



SOURCE: GERAGHTY & MILLER, 1988

ESTIMATED DRAWDOWN IN THE MIDDLE POTOMAC AQUIFER AFTER ONE YEAR OF PUMPING (AT 1,000 GPM.)

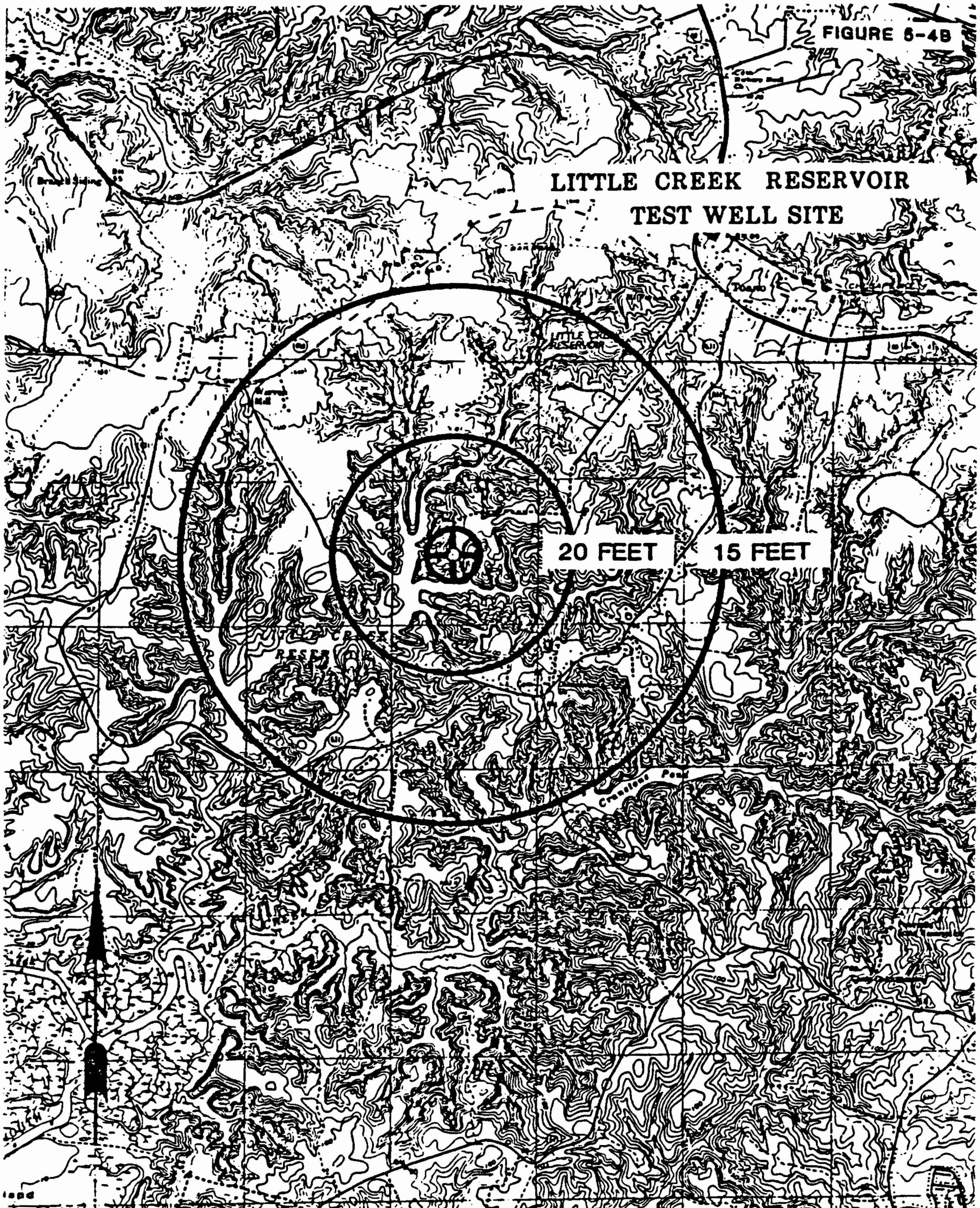
DECEMBER 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

DIASCUND CREEK TEST WELL SITE

1 0 1

SCALE IN MILES

MALCOLM PIRNIE



SOURCE: GERAGHTY & MILLER, 1988

ESTIMATED DRAWDOWN IN THE MIDDLE POTOMAC AQUIFER AFTER ONE YEAR OF PUMPING (AT 800 GPM.)

DECEMBER 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

LITTLE CREEK TEST WELL SITE

1 0 1

SCALE IN MILES

MALCOLM PIRNIE

table shows the regional drawdown predicted in the Middle Potomac Aquifer for a 10 mgd withdrawal located in James City and New Kent counties, based on previous modeling studies.

Estimated Drawdown from Fresh Groundwater Development

Middle Potomac Drawdown (feet)	Average Distance From Center Of Well Field (Miles)
-30	5
-20	12
-10	35
-5	50

Drawdown (or the lowering of groundwater levels) is a result of the nature of converging flow. Impacts may result from the lowering of water levels. Based on the results of the 1988 test well program and recent regional modeling, the anticipated drawdown from the two proposed well fields should not create drawdown exceeding 5 feet in the Yorktown, Chickahominy-Piney Point, and Aquia Aquifers. These aquifers are used for domestic, agriculture, and light industrial use throughout the Lower and Middle Peninsulas. The intervening confining sequences between the Middle Potomac Aquifer and the shallower aquifers limits the amount of vertical hydraulic communication between aquifers.

Based on the approximated regional drawdown in the Middle Potomac Aquifer, increased lift costs and possible lowering of pumps may be expected for some existing groundwater users. These users may include Chesapeake Corporation, the Town of West Point, the City of Williamsburg, the James City Service Authority, and New Kent County. Based on the previous studies conducted by Malcolm Pirnie, and projected future withdrawals based on groundwater use data, a new 10 mgd withdrawal does not appear likely to dewater any portion of the Middle Potomac Aquifer.

Anticipated changes in the potentiometric surface of the Middle Potomac Aquifer could induce east to west flow in limited areas. This condition indicates that a potential for increased east to west encroachment of saline groundwater would exist.

Soil and Mineral Resources

Each well site would require the clearing of approximately 0.5 acres to accommodate the well, well pumphouse, and security fence. Construction activities required would temporarily disturb the soils. In addition, approximately 2 acres of soils would be disturbed for the pipeline ROW for all eight wells. After construction, disturbed soils would be restored to a more natural state.

Air Quality

This alternative would not cause a detrimental impact on air quality. Construction of new pipelines would involve only a minimal amount of land clearing and excavation. As a result, operation of construction equipment and vehicles would release limited quantities of combustion emissions.

5.2.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Substrate

This alternative would involve the removal of 0.09 acres of substrate at the concentrate discharge pipeline outfalls. An additional 0.18 acres of substrate would be temporarily disturbed at the four minor stream/wetland area crossings.

Water Quality

Surface waters involved in this alternative are the outfalls for the concentrate discharges. There are four proposed outfall locations under this alternative, three of which are in waters which would be classified as polyhaline and one is in waters which would be classified as mesohaline to oligohaline. The principal impact of the concentrate discharges would be from salinity, metal concentrations, and possibly nutrients. For the one outfall discharging to mesohaline waters, the increase in salinity in the vicinity of the discharge could be substantial. Because the concentration of metals and nutrients in the brackish groundwater are uncertain, the magnitude of this impact cannot be assessed at this time.

Hydrology

A discussion of the potential hydrologic impacts associated with deep brackish groundwater withdrawals is presented in the following discussion of Groundwater Resources.

Two perennial and two intermittent stream crossings would be required along the pipeline routes for this alternative. Any impacts to the hydrology of these streams from pipeline crossings would be temporary in nature, and are deemed minimal.

Due to the relatively small volume of concentrate which would be discharged per day, and the locations of the outfalls in tidal systems, it is expected that the discharges will have only very minimal, localized impacts on the hydrology of the receiving waters.

Groundwater Resources

Drawdown

Due to the location and depths of the proposed well system, no drawdown would be expected in the overlying shallow aquifers used by homeowners in surrounding areas for outdoor watering. Due to the depths of the anticipated withdrawals, the amount being withdrawn, and based on recent experience with similar withdrawals using the USGS groundwater flow model, no dewatering of the aquifer is anticipated during the project period.

Regional drawdown in the Middle Potomac Aquifer may be 9 to 10 feet at a distance of 10 miles from the center of the well system. The majority of current wells in the Middle and/or Lower Potomac Aquifer in southeastern Virginia should not experience drawdowns from the proposed desalination well system in excess of 5 to 10 feet. Water level declines of 5 to 10 feet are not normally considered severe unless pumping appurtenances are subsequently dewatered.

Water Quality

The area west of the pumping center may experience less brackish groundwater conditions as brackish water encroachment to the west is reversed. Concurrent with this process, existing brackish areas of the aquifer east of the well system may experience an increased brackish condition as groundwater from the eastern portions of the aquifer are encouraged to move toward the pumping center.

Soil and Mineral Resources

The five wells associated with this alternative would be installed in urban and suburban areas in which many major improvements have already been made. Therefore, disturbances to soils during construction would be minimal when compared to existing improvements in the vicinity of the proposed project site.

Soils would be disturbed within the estimated 65 acres of pipeline ROW required for this alternative. After construction, the soils would be restored to a natural state. Permanent construction impacts are expected to affect less than 5 acres of soil.

Air Quality

This alternative has the potential to affect short-term air quality due to the additional automobiles and machinery in the area and traffic delays during construction. However, the impacts are not expected to be noticeable in relation to the far more adverse traffic congestion typical of the region.

5.2.6 Additional Conservation Measures and Use Restrictions

Substrate

Implementation of this alternative would have no impact on aquatic ecosystem substrate.

Water Quality

Implementation of this alternative is not expected to impact existing water quality conditions.

Hydrology

This alternative component could stimulate the installation of new shallow wells to provide water for nonessential uses. However, additional conservation measures and the imposition of use restrictions on customers currently serviced by Lower Peninsula water purveyors would be expected to have a negligible effect on surface and subsurface hydrology.

Groundwater Resources

Implementation of additional conservation measures and use restrictions by municipal water purveyors would be expected to have a negligible impact on groundwater resources.

Soil and Mineral Resources

The implementation of this alternative would have no impact on soil and mineral resources.

Air Quality

The implementation of this alternative would have no adverse impact on ambient air quality.

5.2.7 No Action

Substrate

This alternative would have no impact on aquatic ecosystem substrate.

Water Quality

Existing reservoirs would be drawn down more severely and for more prolonged periods. This would likely result in the degradation of existing water quality in the reservoirs. Diascund Creek Reservoir storage was reduced to 20 to 25 percent of its total capacity for an 8-month period in 1983 and 1984. During this period, hypereutrophic conditions developed in the reservoir, on the basis of a mean total phosphorus concentration of 0.09 mg/l. Concentrations of phosphorus are higher during reservoir drawdown because of: 1) Decreased settling time for tributary inflows of phosphorus, 2) Increased exposure of fine-grained, phosphorus-rich bottom sediments to resuspending forces, and 3) Increased algae uptake of phosphorus directly from bottom sediments (Lynch, 1992). Under the No Action alternative, the reservoirs would be increasingly drawn down to extremely low levels for extended periods of time. Eutrophic conditions could occur during similar periods and would impact all the existing reservoirs in the Lower Peninsula.

Hydrology

The No Action alternative would have an adverse impact due to further stress of already limited surface water and groundwater sources.

Groundwater Resources

If no action is taken, existing sources will be relied upon more heavily, and cumulative impacts on the regional aquifer system may result. As reservoirs are drawn down further, and groundwater use increases to maximum permit limits, some undesirable impacts on groundwater resources would be expected. The USGS has simulated the withdrawal of groundwater at permitted maximums and found that dewatering of limited western portions of some aquifers, and an increase in the potential for salt water encroachment, could occur (Laczniak and Meng, 1988).

Soil and Mineral Resources

The No Action alternative would have no impact on soil and mineral resources.

Air Quality

The No Action alternative would have no adverse impact on ambient air quality.

5.3 BIOLOGICAL RESOURCES

5.3.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Endangered, Threatened or Sensitive Species

No critical habitat has been designated by the USFWS for the Bald Eagle (*Haliaeetus leucocephalus*), Small Whorled Pogonia (*Isotria medeoloides*), or Sensitive Joint-vetch (*Aeschynomene virginica*). Therefore, this alternative would not result in the destruction or adverse modification of any USFWS designated critical habitat.

Due to the distance between the proposed intake on the Pamunkey River at Northbury and the Bald Eagle nests in the vicinity, no consequential adverse impacts to the nest sites are expected as a result of the intake construction or operation. In addition, no measurable impacts to transient individuals are expected, due to the small size of the area of disturbance as compared to the large area of remaining habitat available to the species in the region. The proposed pipeline from the Northbury intake site to the Ware Creek Reservoir may be far enough away from the Bald Eagle nest to preclude direct impacts. However, the VDCR has recommended consultation with the USFWS and the VDGIF to ensure that potential impacts are minimized (T.J. O'Connell, VDCR, personal communication, 1992). If necessary, potential impacts could be avoided by conducting construction activities in areas closest to the Bald Eagle nest outside of the eagle breeding and nesting season to the maximum extent possible.

No direct impacts to Bald Eagles are anticipated as a result of reservoir construction. The presence of an open water system and food source would enhance the potential for eagles to inhabit the area.

No appreciable impacts to Pamunkey River tidal freshwater vegetative communities are expected as a result of salinity changes due to the proposed withdrawal. No known populations of Sensitive Joint-vetch are located in the vicinity of the proposed intake site at Northbury on the Pamunkey River (Perry, 1993) (Appendix 8 of Report E, ***Biological Assessment for Reservoir Alternatives*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document). The species' historical range encompasses at least 19.5 river miles of the Pamunkey and the closest known population of this species occurs approximately 5 miles downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

The wide geographic range of the Sensitive Joint-vetch along the Pamunkey River shows that this species may be tolerant of oligohaline conditions and even mesohaline conditions on occasion. Sweet Hall Marsh (the most downstream occurrence of the species) is an extensive marsh which is drained by many tidal channels which have little freshwater input. Therefore, salinity conditions in this marsh would be expected to be closely approximated by salinity levels at adjacent Pamunkey River transects as indicated in Report I, ***Pamunkey River Intrusion Impact Assessment for Black Creek Reservoir Assessment*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document. At Pamunkey River Transect 36, adjacent to Sweet Hall Marsh, the predicted mean baseline salinity level was 0.67 ppt, or slightly oligohaline. Maximum predicted baseline salinity levels at Transect 36 fall into the mesohaline category (i.e., >5 ppt).

A recent University of Kentucky study submitted to the USFWS has shown that nondormant seeds of the Sensitive Joint-vetch can germinate to high percentages at low (10 ppt) concentrations of various salts, including NaCl, Na_2SO_4, and $MgSO_4$. However, at moderate to high (15 ppt) salt concentrations, germination is inhibited and after several days of incubation at these concentrations, the seeds lose viability (Baskin and Baskin, 1995a).

The salt concentrations tested in Baskin's study were more than an order of magnitude larger than the predicted mean baseline salinity levels at the most downstream occurrence of the Sensitive Joint-vetch at Sweet Hall Marsh. Even at 10 ppt, the Sensitive Joint-vetch was shown to germinate. As shown above, maximum salinities at Sweet Hall Marsh based on expected Year 2040 withdrawals were predicted to be substantially less. Therefore, based on salinity modeling results and known salinity tolerance of the species, the small predicted salinity increases from withdrawals by the RRWSG should not have an effect on the distribution of the Sensitive Joint-vetch in the Pamunkey River.

A site survey for Sensitive Joint-vetch resulted in the identification of no extant populations of the species within Ware Creek tidal wetlands (Perry, 1993) (Appendix 9 of Report E). Impacts to approximately 12 acres of potential habitat of the species could occur during construction activities at the proposed reservoir site. Impacts to approximately 2.5 acres of downstream habitat also could occur through construction activities.

The potential for loss of propagule source due to construction activities is unknown (Perry, 1993). Stands reappear many consecutive years at isolated sites, which indicates that either a substantial number of the seeds lodge near their source each year or that seed banking is involved, or both. On the other hand, some colonies have been noted to exhibit radical population changes from year to year. (Terwilliger, 1991). A recent study submitted to the USFWS has shown that Sensitive Joint-vetch seeds are impermeable to water when fresh but lose dormancy (i.e., seed coats become permeable to water) under extended dry laboratory storage. However, neither wet/dry cycles nor continuous drying for 75 days had an effect on germination of the seeds. (Baskin and Baskin, 1995b). Therefore, it is unlikely that minor changes in hydrology during construction will have an adverse effect on the habitat.

Downstream impacts could be minimized by locating work staging areas away from these areas and by implementing sediment control measures at all times. Additional impacts to Sensitive Joint-vetch habitat could occur due to the anticipated loss of tidal freshwater conditions in Ware Creek below the proposed dam site.

Two Small Whorled Pogonia specimens were found during the 1994 Ware Creek survey. The two plants are located in young forest stands within the proposed pool area and would be flooded by the proposed reservoir. It is possible that the two plants are part of a larger dormant colony. Given the less than ideal habitat (heavy overstory) and the presence of only two vegetative shoots without buds, it is unlikely that a viable population is present. These two plants may be remnants of a previously larger population which is in decline due to timbering, replanting and associated disturbance of the area.

The life history of the Small Whorled Pogonia is not well known or understood. Searches for new populations are necessary throughout the species' range and continued monitoring of existing populations should be conducted until the life history of the species is better understood (D. M. E. Ware, 1991). Study sites for the Ware Creek Reservoir survey were selected using accepted methodology and criteria. However, Small Whorled Pogonia have been found in areas which do not meet the accepted criteria. The presence of Small Whorled Pogonia in the project area indicates that the species occurs in the area and may continue to do so if it is left undisturbed. It also is possible that additional plants are present in the project area outside the study sites. However, all known sites with suitable habitat have been surveyed, thereby minimizing the possibility that any undiscovered plants are part of a viable population.

The RRWSG is investigating mitigation alternatives for potential impacts to Small Whorled Pogonia resulting from any of the reservoir project alternatives. Possible components of a mitigation plan include purchasing a conservation easement for a known viable population which is imminently threatened. With the assistance of Dr. Donna Ware from the College of William and Mary, two possible preservation sites for the Small Whorled Pogonia have been identified. One site, in James City County, is subject to development pressure. The second site, in Gloucester County, has had as many as 40 individuals identified. Details of proposed Small Whorled Pogonia preservation are outlined in Section 3.7.

Due to the modification of the freshwater flow of the Ware Creek system following construction of the dam, it is likely that the freshwater tidal marsh in Ware Creek would become brackish. This rapid salinity change could threaten ecologically important community types and their component species. The principal impacts of reservoir construction on downstream salinities are expected to include loss of tidal freshwater vegetation and reduction or elimination of the oligohaline assemblage.

Fish and Invertebrates

Potential impacts from intake structures include entrainment and impingement of fish eggs and larvae. Alewife and Blueback Herring could be susceptible to greater impacts than other anadromous fish species because their eggs are distributed throughout the water column. The NMFS generally recommends that through-screen velocities at raw water intakes not exceed 0.25 feet per second (fps), for the protection of anadromous fish larvae. To meet this requirement, approximately 40 wedge-wire profile submerged intake screens would be used. These screens would be approximately 5 feet in diameter and 5 feet in length. Screens would require a water depth of at least 15 feet and would be placed midway between the river bottom and average water surface.

With wedge-wire screens having very low entrance velocities (i.e., $\leq$ 0.25 fps) and very small openings (i.e., 1 millimeter slots), it is unlikely that severe impingement and entrainment impacts would occur. Some small fraction of eggs could potentially be damaged while attached to the screens. However, it is expected that eggs which float on the surface over the intake or roll on the bottom would safely pass the intake structures. Also, because American Shad, Hickory Shad, and Striped Bass eggs are slightly heavier than water, it is likely that the majority of these eggs would be located below the intake entrance and would not be affected.

An additional consideration is that while eggs are unable to move away from the intakes, larvae are capable of propelling themselves away from the pull of the intakes. This natural mechanism would help minimize larvae impingement on the intake screens.

It is possible, but probably not likely, that viable river herring eggs or larvae could be transferred from the Pamunkey River to the reservoir and that river herring could become established in the reservoir. If that were to occur, there would be a slight possibility that viable river herring (or eggs or larvae) could be transferred in turn from the reservoir to the James River basin, through reservoir withdrawals. However, it is unlikely that such a transfer would occur at all, or that it would have an adverse effect on the population of river herring in the James River. A more detailed discussion of the possibility for interbasin transfer of river herring is presented in Section 5.3.3.

Anadromous fish species should not be measurably affected by any potential changes in Pamunkey River salinity conditions caused by river withdrawals. These impacts are analyzed in Report I. As indicated in the report, only slight differences in simulated historical and withdrawal salinity records for Pamunkey River transects were observed in salinity model output.

Major impacts to fish and invertebrate species in Ware Creek would result from dam construction and inundation. These impacts would include conversion of current Striped Bass nursery habitat to a reservoir habitat. Once completed, the Ware Creek Reservoir would provide 1,238 acres of valuable open water habitat for freshwater fish and invertebrates. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program would also be implemented and would include supplementary stocking of forage and game species to augment the natural population.

The dam and operation of the reservoir would also affect the nature of the estuarine community in Ware Creek due to reduced freshwater flow rates below the proposed dam. The proposed minimum reservoir release, which ranges from 0.4 to 1.6 mgd, would reduce flow below the dam to between 3.6 and 14.4 percent of average estimated flow at the proposed dam site.

A study conducted by VIMS concluded that predicted changes in the salinity distribution in Ware Creek would result in the elimination of the tidal freshwater vegetation and reduction or elimination of the oligohaline assemblage (Hershner and Perry, 1987). Reduction of freshwater flows would result in the expansion of the type of fish and invertebrate habitat associated with greater salinity. This would be most pronounced in the existing tidal freshwater sections of Ware Creek near the proposed impoundment site.

A Habitat Evaluation Procedures (HEP) analysis has also been conducted for the proposed Ware Creek Reservoir (USFWS, 1987). The study concluded that lacustrine open water habitat value for the reservoir area is projected to increase by 1,416 average annual habitat units or 1,298 percent. The HEP analysis also indicated that the impact on estuarine finfish would be minimal and temporary.

Impacts associated with reservoir construction could include an increase in levels of suspended sediment. These impacts would be temporary and could be minimized by sediment control measures. Unplanned impacts such as oil spills from machinery could also have adverse impacts on benthic species. The degree of impact and recovery would be dependent on the magnitude of the spill (USCOE, 1987).

Impacts to fish and invertebrates associated with pipeline construction would be minimal and temporary.

With a combined maximum raw water discharge capacity of 120 mgd, the two proposed pipeline discharges to Diascund Creek would create a substantially higher flow regime in the Creek. Given this high discharge rate, this reservoir alternative would have the highest probability of adversely affecting fish and invertebrate species at and downstream of the discharge sites due to potential stream scouring and increased sediment suspension.

Other Wildlife

Impacts associated with the construction of the intake site would be limited to the disturbance of approximately 3 acres of forested and agricultural lands. Reptiles, amphibians, and small mammals would be the most affected by construction. Other wildlife would be displaced to adjacent habitats.

Approximately 625 acres of forested land would be lost through clearing and grubbing operations and subsequent inundation. Reptiles, amphibians, and small mammals which are less mobile would be the most affected by construction. Birds in the area are the most mobile of the vertebrate fauna and, as a result, fewer impacts would occur. Because areas adjacent to the reservoir are most likely fully occupied, most migrating individuals will not find room, or will displace others (USCOE, 1984). Approximately 1,194 acres of open water habitat would be gained with reservoir development.

The USFWS conducted a HEP study for the Ware Creek drainage area (USFWS, 1987). Based on cover typing of the study area, it was concluded that reservoir development would markedly affect habitat values in the following existing cover types: upland mixed forest, upland deciduous forest, forested wetland, scrub-shrub wetland, herbaceous wetland, open water and estuarine wetland (USCOE, 1987).

It is expected that the Great Blue Heron rookery would be threatened by inundation of the reservoir area (T. J. O'Connell, VDCR, personal communication, 1992; USEPA, 1992; USCOE, 1984; USCOE, 1987).

Although a large acreage of upland mixed forest would be converted to residential development, the absence of continued timber harvesting in the remaining mixed forested stands is projected to result in an increase in habitat value for this cover type.

Lacustrine habitat values would increase dramatically. All other cover types would suffer a loss of habitat value. The greatest habitat value losses would occur in forested and herbaceous wetland cover-types which would be inundated (USCOE, 1987).

Impacts to species currently utilizing palustrine and estuarine wetlands would occur due to changes in the source of primary productivity. Dabbling ducks such as the Black Duck would be negatively affected by the reservoir. Their food sources would be mostly destroyed by the removal and flooding of vegetation. Negative impacts are anticipated on amphibians requiring specific habitats for breeding and egg laying, such as specific water flow velocities or certain vegetation sizes.

Species utilizing community types along the pipeline route would be temporarily displaced. Due to the relatively small area of land requiring disturbance along the route, and the restoration, where possible, of affected land, the development of the underground pipeline should not substantially impact vertebrate species. Once revegetation (excluding reforestation) is complete, the pipeline ROW would provide valuable open field/shrub habitat adjacent to existing forested areas.

Sanctuaries and Refuges

No impacts to existing designated sanctuaries or refuges are anticipated as a result of intake placement in the vicinity of Northbury on the Pamunkey River, as a result of construction of the proposed Ware Creek Reservoir, or as a result of pipeline construction.

Wetlands and Vegetated Shallows

No direct impacts to wetlands at the intake site are anticipated because the pump station would be built on a high bluff above the river and the intake structures would be installed by directional drilling.

Potential secondary impacts would include:

- Increased sedimentation and wetlands loss downstream due to intake structure construction.
- Changes in tidal freshwater plant communities resulting from salinity increases in the Pamunkey River.

Assuming that the water quality of the Pamunkey River does not deteriorate due to other factors, such as increased wastewater discharges or dramatically increased irrigation withdrawals, the vegetative species composition of the tidal freshwater wetlands should not change appreciably as a result of the proposed water supply withdrawals. Potential salinity intrusion impacts to Pamunkey River wetlands are examined in detail in Report I.

A total of approximately 590 acres of tidal and non-tidal wetlands, including 40 acres of open water, in the Ware Creek watershed would be lost through filling, dredging or inundation as a direct result of construction of the Ware Creek Reservoir.

The Ware Creek Reservoir watershed encompasses approximately 76 percent of the entire Ware Creek watershed. The 590 acres of wetlands affected by the Ware Creek Reservoir project lie within both James City and New Kent Counties. These include nearly all of the wetlands within the reservoir watershed except a small number of headwater streams and isolated wetlands above the normal pool elevation. On a county scale, the 590 acres of wetlands represents approximately 1.8 percent of the estimated 32,957.2 acres found in James City County, or about 2.7 percent of the estimated 21,889.6 acres of tidal and non-tidal wetlands in New Kent County (VDCR, 1990).

According to the Wetland Evaluation Technique (WET) analysis performed for the estuarine and palustrine wetlands at the Ware Creek Reservoir site, the existing wetlands which would be inundated have a high probability of performing the following functions: floodflow alteration, sediment stabilization, sediment/toxicant retention, and wildlife habitat. There also would be a moderate probability that nutrient removal/transformation and production export functions would be lost.

Although the proposed reservoir would function differently from the existing wetlands, the reservoir would have a high probability of providing a number of the same functions that may be lost. Because of the reservoir's large capacity to store water, it would have a high probability of providing floodflow alteration, sediment/toxicant retention, and nutrient removal/transformation. It also would provide aquatic habitat and groundwater recharge. Additionally, it would have a high probability of providing recreation.

Sediment stabilization, wetland-specific wildlife habitat, and uniqueness/heritage value are three wetland functions and values, now likely to exist, which would not be provided by the reservoir. Any loss of the sediment stabilization function would be largely offset by the reservoir's large capacity for sediment retention. Although the proposed reservoir would very likely provide much lacustrine habitat and possibly even rare species habitat, habitat for wetlands dependent species would be lost. Additionally, the existing wetlands have a moderate probability of performing production export and groundwater discharge functions which also would be lost.

Additional impacts related to short-term reservoir construction effects could cause an increase in levels of suspended sediment resulting in siltation of vegetated wetlands below the dam site. However, these impacts would be temporary and could be minimized by effective sediment control measures.

Long-term changes in flow regime would occur in downstream wetlands. To indicate the degree of impact on the downstream segment of Ware Creek, the percent reduction of flow caused by the dam was estimated. Assuming an estimated average streamflow at the dam site of 11.1 mgd and a minimum reservoir release ranging from 0.4 mgd to 1.6 mgd, streamflow at the dam site would be reduced by at least 85.6 percent and perhaps as much as 96.4 percent. During more water-abundant times, a great deal more water than the minimum would be released. These releases do not include the amount of water recharged from the reservoir into local groundwater below downstream wetlands.

The Ware Creek dam would be built in the transition zone between freshwater and oligohaline waters. A VIMS study (Hershner and Perry, 1987) indicated that under average flow conditions after the dam was built, nearly all wetlands downstream of the dam, except those at the mouth of Ware Creek, would experience some change in vegetation community. Those tidal freshwater wetlands which remained downstream of the dam initially after its construction would be eliminated and replaced by an oligohaline vegetational community. The study also indicated that existing oligohaline zones below the proposed dam site would be greatly reduced or eliminated.

Some limited areas of stream/wetlands would be temporarily disturbed by construction of pipeline crossings. As discussed in Section 5.2.1, an estimated 1.2 acres of substrate would be affected by the 21 minor stream/wetland crossings required for pipeline construction. Based on the more detailed investigation of stream/wetland areas along the Black Creek Reservoir and King William Reservoir pipeline routes, the area of stream/wetland disturbance along the route would likely be 5 to 6 acres. Reforestation along the pipeline route would be suppressed to maintain the right-of-way. Pipeline construction and maintenance in forested areas could therefore result in fragmentation of habitat for some interior forest dwelling species. In addition, palustrine forested wetlands would most likely be converted to a palustrine emergent system after pipeline construction. Construction of the pipeline could allow *Phragmites communis* and other exotic species that thrive in disturbed areas to revegetate the pipeline right-of-way.

Mud Flats

No mud flats would be directly impacted in project areas for this alternative. Use of a turbidity curtain during construction of the intake structure would decrease sediment flow, thereby minimizing any potential impacts to downstream mud flats.

5.3.2 Black Creek Reservoir with Pumpover from Pamunkey River

Endangered, Threatened or Sensitive Species

A biological assessment of the Bald Eagle, Sensitive Joint-vetch, and Small Whorled Pogonia was undertaken to identify potential impacts to these species. The detailed results of this assessment are presented in Report E.

No critical habitat has been designated by the USFWS for the Bald Eagle, Small Whorled Pogonia, or Sensitive Joint-vetch. Therefore, this alternative would not result in the destruction or adverse modification of any USFWS designated critical habitat.

Potential impacts to endangered, threatened and other sensitive species resulting from the proposed Pamunkey River withdrawal at Northbury are discussed in Section 5.3.1.

No known populations of designated endangered or threatened species would be directly impacted by construction of the Black Creek Reservoirs. However, the following sensitive species are known to be, or may be, present in the vicinity of the reservoir site: Mabee's Salamander, Bald Eagle, Northern Diamondback Terrapin, and Small Whorled Pogonia.

Surveys of potential suitable habitat for Small Whorled Pogonia were conducted in the proposed reservoir areas in July 1993 and August 1994. No specimens of Small Whorled Pogonia were identified in these surveys. Therefore, it is not anticipated that the project would negatively impact individuals of the species. A detailed description of the survey methodology and results are presented in Report E.

Once the reservoir is constructed, it would provide valuable open water habitat. This would provide important foraging habitat for the Bald Eagle.

The proposed minimum combined release of 1.2 mgd represents 32 percent of the estimated combined average flow at the two dam sites. This release is anticipated to preserve the quality of downstream habitat in Black Creek that sensitive species may use.

The proposed pipeline from the Pamunkey River to the Black Creek Reservoir may be far enough away from the Bald Eagle nest to preclude any direct impacts. However, the VDCR has recommended consultation with the USFWS and the VDGIF to ensure that potential impacts are minimized (T.J. O'Connell, VDCR, personal communication, 1992). If necessary, potential impacts could be avoided by conducting construction activities in areas closest to the Bald Eagle nest outside of the eagle breeding and nesting season to the maximum extent possible.

Fish and Invertebrates

Potential impacts as a result of intake operation include entrainment and impingement of fish eggs and larvae. Alewife and Blueback Herring could be susceptible to greater impacts than other anadromous fish species because their eggs are distributed throughout the water column. The NMFS generally recommends that through-screen velocities at raw water intakes not exceed 0.25 fps for the protection of anadromous fish larvae. To meet this requirement, approximately 40 wedge-wire profile submerged intake screens would be used. These screens would be approximately 5 feet in diameter and 5 feet in length. Screens would require a water depth of at least 15 feet and would be placed midway between the river bottom and average water surface.

With wedge-wire screens, very low entrance velocities (≤0.25 fps), and very small screen openings (1 millimeter slots), it is unlikely that appreciable impingement and entrainment impacts would occur. Some small fraction of eggs could potentially be damaged while attached to the screens. However, it is expected that eggs which float on the surface over the intake or roll on the bottom, would safely pass the intake structures. Also, because American Shad, Hickory Shad, and Striped Bass eggs are slightly heavier than water, it is likely that the majority of the eggs would be located below the intake entrance and would not be affected.

An additional consideration is that while eggs are unable to move away from the intakes, larvae can propel themselves away from the pull of the intakes. This natural mechanism would help minimize larvae impingement of the intake screens.

It is possible, but probably not likely, that viable river herring eggs or larvae could be transferred from the Pamunkey River to the reservoir and that river herring could become established in the reservoir. If that were to occur, there would be a slight possibility that viable river herring (or eggs or larvae) could be transferred in turn from the reservoir to the James River basin, through reservoir withdrawals. However, it is unlikely that such a transfer would occur at all, or that it would have an adverse effect on the population of river herring in the James River. A more detailed discussion of the possibility for interbasin transfer of river herring is presented in Section 5.3.3.

Anadromous fish species should not be measurably affected by any potential changes in Pamunkey River salinity conditions caused by river withdrawals. These impacts are analyzed in Report I. As indicated in the report, only slight differences in simulated historical and withdrawal salinity records for Pamunkey River transects were observed in salinity model output.

Construction of the Black Creek Reservoir dams and inundation of the pool areas would cause the largest potential impacts to fish species in Black Creek. Impacts associated with reservoir construction could include an increase in levels of suspended sediment, resulting in siltation which might affect fish in the project area. However, these effects would be temporary and could be minimized by effective sediment control measures.

The proposed reservoir project would convert the flowing creek system within the pool area to a lacustrine system with deep water habitat and shallow shoreline areas. Some fish species present in the pool area may be eliminated by the loss of benthic food organisms and vegetation for spawning, nursery, and shelter. However, most of the species currently present in Black Creek commonly inhabit reservoir environments (see Table 5-12B).

Table 5-12B

Occurrence of Fish Species in Reservoir Environments
Black Creek Non-tidal Waters

Species		Commonly Inhabit	Rarely Inhabit
Scientific Name	Common Name	Reservoir Environments	Reservoir Environments
Ameiurus nebulosus	Brown Bullhead	X	
Anguilla rostrata	American Eel		X
Aphredoderus sayanus	Pirate Perch	X	
Clinostomus funduloides	Rosyside Dace		X
Enneacanthus gloriosus	Bluespotted Sunfish	X	
Erimyzon oblongus	Creek Chubsucker	X	
Esox americanus	Redfin Pickerel	X	
Esox niger	Chain Pickerel	X	
Etheostoma olmstedi	Tessellated Darter		X
Gambusia holbrooki	Eastern Mosquitofish	X	
Hybognathus regius	Eastern Silvery Minnow		X
Lampetra aepyptera	Least Brook Lamprey		X
Lepomis auritus	Redbreast Sunfish	X	
Lepomis gibbosus	Pumpkinseed	X	
Lepomis gulosus	Warmouth	X	
Lepomis macrochirus	Bluegill Sunfish	X	
Micropterus salmoides	Largemouth Bass	X	
Nocomis leptocephalus	Bluehead Chub		X
Notemigonus crysoleucas	Golden Shiner	X	
Notropis amoenus	Comely Shiner		X
Noturus gyrinus	Tadpole Madtom	X	
Rhinichthys atratulus	Blacknose Dace		X
Semotilus corporalis	Fallfish		X
Semotilus atromaculatus	Creek Chub		X
Umbra pygmaea	Eastern Mudminnow	X	
Total Number of Species	25	15	10

Sources:
Jenkins and Burkhead, 1993
VDGIF, 1993
R. Jenkins, personal communication, 1996

According to Dr. Robert Jenkins of Roanoke College (Jenkins, 1996), 14 of the 25 species found in Black Creek spawn in reservoirs. Eight of the 11 remaining species may spawn in the headwaters and persist in the reservoir: Rosyside Dace, Creek Chubsucker, Tessellated Darter, Least Brook Lamprey, Bluehead Chub, Blacknose Dace, Fallfish, and Creek Chub. Although the Creek Chubsucker spawns in creeks, this species may thrive in reservoir environments. The Comely Shiner and Eastern Silvery Minnow are riverine species and may become extirpated from the pool area (Jenkins, 1996). The catadromous American Eel is the only migratory fish found in the Black Creek Reservoir pool area. Although the eels present in the pool area could survive, recruitment of the species from outside the reservoir would be eliminated.

Construction of the two reservoirs would also block the potential passage of spawning anadromous or catadromous fish into the upper 3.8 miles and 2.8 miles of the Southern and Eastern branches of Black Creek, respectively, above the dams. This would effectively terminate all remaining fish passage in the Southern and Eastern branches of Black Creek above the dams and preclude future restoration of potential anadromous fish spawning habitat in Black Creek. Currently, fish passage in Black Creek is impeded, but not completely blocked, by numerous beaverdams which occur sporadically throughout the non-tidal portions of Black Creek. The impact of numerous beaverdams on fish passage is additive in that fewer and fewer fish are able to transverse each successive dam (Jenkins and Burkhead, 1993). Catadromous American Eels *(Anguilla rostrata)* were found in the upper reaches of the Black Creek watershed, but that does not indicate possible anadromous fish passage because eels are able to surmount much greater structures than most fish species (Jenkins and Burkhead, 1993).

By reducing freshwater flow rates, the operation of the reservoirs could affect fish habitat in Black Creek below the dams. If the reservoirs are built and operated as proposed, however, at least one-third of the average streamflow of Black Creek would be released from the dams at all times. These releases are expected to be sufficient to maintain existing fish habitat downstream of the dams. Therefore, only minimal changes in fish assemblages are anticipated in these areas.

Impacts to fish and invertebrates associated with pipeline construction would be minimal and temporary. With a maximum raw water discharge capacity of 40 mgd, the proposed pipeline discharge to Diascund Creek would create a higher flow regime in the Creek. Given this discharge rate, this reservoir alternative may adversely affect fish and invertebrate species at and downstream of the discharge site due to potential stream scouring and increased sediment suspension. However, adverse effects would be substantially less than the Ware Creek alternative which would have a maximum raw water discharge capacity of 120 mgd through two pipeline discharges.

Other Wildlife

Potential impacts to other wildlife at the proposed Pamunkey River intake site are discussed in Section 5.3.1.

Within the proposed reservoir pool area, approximately 546 acres of forested land (60 percent of the normal pool area) would be converted to open water. In addition, it is estimated that 285 acres of wetlands and 79 acres of agricultural/open field communities would be inundated. The loss of 910 acres of habitat represents 0.7 percent of the total 126,556 acres of forest open space and agricultural area in New Kent County (RRPDC, 1991). Approximately 864 acres of open water habitat would be gained.

The reservoir fringe and pool would provide habitat for some resident species and for some new species; however, terrestrial and wetland dependent wildlife would be affected by the inundation of wetland and forested areas. Species inhabiting the flooded area would be forced to migrate to other areas of similar habitat. If neighboring habitat patches are at or near their carrying capacity for a particular species, the increased population could alter population dynamics of that species until the population reaches equilibrium. For instance, an increased population could reduce the amount of food available per individual causing malnutrition and reduced survival of juveniles. If the population is at its carrying capacity, it also could be affected by reduced reproduction, increased predation, increased natural mortality, or increased emigration. If so, the overall effect would be a reduced population of that species in the region.

Less mobile species and species dependent on large contiguous habitat patches would be the most affected by reservoir construction. Reptiles, amphibians, and some small mammals would be least able to migrate to other habitat unless suitable habitat was available adjacent to the pool area. Birds would most likely be able to migrate, but could be limited by available suitable habitat.

Reduction in habitat also could affect temporary resident species. For example, many neotropical migratory song birds rely on large patches of temperate forest for breeding. Because of continued forest fragmentation and decreasing habitat, neotropical migratory birds have become more susceptible to predation. Therefore, reduction in habitat could result in decreased breeding success for certain neotropical migratory bird species.

Impacts to species currently utilizing palustrine wetlands would occur due to changes in the source of primary productivity. Dabbling ducks such as the Black Duck would be negatively affected by the reservoir. Their food sources would be mostly destroyed by the removal and flooding of vegetation. Negative impacts are anticipated on amphibians requiring specific habitats for breeding and egg laying, such as specific water flow velocities or certain vegetation sizes.

Some indirect effects (such as reduced foraging areas) could be felt by heron rookeries as a result of reservoir construction. However, no direct adverse effects upon these resources are anticipated because they are not in the immediate vicinity of the project site.

Due to the relatively narrow width of the pipeline right-of-way, and the restoration of affected land, where possible, the construction of the underground pipeline should not permanently impact vertebrate species. Once revegetation is complete, the pipeline right-of-way would provide open field or scrub/shrub habitat.

To allow access for maintenance of the pipeline, reforestation of the right-of-way would be suppressed. Therefore, sections of the pipeline traveling through forested areas could result in fragmentation of habitat for some species. The pipeline right-of-way could introduce edge species which may compete with or prey on forest interior species. For less mobile species, the right-of-way also could pose an unpassable barrier, thereby dividing a previously single population into two. This could result in decreased genetic diversity and increased susceptibility of each resulting population to disturbances.

Sanctuaries and Refuges

No impacts to existing designated sanctuaries or refuges are anticipated as a result of intake placement in the vicinity of Northbury on the Pamunkey River, as a result of construction of the proposed Black Creek Reservoir, or as a result of pipeline construction for this alternative component.

Wetlands and Vegetated Shallows

Project impacts in the vicinity of the Northbury site are described in Section 5.3.1.

An estimated total of 285 acres of non-tidal wetlands, including 46 acres of open water, would be inundated, filled, or removed by construction of the Black Creek impoundment. Estimates of the number of acres of wetlands affected were increased as a result of limited field verification. Before verification could proceed very far at the Black Creek Reservoir site, however, the New Kent County Board of Supervisors directed that this field work (and other studies related to construction of this Reservoir) be stopped.

The Black Creek Reservoir watershed encompasses approximately 17 percent of the entire Black Creek watershed. If built, the Reservoirs would flood or otherwise destroy almost all of the wetlands in Black Creek above the dams. The exceptions would be those wetlands on the small number of headwater streams and isolated wetlands above the normal pool elevation. The number of acres impacted by the Black Creek Reservoir were compared with the number of acres of wetlands throughout New Kent County, according to ***The Virginia Non-Tidal Wetlands Inventory*** (VDCR, 1990). The estimated 285 acres of wetlands affected by the Black Creek Reservoir project comprise approximately 1.3 percent of the estimated total of 21,889.6 acres of tidal and non-tidal wetlands in New Kent County (VDCR, 1990).

According to the Wetland Evaluation Technique (WET) analysis performed for the palustrine wetlands at the Black Creek Reservoir site, the existing wetlands which would be inundated have a high probability of performing the following functions: floodflow alteration, sediment stabilization, sediment/toxicant retention, and wildlife habitat. There also would be a moderate probability that groundwater discharge, and production export functions would be lost.

Although the proposed reservoir would function differently from the existing wetlands, the reservoir would have a high probability of providing a number of the same functions that may be lost. Because of the reservoir's large capacity to store water, it would have a high probability of providing floodflow alteration, sediment/toxicant retention, and nutrient removal/transformation. It also would likely provide aquatic habitat and groundwater recharge. Additionally, it would have a high probability of providing recreation.

Any loss of sediment stabilization function would be largely offset by the reservoir's large capacity for sediment retention. Although the proposed reservoir would very likely provide much lacustrine habitat and possibly even rare species habitat, habitat for wetlands dependent species would be lost. Additionally, the existing wetlands have a moderate probability of performing production export and groundwater discharge functions which also would be lost.

Additional impacts related to short-term reservoir construction effects could cause an increase in levels of suspended sediment resulting in siltation of vegetated wetlands below the dam sites. However, these impacts would be temporary and could be minimized by effective sediment control measures.

Based on field inspections of existing water supply reservoirs in the Virginia Coastal Plain, construction of the reservoir would likely result in little dewatering of the 210 acres of wetlands between the impoundment areas and the mouth of Black Creek. The combination of increased local groundwater levels caused by reservoir seepage, beaverdams, and the proposed minimum release of 1.2 mgd should be sufficient to maintain the hydrology of the downstream wetlands. However, slight vegetation community changes could take place downstream as a result of a relative shift in hydrologic source from surface water to groundwater and the attenuation of both flood and drought streamflows.

Approximately 6.4 acres of stream/wetland areas would be temporarily disturbed by construction of pipeline crossings. Reforestation along the pipeline route would be suppressed to maintain the right-of-way. Pipeline construction and maintenance in forested areas could therefore result in fragmentation of habitat for some interior forest dwelling species. In addition, palustrine forested wetlands would most likely be converted to a palustrine emergent system after pipeline construction. Construction of the pipeline route could allow *Phragmites communis* and other exotic species that thrive in disturbed areas to revegetate the pipeline right-of-way. Pipeline construction across an arm of Little Creek Reservoir would affect a deep open water area approximately 500 feet wide. Approximately 0.15 acres of stream/wetland areas would be affected by the outflow structure at Diascund Creek.

Mud Flats

No mud flats would be directly impacted in project areas for this alternative. Use of a turbidity curtain during construction of the intake structure would decrease sediment flow, thereby minimizing any potential impacts to downstream mud flats.

5.3.3 King William Reservoir with Pumpover from Mattaponi River

Four dam configurations are being presented for the King William Reservoir with pumpover from the Mattaponi River alternative: KWR I, KWR II, KWR III, and KWR IV. The intake site, pump station size, and a majority of the pipeline route for all four dam configurations are the same. The dam locations, pool elevations, and river withdrawal operating rules vary. Specific characteristics of each dam configuration are described in Section 3.4.15. Unless otherwise specified, biological resources are the same for all dam configurations of the King William Reservoir alternative.

Endangered, Threatened or Sensitive Species

A biological assessment of the Bald Eagle, Sensitive Joint-vetch and Small Whorled Pogonia was undertaken to identify potential impacts to these species. The detailed results of this assessment are presented in Report E.

No critical habitat has been designated by the USFWS for the Bald Eagle, Small Whorled Pogonia, or Sensitive Joint-vetch. Therefore, this alternative would not result in the destruction or adverse modification of any USFWS designated critical habitat.

No appreciable impacts to Mattaponi River tidal freshwater vegetative communities are expected as a result of salinity changes due to the proposed withdrawal. No known populations of species with special federal and/or state status in the tidal region of the Mattaponi River are anticipated to be directly impacted by intake construction and operation.

Colonies or specimens of Sensitive Joint-vetch, which is a federally-listed threatened plant species and has been proposed for state listing as endangered, have been recorded in five areas along a 15-mile stretch of the Mattaponi River, from Wakema/Gleason Marsh (downstream limit near Mattaponi River mile 13) upstream to just below Walkerton (upstream limit near Mattaponi River mile 28) (J.R. Tate, VDACS, personal communication, 1993). During a 1993 VIMS survey, approximately 2.5 acres of Sensitive Joint-vetch habitat were identified within the Garnetts Creek Marsh area directly across the River from the intake site (Perry, 1993). Subsequent surveys have recorded the presence of the vetch in Garnetts Creek Marsh and in a marsh approximately 600 feet upstream of Scotland Landing on the south side of the river (Rouse, 1995; Malcolm Pirnie, 1995; Rouse, 1996).

The wide geographic range of the Sensitive Joint-vetch along the Mattaponi River shows that this species may be tolerant of oligohaline conditions and even mesohaline conditions on occasion. Wakema/Gleason Marsh (the most downstream occurrence of the species) is an extensive marsh which is drained by many tidal channels which have little freshwater input. Therefore, salinity conditions in this marsh would be expected to be closely approximated by salinity levels at adjacent Mattaponi River transects as indicated in Report J, ***Tidal Wetlands on the Mattaponi River: Potential Responses of the Vegetative Community to Increased Salinity as a Result of Freshwater Withdrawal*** (Hershner et al., 1995) which is incorporated herein by reference and is an appendix to this document. Based on historical data, at Mattaponi River Transect 32 adjacent to Wakema/Gleason Marsh, the predicted mean baseline salinity level was 0.46 ppt, or slightly oligohaline. Maximum predicted baseline salinity levels at Transect 32 are 6.07 ppt, which fall into the mesohaline category (i.e., >5 ppt). Maximum salinities based on expected Year 2040 withdrawals were predicted to be 6.09 ppt, or 0.02 ppt greater than baseline levels.

The resolution of the VIMS salinity model is limited by the distance between adjacent transects. However, the model includes 43 Mattaponi River transects over the lower 36.2 miles of the river with only small differences in predicted salinity levels between adjacent transects. The predicted mean annual salinity levels in the critical tidal freshwater-oligohaline transition zone would differ by only about 0.1 to 0.2 ppt. This magnitude of salinity change is small compared to the salinity tolerance ranges for aquatic plants and animals which are documented in Report I. Therefore, salinity predictions for additional intermediate transects (obtained through refining model resolution) would not improve biological impact assessment capability, since predicted salinity changes between closer transects would be even smaller relative to species' tolerance limits. The Sensitive Joint-vetch, which was considered to have relatively narrow salinity tolerance limits, has been recorded within a 15-mile reach of the Mattaponi River and a 19.5 reach of the Pamunkey River. These river reaches are 18 to 23 times longer than the average distance separating the salinity model's current Mattaponi River transects (0.84 miles).

A recent University of Kentucky study submitted to the USFWS has shown that nondormant seeds of the Sensitive Joint-vetch can germinate to high percentages at low (10 ppt) concentrations of various salts, including $NaCl$, Na_2SO_4, and $MgSO_4$. However, at moderate to high (15 ppt) salt concentrations, germination is inhibited and after several days of incubation at these concentrations, the seeds lose viability (Baskin and Baskin, 1995a).

The salt concentrations tested in Baskin's study were more than an order of magnitude larger than the predicted baseline salinity levels at the most downstream occurrence of the Sensitive Joint-vetch at Wakema/Gleason Marsh, where predicted salinity effects on the species are greatest. Even at 10 ppt, the Sensitive Joint-vetch was shown to germinate. As shown above, maximum salinities at Wakema/Gleason Marsh based on expected Year 2040 withdrawals were predicted to be substantially less. Therefore, based on the VIMS salinity modeling results and known salinity tolerance of the species, the small predicted salinity increases from withdrawals by the RRWSG should not have an effect on the distribution of the Sensitive Joint-vetch in the Mattaponi River.

Impacts to Sensitive Joint-vetch individuals and approximately 2.5 acres of potential Sensitive Joint-vetch habitat could occur during construction activities and operation of the Mattaponi River intake site. Little information on the availability of seed for the species from the seed bank is available. Stands reappear many consecutive years at isolated sites, which indicates that either a substantial number of the seeds lodge near their source each year or that seed banking is involved, or both. On the other hand, some colonies have been noted to exhibit radical population changes from year to year. (Terwilliger, 1991). Potential propagule loss and damage to species habitat would be reduced or eliminated by:

- Locating work staging areas away from wetland areas.
- Implementing sediment control measures at all times.
- Avoiding compaction and disturbance of wetland soils.

In its 1993 Sensitive Joint-vetch study, VIMS concluded that: "... it appears that no existing plant will be impacted within the primary or secondary study areas by the proposed project" (Perry, 1993). The primary study area was defined by VIMS as both sides of the Mattaponi River from just below Scotland Landing upstream to Mantua Ferry. The secondary study area was defined by VIMS as the remainder of the tidal freshwater zone of the Mattaponi River. The tidal freshwater zone of the Mattaponi River encompasses all of the sites along the River for which historic Sensitive Joint-vetch occurrence records exist.

Consideration was given to the possibility that changes in river water velocities and sediment as a result of intake operation might alter Garnetts Creek marsh and impact Sensitive Joint-vetch habitat. Dr. David Basco, a civil/coastal engineer, prepared the ***Study of Potential Erosional Impact of Scotland Landing Water Intake Structure on Garnetts Creek Marsh, Mattaponi River, Virginia*** (Basco, 1996) which is incorporated herein by reference and is an appendix to this document (Report N). The study concluded that the relative change, if any, in water velocities and sediment transport potential are so small that the possibility for increased erosion on either side of the river is minimal to non-existent. Sediment deposition on the north side of the meander bend is expected to continue to increase the size of Garnetts Creek marsh in the future, providing more possible habitat for the Sensitive Joint-vetch. Natural sediment erosion on the south side of the meander bend does occur due to inundation and high velocities during freshwater flood events, and this is expected to continue. The habitat suitable for the south side colony of the Sensitive Joint-vetch is impacted by high bend velocities during normal, freshwater flood events (Basco, 1996). The results of the study show that no impacts are expected to the Sensitive Joint-vetch habitat at Garnetts Creek marsh as a result of intake operation. However, monitoring of conditions at the south side colony was suggested as a precaution to determine the cause of any erosion that may occur.

The proposed KWR pump station and residence at Scotland Landing is approximately 1,800 feet from a Bald Eagle nest. No adverse impacts to Bald Eagles are anticipated as a result of intake placement and operation, due to the small area of disturbance in relation to the large area of remaining habitat available to the species in the region and the distance of the structures from the nest. Noise resulting from operation of the pump station is not expected to disturb the eagles.

The KWR I dam would be approximately 375 feet from an existing Bald Eagle nest. Potential impacts to the eagles have been minimized by locating the KWR II dam 2,900 feet (channel distance) farther upstream. Additionally, the KWR III and KWR IV dams would be 7,500 and 9,700 feet (channel distance), respectively, from the KWR I dam site. However, the gravity pipeline for KWR I would still approach within 375 feet of the nest. The pipelines for KWR II, III, and IV would be more than 0.5 mile from the nest.

The primary threat to eagles using this nest is considered to be the short-term noise and disruption which would result from pipeline construction activities for the KWR I configuration. Those impacts can be avoided by conducting construction activities in the areas closest to the Bald Eagle nest outside of the eagle breeding and nesting season to the maximum extent possible.

The Bald Eagle nest in New Kent County (located within 0.5 miles of the KWR pipeline) is not expected to be affected by the project (J. Trollinger, VDGIF, personal communication, 1996).

Once the reservoir is constructed, it would provide valuable open water habitat for Bald Eagles. A discussion of the potential for the creation of Bald Eagle habitat at the reservoir site is presented in Report E. With appropriate management efforts, Bald Eagle foraging and nesting habitat could be successfully created at the proposed King William Reservoir site, especially given the following factors:

- Once the reservoir is filled, extensive undeveloped shoreline with large diameter trees would exist around the reservoir. The mature forests adjacent to the open water would greatly expand local Bald Eagle habitat by providing nesting, roosting, and perching sites.

- Extensive shallow water areas and freshwater fisheries would exist within the reservoir, thus greatly expanding the Bald Eagle's local foraging habitat and potential food supply.

- Large numbers of active Bald Eagle nesting sites already exist in the region, and the population could expand at the King William Reservoir site.

- The proposed King William Reservoir would provide an environment much more suited to Bald Eagle establishment than existing land use conditions, in which the site is used for timbering and hunting.

To minimize potential impacts and to enhance Bald Eagle habitat at the proposed reservoir, the following potential management measures may be useful:

- To the maximum extent possible, avoid construction activities in areas closest to the Bald Eagle nest during the entire eagle breeding season.

- Protect any new Bald Eagle nesting sites by establishing buffer zones around the nests. Cooperative agreements should be pursued with landowners to protect such nesting habitat.

- Promote eagle roosting site creation by establishing buffer zones around selected large open areas containing large trees (i.e., greater than 1.6-foot diameter) at low densities. Selective timbering of areas may be necessary to create suitable roost stands.

- Promote eagle perching site creation by establishing buffer zones around selected large trees (i.e., greater than 1.6-foot diameter) along the reservoir shore which have more open crowns than other trees along the shore.

- Install buoys to keep boats from approaching too close to eagle nest sites which are established around the King William Reservoir.

- Develop educational materials such as posters and leaflets to place in public locations close to established eagle roosting, nesting, and foraging areas. Such materials should educate the general public on the effects of land development, shooting, and other human activity on Bald Eagles.

Small Whorled Pogonia were found in two locations within the pool area common to all proposed King William Reservoir configurations. A single specimen was found in 1993 and 1994 in an upland deciduous second growth forest, and five plants were found in 1994 on an upland hummock between two small streams within a young pine stand. Both locations would be flooded by the proposed reservoir.

It is possible that both these areas may have supported more individuals of the species in the past. However, given the presence of only one shoot in two years of monitoring and the less than ideal habitat at the first location, and given the high degree of habitat degradation and uncharacteristic habitat at the second location, it is unlikely that these plants are part of a viable population.

The life history of the Small Whorled Pogonia is not well known, and the ability of scientists to predict where individual specimens may be found is limited. The presence of Small Whorled Pogonia in two locations in the project area indicates that the species can be found in the area and may be present in areas outside the study sites. However, all known sites with suitable habitat have been surveyed, thereby minimizing the possibility that any undiscovered plants are part of a viable population. Furthermore, three teams of biologists inspected the entire pool area of the reservoir during the Small Whorled Pogonia flowering period while conducting the wetland delineation.

The RRWSG is investigating mitigation alternatives for potential impacts to Small Whorled Pogonia resulting from any of the reservoir project alternatives. Possible components of a mitigation plan include relocation of threatened individuals and purchasing a conservation easement for a known viable population which is imminently threatened. With the assistance of Dr. Donna Ware from the College of William and Mary, two possible preservation sites have been identified. One site, in James City County, is subject to development pressure. The second site, in Gloucester County, has had as many as 40 individual specimens. Details of proposed Small Whorled Pogonia mitigation are outlined in Section 3.7.

Other sensitive species which may be present in the vicinity of the reservoir site include Mabee's Salamander and the Northern Diamondback Terrapin.

The originally proposed KWR-I minimum reservoir release is 3 mgd and does not vary seasonally. An alternative release schedule has been developed for the RRWSG's preferred KWR-II configuration which would average 3 mgd during normal higher reservoir pool conditions and 1 mgd during critical reservoir drawdown periods.[2] The 1 mgd average release schedule would be triggered when available King William Reservoir storage declines to less than 80 percent. The alternative release scenario varies by month to mimic the natural Cohoke Creek streamflow hydrograph. A 3 mgd release which, under projected Year 2040 demand conditions, would be in place approximately 70 percent of the time, represents 38 percent of the estimated average flow of Cohoke Creek at the KWR-II dam site. Both release scenarios are anticipated to preserve the quality of downstream habitat in Cohoke Millpond and Cohoke Creek that sensitive species may use. The reservoir is expected to also increase local groundwater recharge rates, thereby helping to preserve the quality of the downstream habitat.

Fish and Invertebrates

Potential impacts as a result of intake operation include entrainment and impingement of fish eggs and larvae. Alewife and Blueback Herring could be susceptible to greater impacts than other anadromous fish species because their eggs are distributed throughout the water column. The NMFS generally recommends that through-screen velocities at raw water intakes not exceed 0.25 fps for the protection of anadromous fish larvae. To meet this requirement, approximately 12 wedge-wire profile submerged intake screens would be used. These screens would be approximately 7 feet in diameter and 7 feet in length. Screens would require a water depth of at least 21 feet and would be placed midway between the river bottom and average water surface.

With wedge-wire screens, very low entrance velocities (≤0.25 fps), and very small screen openings (1 millimeter slots), it is unlikely that appreciable impingement and entrainment impacts would occur. Some small fraction of eggs could potentially be damaged while attached to the screens. However, it is expected that eggs which float on the surface over the intake, or roll on the bottom, would safely pass the intake structures. Also, because American Shad, Hickory Shad, and Striped Bass eggs are slightly heavier than water, it is likely that the majority of the eggs would be located below the intake entrance and would not be affected.

2 For the currently proposed KWR-IV configuration, the minimum release would average 2 mgd during normal higher reservoir pool conditions and 1 mgd during critical reservoir drawdown periods (see Section 3.3.3).

An additional consideration is that while eggs are unable to move away from the intakes, larvae can propel themselves away from the pull of the intakes. This natural mechanism would help minimize larvae impingement of the intake screens.

It is possible, but probably not likely, that viable river herring eggs or larvae could be transferred from the Mattaponi River to the reservoir and that river herring could become established in the reservoir. If that were to occur, there would be a slight possibility that viable river herring (or eggs or larvae) could be transferred in turn from the reservoir to the Pamunkey or James River basins, through reservoir releases or withdrawals. However, it is unlikely that such a transfer would occur at all, or that it would have an adverse effect on the populations of river herring in the Pamunkey or James Rivers. This is due to the improbability of the transfer of fish from the Mattaponi River to the reservoir, the improbability of the transfer of fish from the reservoir to the Pamunkey or James River basins, the naturally occurring genetic mixing of river herring populations in Chesapeake Bay tributaries, incidental mixing of stocks by man, and naturally occurring genetic variability in these fish populations. A full examination of the potential impact to river herring is presented in Report P, ***Literature Review on the Genetic Variability and Migration Patterns of Alewife and Blueback Herring Stocks in Chesapeake Bay Tributaries*** (Malcolm Pirnie, 1996) which is incorporated herein by reference and is an appendix to this document.

Anadromous fish species should not be measurably affected by any potential changes in Mattaponi River salinity conditions caused by river withdrawals. These impacts are analyzed in Report J. As indicated in the report, only slight differences in simulated historical and withdrawal salinity records for Mattaponi River transects were observed in salinity model output.

Due to the slight differences in historical and withdrawal scenarios for the Mattaponi River transects simulated in the VIMS model, measurable impacts to Mattaponi River tidal freshwater invertebrates are not expected as a result of river withdrawals. Many invertebrate species which inhabit the Mattaponi River can tolerate wide ranges of salinity. Invertebrate species that inhabit transitional areas (e.g., the tidal freshwater/oligohaline transition zone) are necessarily adapted to variable salinity conditions that occur both seasonally and as a result of short-term weather conditions.

Chironomid Midges, which are dominant species found in both tidal freshwater and oligohaline benthic samples from the Mattaponi River, have an approximate LC_{50} of 8.85 ppt salinity (*Chironomus attenuatus* tested in sodium chloride)[3] (USEPA, 1988). Other invertebrates, such as Oligochaete worms, scuds, snails, Nematode worms, Mayflies, and Aquatic Leaf Beetles were found in both freshwater and oligohaline samples. This range implies some tolerance of variable salinity conditions. Some water beetles and Caddisflies were only found in tidal freshwater samples. Of these, *Hydroptila angusta*, a Caddisfly, has an approximate LC_{50} of 7.30 ppt salinity (tested in sodium chloride) (USEPA, 1988). These toxicity values exceed the overall mean and maximum salinity values predicted for the tidal freshwater/oligohaline transition zone (Mattaponi River Transect 32). As presented in Report J, the predicted overall mean salinity under Year 2040 withdrawals is 0.49 ppt, or 0.03 ppt over the mean historical value. The predicted overall maximum salinity under Year 2040 withdrawals is 6.09 ppt, or 0.02 ppt greater than the maximum historical

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[3] An LC_{50} is the lowest concentration tested in which 50 percent mortality of the test organisms was observed. LC_{50}s in the literature are expressed in terms of mg/l of chloride. Values are converted to parts per thousand salinity using the following equation: salinity (ppt) = 1.80655 chlorinity (ppt) (Stumm and Morgan, 1981).

value. Natural Mattaponi River salinity fluctuations greatly exceed any salinity changes that were predicted under the Year 2040 withdrawal scenario. Because of the range of benthic invertebrates observed within the Mattaponi River samples, the LC_{50} values of species observed, and the small increases in salinity values predicted for tidal freshwater transects in the Mattaponi, impacts to tidal freshwater benthic invertebrates are not expected as a result of predicted salinity changes under Year 2040 withdrawals.

Construction of the King William Reservoir dam and inundation of the pool area would cause the largest potential impacts to fish species in Cohoke Creek. Impacts associated with reservoir construction could include an increase in levels of suspended sediment, resulting in siltation which might affect fish in the project area. However, these effects would be temporary and could be minimized by effective sediment control measures.

Once completed, the reservoir would convert the flowing creek system within the pool area to a lacustrine system with deep water habitat and shallow shoreline areas. Some fish species present in the reservoir pool area may be eliminated by the loss of benthic food organisms and vegetation for spawning, nursery, and shelter, but most species currently present in Cohoke Creek have been documented in reservoir environments (Table 5-12C).

According to Dr. Robert Jenkins of Roanoke College (Jenkins, 1996), 17 of the 22 species found in Cohoke Creek spawn in reservoirs. Four of the five remaining species may spawn in the headwaters of the reservoir. Although the Creek Chubsucker spawns in creeks, the species may thrive in the reservoir environment. The Tessellated Darter, Least Brook Lamprey, and Blacknose Dace may also persist in the reservoir; however, the Blacknose Dace may be absent from the majority of the reservoir pool area (Jenkins, 1996). The catadromous American Eel is the only migratory fish found in the King William Reservoir pool area. Although the eels present in the pool area could survive, recruitment of the species from outside the reservoir would be eliminated.

Construction of the reservoir would also block the potential passage of spawning anadromous or catadromous fish into the upper 10.75 miles of potential anadromous fish habitat above the KWR I dam. Construction of the KWR II dam would block approximately 10.2 miles of potential anadromous fish habitat. Construction of the KWR III dam would block approximately 9.3 miles of potential anadromous fish habitat and construction of the KWR IV dam would block approximately 8.2 miles of potential habitat. Reservoir construction would effectively preclude future opening of potential anadromous fish spawning habitat in Cohoke Creek. However, fish passage in Cohoke Creek is presently limited by the Cohoke Millpond dam and further by numerous beaverdams upstream of the Millpond. Results of fish sampling in the Chickahominy River by the VDGIF have shown that the quantity of anadromous fish collected upstream of beaverdams was considerably lower than the quantity collected downstream of the beaverdams (D. L. Fowler, VDGIF, personal communication, 1996).

Construction of a reservoir dam in Cohoke Creek would further restrict fish passage in the project area, but the incremental impact would be minimal because the downstream Cohoke Millpond dam effectively bars fish passage into the project area. Catadromous American Eels (*Anguilla rostrata*) were found in the upper reaches of the Cohoke Creek watershed, but that does not indicate possible anadromous fish passage because eels are able to surmount much greater structures than most fish species (Jenkins and Burkhead, 1993). Although the Millpond dam is privately owned by the Cohoke Club, the state does have the authority to require installation of a fishway for passage of migratory fish (Virginia Code § 29.1-532). However, the Cohoke Millpond dam is not currently listed as one of the state's priority areas for restoration of fish passage (VDGIF, 1995) and no plans

Table 5-12C

Occurrence of Fish Species in Reservoir Environments
Cohoke Creek Non-tidal Waters Above Cohoke Millpond

Species		Commonly Inhabit	Rarely Inhabit
Scientific Name	Common Name	Reservoir Environments	Reservoir Environments
Ameiurus natalis	Yellow Bullhead	X	
Ameiurus nebulosus	Brown Bullhead	X	
Amia calva	Bowfin	X	
Anguilla rostrata	American Eel		X
Aphrediderus sayanus	Pirate Perch	X	
Centrarchus macropterus	Flier	X	
Enneacanthus gloriosus	Bluespotted Sunfish	X	
Erimyzon oblongus	Creek Chubsucker	X	
Esox niger	Chain Pickerel	X	
Esox americanus	Redfin Pickerel	X	
Etheostoma olmstedi	Tessellated Darter		X
Gambusia holbrooki	Eastern Mosquitofish	X	
Lampetra aepyptera	Least Brook Lamprey		X
Lepomis gibbosus	Pumpkinseed	X	
Lepomis gulosus	Warmouth	X	
Lepomis macrochirus	Bluegill Sunfish	X	
L. gibbosus X.L. macrochirus	Hybrid Sunfish	X	
Micropterus salmoides	Largemouth Bass	X	
Notemigonus crysoleucas	Golden Shiner	X	
Noturus gyrinus	Tadpole Madtom	X	
Rhinichthys atratulus	Blacknose Dace		X
Umbra pygmaea	Eastern Mudminnow	X	
Total Number of Species	22	18	4

Sources:
Jenkins and Burkhead, 1993
VDGIF, 1993
R. Jenkins, personal communication, 1996

exist for removal of the dam. Given the long history of private ownership of the Cohoke Millpond dam (over 100 years) and the surrounding homes, it appears unlikely that the dam will be removed.

By reducing freshwater flow rates, the operation of the reservoir could affect fish habitat in Cohoke Creek below the dam. The originally proposed KWR-I minimum reservoir release is 3 mgd and does not vary seasonally. An alternative release schedule has been developed for the RRWSG's preferred KWR-II configuration which would average 3 mgd during normal higher reservoir pool conditions and 1 mgd during critical reservoir drawdown periods[4]. The 1 mgd average release schedule would be triggered when available King William Reservoir storage declines to less than 80 percent. The alternative release scenario varies by month to mimic the natural Cohoke Creek streamflow hydrograph. A 3 mgd release which, under projected Year 2040 demand conditions, would be in place approximately 70 percent of the time, represents 38 percent of the estimated average flow of Cohoke Creek at the KWR-II dam site. Comparing this to Tennant's method for defining instream flow recommendations, 40 percent of average streamflow would maintain "outstanding" fisheries habitat during dry months and "good" fisheries habitat during wet months. Therefore, only minimal changes in fish species composition are anticipated in the existing fish habitat downstream of the dam.

The Pamunkey Indian Fish Hatchery is located on the Pamunkey River approximately 3.0 river miles upstream of Cohoke Creek. There are no impacts to the fish hatchery anticipated as a result of project implementation. Implementation of the project will not reduce fish nursery habitat and will not affect the size of the Pamunkey River fish populations. In addition, the flow of Cohoke Creek is minute when compared to the flow of the Pamunkey River as a whole. Therefore, potential reduced flow from Cohoke Creek as a result of project implementation will not affect flows in the Pamunkey River.

Impacts to fish and invertebrates associated with pipeline construction would be minimal and temporary. No impacts to fish and invertebrates would be realized as a result of reservoir pump station construction for KWR II, III, or IV.

The proposed pipeline discharge to Beaverdam Creek for KWR I would create a higher flow regime in the lower 1.3 miles of the Creek above the normal pool of the Diascund Reservoir. For KWR II, III, and IV, the outfall location was extended downstream 0.5 miles which will create a high flow regime in only the upper 0.8 miles of the creek above the normal pool of Diascund Reservoir. This extends the outfall to an area where the channel is better suited to accepting high flows, thereby reducing potential erosional effects. The calculated maximum stream velocity is 1.3 fps, which is non-erosive for most soil types. Beaverdam Creek has stiff, erosion-resistant clay soils in its bed and banks. Therefore, expected erosional effects are minimal. The proposed change in outfall location should minimize potential impacts to fish and invertebrates.

Other Wildlife

Construction of a pump station at Scotland Landing would disturb approximately 3 acres of forested land. Reptiles, amphibians, and small mammals would be the most impacted by construction. Other wildlife would be displaced to adjacent habitats.

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4 For the currently proposed KWR-IV configuration, the minimum release would average 2 mgd during normal higher reservoir pool conditions and 1 mgd during critical reservoir drawdown periods (see Section 3.3.3).

Within the proposed KWR I pool area, approximately 1,588 acres of forested upland habitat would be converted to open water. There are approximately 1,394 acres, 1,182 acres, and 875 acres of forested upland habitat within the KWR II, KWR III, and KWR IV pool areas, respectively. The loss of acres of this forested wildlife habitat represents 1.2, 1.0, 0.9, and 0.6 percent for KWR I, II, III, and IV, respectively, of the total 137,978 acres of forested and other habitat, including recreational and wildlife areas, in King William County (SWCB, 1988). Approximately 2,210, 2,181, 1,868, and 1,490 acres of open water habitat would be gained with KWR I, II, III and IV, respectively.

Although the reservoir fringe and pool would provide habitat for some resident species and for some new species, terrestrial and wetland-dependent wildlife would be affected by the inundation of wetland and forested areas. Many species inhabiting the flooded area would be forced to migrate to other areas of similar habitat. If neighboring habitat patches are at or near their carrying capacity for a particular species, the increased population could alter population dynamics of that species until the population reaches equilibrium. For instance, an increased population could reduce the amount of food available per individual, causing malnutrition and reduced juvenile survival. If the population is at its carrying capacity, it also could be affected by reduced reproduction, increased predation, increased natural mortality, or increased emigration. Under such circumstances, the overall effect would be a reduction of the population of that species in the region.

Less mobile species and species dependent on large contiguous habitat patches would be the most affected by reservoir construction. Reptiles, amphibians, and some small mammals would most likely be unable to migrate to other habitat unless suitable habitat was available adjacent to the pool area. Birds would most likely be able to migrate, but could be limited by the extent of available suitable habitat.

Reduction in habitat also could affect temporary resident species. For example, many neotropical migratory song birds rely on large patches of temperate forest for breeding. Because of continued forest fragmentation and decreasing habitat, neotropical migratory birds have become more susceptible to predation. Therefore, reduction in habitat could result in decreased breeding success for certain neotropical migratory bird species.

Although the proposed reservoir will affect wildlife, current timbering practices which occur in the majority of the watershed are already affecting wildlife. Approximately 65 percent of the watershed is currently used for silviculture. Selected areas of pine, hardwood, or mixed forests are clear cut, burned, and either replanted with Loblolly Pine (*Pinus taeda*) or left to regrow naturally. Pine plantations are thinned by about 30 to 40 percent when the stand is 17 to 22 years old. Saw timber is harvested by clear cutting when the stand is about 30 to 35 years old. Hardwoods used for pulpwood are harvested at 25 years. Hardwoods used for saw timber are thinned at 20 years and harvested at 40 years (C. Kerns, Delmarva Properties, personal communication, 1995). While in the past timbering companies concentrated on fast growing pine forests, current market demands are causing them to rely on mixed hardwood forests as well. Therefore, all forests within the KWR watershed are susceptible to clear cutting. In addition, due to improvements in cutting machinery, forests on steep slopes or in wetlands that could not have been cut in the past can now be cleared (J. Willis, Delmarva Properties, personal communication, 1995).

Clear cutting of large segments of forest causes loss of wildlife habitat, forest fragmentation, and changes in community structure. Clear cutting also affects adjacent wetland water quality and vegetation due to increased sedimentation and debris deposition, increased floodflow, and increased nutrient/toxicant influx. These forestry practices are expected to continue in the watershed.

However, with reservoir development, a permanent buffer area would be established around the perimeter and would protect existing cove hardwood stands. This would also allow for natural succession of the remainder of the buffer area into fully mature cove hardwood forests and mixed deciduous/evergreen forests.

Impacts to species currently utilizing palustrine wetlands would occur due to changes in the source of primary productivity. Dabbling ducks such as the Black Duck would be negatively affected by the reservoir. Much of their food sources would be destroyed by the removal and flooding of vegetation. However, the wetland fringe expected to develop in the shallows of the reservoir should provide forage habitat for these species.

The Great Blue Heron rookery would be inundated by the reservoir, forcing the breeding individuals to find another area to nest. However, suitable nesting habitat is likely to be available in abundance in nearby adjacent watersheds.

Due to the relatively narrow width of the pipeline right-of-way, and the restoration of affected land, where possible, the construction of the underground pipeline should not permanently impact vertebrate species. Once revegetation is complete, the pipeline right-of-way would provide open field or scrub/shrub habitat.

Reforestation of the right-of-way would be suppressed to provide access for maintenance of the pipeline. Pipeline construction and maintenance in forested areas could therefore result in fragmentation of habitat for some species. The right-of-way could also allow the introduction of edge species which compete with or prey on forest interior species. For less mobile species, the right-of-way could pose an unpassable barrier, dividing a previously single population into two. This could result in decreased genetic diversity and increased susceptibility of each resulting population to disturbances.

Construction of the reservoir pump station for KWR II, III, or IV would disturb less than 3 acres of forested land. Birds and small mammals which forage in the area would be most affected by construction. Wildlife would be displaced to adjacent habitats.

Sanctuaries and Refuges

No impacts to existing sanctuaries or refuges are anticipated as a result of intake placement in the vicinity of Scotland Landing on the Mattaponi River, as a result of construction of the proposed King William Reservoir, or as a result of pipeline construction for this alternative component.

Wetlands and Vegetated Shallows

No direct impacts to wetlands at the intake site are anticipated because the pump station would be located on a high bluff above the river and the intake structure would be installed by directional drilling.

Potential secondary impacts would include:

- Increased sedimentation due to intake structure construction; and
- Changes in tidal freshwater plant communities resulting from salinity increases in the Mattaponi River.

Assuming that the water quality of the Mattaponi River does not deteriorate due to other factors, such as increased wastewater discharges or dramatically increased irrigation withdrawals, the vegetative species composition of the tidal freshwater wetlands should not change appreciably as a result of the proposed water supply withdrawals. Potential salinity intrusion impacts to Mattaponi River wetlands are examined in detail in Report J. Based on this VIMS study, predicted mean salinity levels at all transects under withdrawal conditions were less than the historical mean salinity levels at adjacent downstream transects. Given this finding, VIMS concluded that little or no impact to wetland plant distributions is anticipated as a result of salinity changes caused by proposed freshwater withdrawal levels. Natural Mattaponi River salinity fluctuations greatly exceed any salinity changes that were predicted due to withdrawals.

Impacts to non-tidal wetlands and open water as a result of the four KWR dam configurations are presented in the following table:

Cover Type	KWR I Acreage	KWR II Acreage	KWR III Acreage	KWR IV Acreage
Unvegetated U.S. Waters	74	41	41	34
Vegetated Wetlands	579	533	470	403
Total Waters of the U.S.	**653**	**574**	**511**	**437**

The 574 acres of vegetated wetlands and open water that would be inundated by KWR II represent 2.1 percent of the estimated 26,768 acres of wetlands in King William County (VDCR, 1990). The total wetlands in the Pamunkey River system and the York River system are approximately 70,000 and 127,000 acres, respectively.[5] Therefore, the wetlands that would be impacted by the project are a very small percentage of the total wetlands in the Pamunkey and York River basins (0.82 and 0.45 percent, respectively) and in King William County.

The KWR I watershed encompasses approximately 78 percent of the entire 17.0 square mile Cohoke Creek watershed. The watersheds for KWR II, III, and IV encompass approximately 67, 61, and 52 percent, respectively, of the entire Cohoke Creek watershed. If built, the Reservoir would inundate almost all of the wetlands in Cohoke Creek above the King William Reservoir dam. The

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5 The wetland estimates for the Pamunkey and York River basins were developed by Malcolm Pirnie based on the National Wetland Inventory Maps and wetland estimates presented in Hyer, P.V., C.S. Fang, E.P. Ruzecki and W.J. Hargis, Jr. *Studies of the distribution of salinity and Dissolved Oxygen in the Upper York System*, VIMS, 1971.

exceptions would be those wetlands on the small number of headwater streams and isolated wetlands above the normal pool elevation.

According to the Wetland Evaluation Technique (WET) analysis performed for the palustrine wetlands at the King William Reservoir II site, the existing wetlands which would be inundated have a high probability of performing the following functions: floodflow alteration, sediment stabilization, sediment/toxicant retention, and wildlife habitat. They also would have a moderate probability of performing groundwater discharge and production export functions which also would be lost.

According to the Evaluation for Planned Wetlands analysis performed for the wetlands at the KWR II site, the existing wetlands provide a high degree of sediment stabilization and water quality functions, a moderately high degree of shoreline bank erosion control functions, and a moderate degree of wildlife and fish functions.

Although the proposed reservoir would function differently from the existing wetlands, the reservoir would have a high probability of providing a number of the same functions that may be lost. Because of the reservoir's large capacity to store water, it would have a high probability of providing floodflow alteration, sediment/toxicant retention, and nutrient removal/transformation. It also would likely provide aquatic habitat and groundwater recharge. Additionally, it would have a high probability of providing recreation.

Sediment stabilization, wetland-specific wildlife habitat, and uniqueness/heritage value are three wetland functions and values, now likely to exist, which would not be provided by the reservoir. Any loss of the sediment stabilization function would be largely offset by the reservoir's large capacity for sediment retention. Although the proposed reservoir would very likely provide much lacustrine habitat and possibly even rare species habitat, habitat for wetlands dependent species would be lost.

There also would be a moderate probability that production export and groundwater discharge would be lost. However, the existing Cohoke Millpond already limits the amount of primary productivity exported from Cohoke Creek to the greater Pamunkey River system. This factor was not fully addressed in the WET analysis, because the assessment area was limited to the reservoir watershed.

Additional impacts related to short-term reservoir construction effects could cause an increase in levels of suspended sediment resulting in siltation of vegetated wetlands below the dam site. However, these impacts would be temporary and could be minimized by effective sediment control measures.

Based on field inspections of existing water supply reservoirs in the Virginia Coastal Plain, construction of KWR I should result in little dewatering of the 17 acres of wetlands in the main stem between the King William Reservoir dam site and the upper reaches of Cohoke Millpond. These wetlands are supported hydrologically by flows upstream of the King William Reservoir dam site. Forty acres of wetlands lie between the KWR II dam site and the upper reaches of Cohoke Millpond. Eighty-one acres occur between KWR III and the upper reaches of Cohoke Millpond and 105 acres occur between KWR IV and Cohoke Millpond. It is unlikely that dewatering of downstream wetlands would occur with any reservoir configuration.

The existing Cohoke Millpond already provides a sizeable degree of streamflow moderation in the lower reaches of Cohoke Creek. The combination of increased local groundwater levels caused by reservoir seepage, beaverdams, and the minimum reservoir release should be sufficient to maintain the hydrology of the downstream wetlands. However, slight vegetation community changes could take place downstream as a result of a relative shift in hydrologic source from surface water to groundwater and the attenuation of both flood and drought streamflows.

As presented in Table 4-49B, approximately 9.0 acres of stream/wetland areas would be temporarily disturbed by construction of the KWR I pipeline crossings. Approximately 10.3 acres of stream/wetland areas would be temporarily disturbed by construction of the KWR II pipeline crossings. Approximately 10.5 acres of stream/wetland areas would be disturbed by construction of the KWR III pipeline and 10.4 acres of stream/wetland areas would be disturbed by construction of the KWR IV pipeline. Reforestation along the pipeline route would be suppressed to maintain the right-of-way. Pipeline construction and maintenance in forested areas could therefore result in fragmentation of habitat for some interior forest dwelling species. In addition, palustrine forested wetlands would most likely be converted to a palustrine emergent system after pipeline construction. Construction of the pipeline route could allow *Phragmites communis* and other exotic species that thrive in disturbed areas to revegetate the pipeline right-of-way.

Approximately 0.30 acres of wetlands would be affected by the KWR I outfall structure at Beaverdam Creek. The high flow regime could result in some scouring of the natural channel and existing wetlands in Beaverdam Creek downstream of the KWR I outfall. In order to reduce possible erosional effects, the proposed outfall for KWR II, III, and IV was moved downstream 0.5 miles. Beaverdam Creek at this location has a flatter slope and its channel is wider, allowing for a greater flow than the upstream location. Approximately 0.15 acres of wetlands would be affected by the KWR-II, III, and IV outfall structure. Much of the channel downstream of the outfall location to the reservoir is flooded under normal conditions. At a flow of 54.5 mgd (50 mgd peak pipeline discharge plus current average daily flow), the maximum flow velocity would be about 1.3 feet per second. This relatively low velocity is expected to have minimal erosive effects on the natural stream channel's stiff clay soils and existing wetlands downstream of the proposed outfall location.

Pipeline construction across an arm of Little Creek Reservoir would affect a deep open water area approximately 500 feet wide. The Pamunkey River crossing would be accomplished using directional drilling techniques which would not disturb river bottom substrate or adjacent wetlands in Cousiac Marsh.

Mud Flats

No mud flats would be directly impacted in project areas for this alternative. Use of a turbidity curtain during construction of the intake structure would minimize any potential impacts to downstream mud flats. Potential sediment flow created by intake construction would be carried downstream; therefore, mud flats located upstream would not be impacted.

5.3.4 Fresh Groundwater Development

Endangered, Threatened or Sensitive Species

No endangered, threatened or sensitive species would be adversely impacted from development of this alternative.

Fish and Invertebrates

Disturbance of a combined 6,000 square feet at Diascund Creek and Little Creek reservoirs for placement of pipelines may impact invertebrate species inhabiting wetlands adjacent to the reservoirs.

Because groundwater withdrawals would occur when the reservoir drop to 75 percent of capacity, this alternative would prevent more severe reservoir drawdowns than would otherwise occur. This would be beneficial to fish and invertebrates.

Other Wildlife

The development of eight wells along the perimeter of Diascund Creek and Little Creek Reservoirs would impact a relatively small area of forested land. Construction activities would require a maximum disturbance of approximately 8 acres. Pipeline impact is expected to be minimal due to well proximity to the reservoirs. Species would be temporarily displaced to adjacent areas.

Sanctuaries and Refuges

No impacts to sanctuaries or refuges are anticipated as a result of implementation of this alternative component.

Wetlands and Vegetated Shallows

It is anticipated that deep aquifer freshwater withdrawals would not have any measurable impacts on wetlands in the area, which are maintained by surface water and shallow groundwater hydrology.

Impacts to wetlands would result from the construction of outfall structures and associated placement of stone rip-rap in the Diascund Creek Reservoir proper, and in tributaries leading to Little Creek Reservoir. Assuming that each outfall structure and associated rip-rap would cover an area 20 feet wide by 50 feet long, this project component would impact 1,000 square feet of lacustrine limnetic, open water wetlands (L1OWU) at each of the four Diascund Creek Reservoir discharge points and 1,000 square feet of palustrine forested, broad-leaved deciduous, temporary wetlands (PFO1A) at two of the four Little Creek Reservoir discharge points.

Mud Flats

No mud flats are located in the vicinity of proposed groundwater wells or associated pipelines and outfall structures; therefore, no impacts to mud flats would occur.

5.3.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Endangered, Threatened or Sensitive Species

No adverse impacts to known threatened, endangered or sensitive species are anticipated as a result of this alternative.

Fish and Invertebrates

Stream impacts due to concentrate discharge pipelines would be minor and transient. The four stream crossings required would be accomplished by cut and fill techniques, with stream contours restored following construction.

Three of the four concentrate discharge pipeline outfalls would be placed in areas where polyhaline conditions already occur, to avoid any potential impacts to existing fish and invertebrate species. The fourth outfall (Site 4), located at the south bank of the mouth of Skiffes Creek, could cause impacts since natural salinity is lower at this location.

Newport News Waterworks is actively pursuing a brackish groundwater desalting project that would include a concentrate outfall in the vicinity of Site 4. However, rather than using Site 4, an outfall location has been identified along the east bank of the James River, approximately 1,300 feet downstream of an existing wastewater pipeline and outfall. It is in an open stretch of the James River, which will likely have better mixing and dilution characteristics than a closer location near the existing wastewater outfall, which is in a protected inlet area and does not appear to have good flow turnover (Camp Dresser & McKee, 1996).

Other Wildlife

Groundwater development at five well locations and RO treatment plant construction would disturb approximately 5 acres. The proposed locations of the wells and RO plants are within urbanized areas. Impacts to vegetation communities and their associated wildlife species would be minimal.

Construction of concentrate discharge pipelines would disturb approximately 65 acres along the proposed pipeline routes. Wildlife species inhabiting these areas would be temporarily displaced. Due to the relatively small area of land disturbance at any one area along the routes and the restoration, where possible, of the affected land, development of the underground pipeline should have minimal impacts on vertebrate species.

Sanctuaries and Refuges

No impacts to sanctuaries or refuges are anticipated as a result of implementation of this alternative.

Wetlands and Vegetated Shallows

Impacts to wetlands would include the construction of outfall structures and placement of approximately 4,000 square feet of rip-rap in wetlands associated with discharge points. The total wetlands acreage disturbed would be 0.9 acres.

Mud Flats

For Site 1, the concentrate outfall structure would temporarily or permanently impact 4,000 square feet of mud flats in Hampton Roads Harbor. No sizeable impacts to mud flats would be anticipated for the other well sites.

5.3.6 Additional Conservation Measures and Use Restrictions

Endangered, Threatened or Sensitive Species

The implementation of the Additional Conservation Measures and Use Restrictions alternative would have no impact on endangered, threatened or sensitive species on the Lower Peninsula.

Fish and Invertebrates

The implementation of the Additional Conservation Measures and Use Restrictions alternative would have no impact on fish and invertebrate species in the Lower Peninsula.

Other Wildlife

Implementation of the Additional Conservation Measures and Use Restrictions alternative should have no impact on existing wildlife resources in the Lower Peninsula.

Sanctuaries and Refuges

The implementation of the Additional Conservation Measures and Use Restrictions alternative on the Lower Peninsula would have no impact on sanctuaries and refuges in the region.

Wetlands and Vegetated Shallows

There would be no impacts to wetlands as a result of implementing the Additional Conservation Measures and Use Restrictions alternative

Mud Flats

No impacts to mud flats would occur with implementation of the Additional Conservation Measures and Use Restrictions alternative.

5.3.7 No Action

Endangered, Threatened or Sensitive Species

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to wetland species due to the increased frequency and severity of drawdowns in existing reservoirs. Increasingly, existing reservoirs would be drawn down to levels which could negatively impact adjacent wetland communities. The largest impacts would be expected at Diascund Creek and Little Creek as these reservoirs experience the most frequent and severe drawdowns.

No endangered, threatened or sensitive species are known to occur in areas surrounding Diascund and Little Creek reservoirs. Bald Eagles are documented as occurring in the project vicinity. Foraging habitat of this species may be affected if increased water demands result in more severe reservoir drawdowns.

Fish and Invertebrates

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to fish and invertebrate species due to the increased frequency and severity of drawdowns in existing reservoirs. Increasingly, existing reservoirs would be drawn down to levels which could negatively impact adjacent wetland communities. Species inhabiting shallow streams within these wetland communities would be most impacted.

Other Wildlife

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to wildlife species due to the increased frequency and severity of drawdowns in existing reservoirs. Increasingly, existing reservoirs would be drawn down to levels which could negatively impact adjacent wetland communities. Wildlife species depending on these communities could be affected.

Sanctuaries and Refuges

If no action is taken to augment the existing water supplies on the Lower Peninsula, there will be no impact to existing sanctuaries and refuges in the region.

Wetlands and Vegetated Shallows

The No Action alternative would require increasing reliance on existing reservoirs to satisfy growing water demands. As a result, these reservoirs would be increasingly drawn down to levels that could negatively impact adjacent wetland communities.

In addition, there would be an increasing dependence on shallow groundwater sources. This, in turn, could result in a potential negative impact to wetlands supplied by shallow groundwater.

Mud Flats

The No Action alternative would result in more frequent and severe drawdowns in existing water supply reservoirs serving the Lower Peninsula. Mud flats along the peripheral areas of reservoirs would, therefore, be more frequently exposed to the atmosphere, and for longer periods of time. Adverse impacts from such exposure could include some dewatering during extended periods of reservoir drawdown.

5.4 CULTURAL RESOURCES

Potential impacts to known cultural resources within project areas are discussed in this section. Direct impacts resulting from disturbance of cultural resources are discussed.

5.4.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Intake

Due to the high potential for cultural resources in the area, the USCOE (1984) has indicated that a site survey would be necessary to identify the extent of any resources in the vicinity of the intake site. The site was examined during field studies for Report G, ***Phase I Cultural Resource Survey of the Proposed King William Reservoir, King William County, Virginia and a Background Review, Architectural Survey and Archaeological Reconnaissance for the Proposed Black Creek Reservoir, New Kent County, Virginia*** (MAAR Associates, 1996) which is incorporated herein by reference and is an appendix to this document. However, the survey concentrated on the reservoir area with limited research conducted at the intake site.

One known prehistoric site identified during field studies of the proposed intake site would be affected by construction of the proposed intake and pump station. Impacts to "Chericoke", which is also located in the vicinity of the Northbury withdrawal site, would not be anticipated since the resource is well separated from the intake site.

Reservoir

The USCOE (1984) stated that the Stonehouse archaeological site could be damaged if reservoir construction is not carefully executed. At the time of the study, the existence of other cultural resources in the reservoir area was unknown, but it was expected that several other sites existed. The USCOE suggested that further archaeological survey work be conducted to determine the degree of resources within the reservoir area.

The 45 prehistoric and historic period sites which were identified as being at or below the 35-foot contour elevation would be directly impacted by reservoir construction. In addition, 16 historic-period sites could be impacted.

Pipeline

One known historic site (44NK81) could be impacted from pipeline construction for this alternative component. Two additional archaeological sites (44JC269 and 44JC297) are located adjacent to the pipeline route. Impacts to these sites would be avoided to the maximum extent possible during construction.

The Slater House (47JC19) is located adjacent to the pipeline route. Assuming a 50-foot wide right-of-way for pipeline construction, impacts to this resource could be avoided. However, Burnt Ordinary (47JC63) is located in close proximity to the proposed pipeline route. A site survey would be conducted prior to construction to assure that impacts to the resources would be minimized.

Due to several known locations of archaeological resources along the pipeline route, additional survey work would likely be required to identify any other cultural resources which could be impacted.

5.4.2 Black Creek Reservoir with Pumpover from Pamunkey River

Intake

Potential impacts to cultural resources resulting from construction and operation of an intake and pumping station at Northbury are discussed in Section 5.4.1.

Reservoir

Based on the results of a Phase IA Cultural Resource Survey conducted at the reservoir site (See Report G), construction of the reservoir would directly impact Crump's Mill (63NK70). This resource would be inundated with a reservoir normal pool elevation of 100 feet msl. One or two additional historic sites identified by the New Kent County Historical Society may also be located within the proposed reservoir pool area.

The predictive model used to estimate the potential for cultural resources at the Black Creek site indicated that there are likely to be few prehistoric sites located within the impoundment area. As a result, it is suggested that impacts to prehistoric cultural resources within the impoundment area would be relatively small (MAAR Associates, 1996).

As indicated by the VDHR in its review of the Phase IA Cultural Resource Survey for the reservoir area, four properties would require further evaluation to determine the potential effects of the project on the resources. These include Crump's Mill (VDHR 63-70), Iden (VDHR 63-41; MAAR 2), VDHR 63-203 (MAAR 13), and VDHR 63-178 (MAAR 70). The inundation of Crump's Mill would almost certainly constitute an adverse effect. The VDHR has indicated that the effects on the other three properties may possibly be limited to visual effects and that the potential effects might not be adverse (H. B. Mitchell, VDHR, personal communication, 1993).

Pipeline

It is anticipated that some impacts to cultural resources would result along the pipeline route, primarily to yet unidentified archaeological sites. Two previously recorded sites may be impacted by pipeline construction.

Based on review of VDHR records, two additional known sites (44JC642 and 44JC644) would be directly impacted by pipeline construction for this alternative component. These sites are identified in VDHR's records as having been recently surveyed and have been described as being badly eroded. As a result, no further work was recommended. It is unlikely that additional survey work would be required at these sites, and precautions would be taken during pipeline construction to minimize impacts to known resources adjacent to the pipeline.

5.4.3 King William Reservoir with Pumpover from Mattaponi River

The Phase I survey of the proposed King William Reservoir project area resulted in the location and identification of 156 archaeological sites at the intake site, reservoir site (upstream of the originally proposed KWR-I dam site and up to elevation 96 feet msl), and along the pipeline route. In addition, 76 architectural sites were identified within the project's Area of Potential Effect, which is defined as those areas located within 500 feet of the 110-foot contour interval. No architectural sites and 148 archaeological sites are located in the reservoir impoundment area (below the 96-foot contour interval and upstream of the originally proposed KWR-I dam site), the pump station project area, or within the pipeline rights-of-way. Thirteen of the architectural sites were identified to be eligible for nomination to the National Register of Historic Places, and an additional three were identified as warranting further investigation for potential eligibility. Ninety-eight of the archaeological sites were identified as potentially eligible for nomination to the National Register of Historic Places.

Architectural Resources:

Of the 16 architectural sites identified as eligible or potentially eligible for nomination to the National Register of Historic Places, all were located at or above the 110-foot contour interval and/or located well away from the proposed facilities. Based on these findings, it was determined that there would be no direct impact to any of the architectural sites. A further analysis of project plans and architectural site locations led to a finding that the project was not likely to have any indirect visual impact on architectural sites. Based on these findings, it appears unlikely that any of the King William Reservoir project configurations would have an adverse effect on architectural resources, and that further investigations of architectural resources would not likely be required (VDHR Review Committee Finding, December 17, 1993), (MAAR 1996). Only after full interagency coordination under Section 106 of the National Historic Preservation Act, will there be a final determination of the effects of the project on historic resources.

Archaeological Resources:

Of the 156 archaeological sites recorded in the course of the Phase I Survey of the proposed King William Reservoir project (MAAR 1996), eight were determined to be outside of the Area of Direct Impact. Of the remaining 148 sites, 98 have been identified as potentially eligible for nomination to the National Register of Historic Places. The 98 sites include 25 prehistoric basecamps, 50 prehistoric transient camps, and 25 sites containing historic period resources. Two of the historic period sites overlap prehistoric transient camps.

Phase II evaluation surveys are being recommended for all of the potentially eligible sites which are likely to be adversely affected by direct and indirect construction activities, as well as inundation due to the creation of an impoundment in the upper reaches of Cohoke Creek.

Intake

A total of five potentially eligible archaeological sites may be adversely affected by construction of the intake, including four sites located in the vicinity of the proposed pump station at Scotland Landing and one along the associated pipeline right-of-way. These sites include two prehistoric basecamps, one prehistoric transient camp, and two historic period sites. All of the sites were identified to be potentially significant.

Reservoir

Up to 80 potentially eligible archaeological sites will be adversely affected by the construction of the originally proposed KWR-I impoundment. These sites include 25 prehistoric basecamps, 50 prehistoric transient camps, seven historic period sites, and 18 historic period sites which overlap some of the prehistoric basecamps and transient camps. A Phase II evaluation will be conducted as needed to establish eligibility or non-eligibility for nomination to the National Register of Historic Places.

The RRWSG's preferred KWR II impoundment would avoid 11 sites, six of which are potentially significant downstream archaeological resources. The RRWSG's preferred KWR II configuration would adversely affect 74 potentially significant sites. Other dam configurations would further avoid potential impacts to identified sites. The KWR-III configuration would impact 62 potentially significant sites and the currently proposed KWR-IV configuration would impact 55 potentially significant sites. Table 5-12D lists the identified archaeological sites within the proposed impoundment area for each KWR configuration.

Pipeline

Up to 12 potentially eligible sites may be adversely affected by the construction of the pipeline which extends through portions of King William and New Kent Counties. These sites include five prehistoric basecamps, six prehistoric transient camps, one historic period site, and two additional historic components which overlap with prehistoric basecamps. Phase II evaluation surveys have been recommended for all 12 sites in order to establish eligibility or non-eligibility for nomination to the National Register of Historic Places. It is possible that further pipeline route studies could lead to a different route and, consequently, create the need for additional cultural resource investigations.

5.4.4 Fresh Groundwater Development

The VDHR conducted a search of its cultural resource site inventory for the project areas encompassed by the Fresh Groundwater Withdrawals alternative and identified two previously recorded archaeological sites in the vicinity of the Diascund Creek Reservoir well sites. However, VDHR indicated that impacts to these sites should not occur given the great distances which separate these sites from the project areas.

Additional survey work may be required at the Little Creek Reservoir project area to verify the location of potential resources and to identify any additional resources which could be affected.

5.4.5 Groundwater Desalination in Newport News Waterworks Distribution Area

No known archaeological sites are located in the vicinity of Site 1. The VDHR believes that since concentrate discharge pipeline construction would take place in already disturbed rights-of-way, this project area has a low potential for containing intact archaeological resources. Therefore, minimal impacts are expected.

Forty-seven archaeological sites are known to be located in close proximity to the Site 2 project area. It is likely that additional survey work would be required.

Five archaeological sites are known to be located in close proximity to the Site 3 area. However, most of the facilities for Site 3 would be constructed in existing rights-of-way which have already been disturbed. Therefore, minimal impacts are expected.

Eighteen archaeological sites are known to be located in close proximity to the Site 4 project area. Of the 4 groundwater desalting project areas, VDHR believes that Site 4 has the greatest potential to affect previously unidentified archaeological sites.

TABLE 5-12D

ARCHAEOLOGICAL SITES WITHIN IMPOUNDMENT AREAS AFFECTED BY KING WILLIAM RESERVOIR (KWR) DAM CONFIGURATIONS

SITE #	KWR I	KWR II	KWR III	KWR IV	POTENTIALLY SIGNIFICANT
44KW82	X	X			Yes
44KW83	X	X	X		Yes
44KW84		X			Yes
44KW85	X	X			Yes
44KW86	X	X			Yes
44KW87	X	X			Yes
44KW88	X	X			Yes
44KW89	X	X			No
44KW90	X				Yes
44KW91	X				Yes
44KW92	X				Yes
44KW93	X				Yes
44KW94	X				No
44KW95	X				Yes
44KW96	X	X			No
44KW97	X	X	X	X	No
44KW98	X	X	X	X	Yes
44KW99	X	X	X	X	No
44KW100	X	X	X	X	Yes
44KW101	X	X	X	X	Yes
44KW102	X	X	X	X	Yes
44KW103	X	X	X		Yes
44KW104	X	X	X		No
44KW105	X	X	X	X	No
44KW106	X	X	X		Yes

TABLE 5- 12D

ARCHAEOLOGICAL SITES WITHIN IMPOUNDMENT AREAS AFFECTED BY KING WILLIAM RESERVOIR (KWR) DAM CONFIGURATIONS

(CONTINUED)

SITE #	KWR I	KWR II	KWR III	KWR IV	POTENTIALLY SIGNIFICANT
44KW107	X	X	X	X	No
44KW108	X	X	X	X	Yes
44KW109	X	X	X	X	Yes
44KW110	X	X	X	X	Yes
44KW111	X	X	X	X	No
44KW112	X	X	X	X	Yes
44KW113	X	X	X	X	Yes
44KW114	X	X	X	X	No
44KW115	X	X	X	X	Yes
44KW116	X	X	X	X	Yes
44KW117	X	X	X	X	Yes
44KW118	X	X	X	X	No
44KW119	X	X	X	X	No
44KW120	X	X	X	X	Yes
44KW121	X	X	X	X	No
44KW122	X	X	X	X	No
44KW123	X	X	X	X	Yes
44KW124	X	X	X	X	Yes
44KW125	X	X	X	X	Yes
44KW126	X	X	X	X	Yes
44KW127	X	X	X	X	Yes
44KW128	X	X	X	X	Yes
44KW129	X	X	X	X	No

TABLE 5- 12D

ARCHAEOLOGICAL SITES WITHIN IMPOUNDMENT AREAS AFFECTED BY KING WILLIAM RESERVOIR (KWR) DAM CONFIGURATIONS

(CONTINUED)

SITE #	KWR I	KWR II	KWR III	KWR IV	POTENTIALLY SIGNIFICANT
44KW130	X	X	X	X	Yes
44KW131	X	X	X	X	Yes
44KW132	X	X	X	X	No
44KW133	X	X	X	X	Yes
44KW134	X	X	X	X	Yes
44KW135	X	X	X	X	Yes
44KW136	X	X	X	X	No
44KW137	X	X	X	X	Yes
44KW138	X	X	X	X	No
44KW139	X	X	X	X	Yes
44KW140	X	X	X	X	Yes
44KW141	X	X	X	X	No
44KW142	X	X	X	X	No
44KW143	X	X	X	X	No
44KW144	X	X	X	X	No
44KW145	X	X	X	X	Yes
44KW146	X	X	X	X	No
44KW147	X	X	X	X	Yes
44KW148	X	X	X	X	Yes
44KW149	X	X	X	X	Yes
44KW150	X	X	X	X	Yes
44KW151	X	X	X	X	No
44KW152	X	X	X	X	Yes

TABLE 5- 12D

ARCHAEOLOGICAL SITES WITHIN IMPOUNDMENT AREAS AFFECTED BY KING WILLIAM RESERVOIR (KWR) DAM CONFIGURATIONS

(CONTINUED)

SITE #	KWR I	KWR II	KWR III	KWR IV	POTENTIALLY SIGNIFICANT
44KW153	X	X	X	X	Yes
44KW154	X	X	X	X	Yes
44KW155	X	X	X	X	Yes
44KW156	X	X	X	X	Yes
44KW157	X	X	X	X	Yes
44KW158	X	X	X	X	No
44KW159	X	X	X	X	No
44KW160	X	X	X	X	No
44KW161	X	X	X	X	Yes
44KW162	X	X	X	X	Yes
44KW163	X	X	X	X	Yes
44KW164	X	X	X	X	No
44KW165	X	X	X	X	No
44KW166	X	X	X	X	Yes
44KW167	X	X	X	X	Yes
44KW168	X	X	X	X	No
44KW169	X	X	X	X	No
44KW170	X	X	X	X	No
44KW171	X	X	X	X	Yes
44KW172	X	X	X	X	No
44KW173	X	X	X	X	Yes
44KW174	X	X	X	X	No
44KW175	X	X	X	X	Yes

TABLE 5- 12D

ARCHAEOLOGICAL SITES WITHIN IMPOUNDMENT AREAS AFFECTED BY KING WILLIAM RESERVOIR (KWR) DAM CONFIGURATIONS

(CONTINUED)

SITE #	KWR I	KWR II	KWR III	KWR IV	POTENTIALLY SIGNIFICANT
44KW176	X	X	X	X	Yes
44KW177	X	X	X	X	Yes
44KW178	X	X	X	X	No
44KW179	X	X	X	X	Yes
44KW180	X	X	X	X	No
44KW181	X	X	X	X	Yes
44KW182	X	X	X	X	Yes
44KW188	X	X	X		Yes
44KW189	X	X	X		Yes
44KW190	X	X	X		No
44KW191	X	X	X	X	Yes
44KW192	X	X	X	X	Yes
44KW193	X	X	X	X	No
44KW194	X	X	X		No
44KW195	X	X	X		No
44KW196	X	X			Yes
44KW197	X	X			Yes
44KW198	X	X			No
44KW199	X	X			Yes
44KW200	X	X	X		Yes
44KW201	X	X	X		No
44KW202	X				No
44KW203	X	X			No

TABLE 5- 12D

ARCHAEOLOGICAL SITES WITHIN IMPOUNDMENT AREAS AFFECTED BY KING WILLIAM RESERVOIR (KWR) DAM CONFIGURATIONS

(CONTINUED)

SITE #	KWR I	KWR II	KWR III	KWR IV	POTENTIALLY SIGNIFICANT
44KW204	X	X			Yes
44KW205	X	X			Yes
44KW206	X	X			No
44KW207	X	X			No
44KW208	X	X			No
44KW209	X				Yes
44KW210	X				Yes
44KW211	X				No
44KW212	X				No
44KW216	X	X	X	X	Yes
44KW217	X	X	X	X	No
44KW218	X	X	X	X	Yes
44KW219	X	X	X	X	Yes
44KW220	X	X	X	X	No
44KW221	X	X	X	X	No
Total Sites	**131**	**120**	**103**	**92**	
Potentially Significant Sites	**80**	**74**	**62**	**55**	

5.4.6 Additional Conservation Measures and Use Restrictions

Implementation of this alternative would not impact cultural resources.

5.4.7 No Action

If no action is taken by local purveyors to augment existing water supplies, there would be no direct impacts to cultural resources within the region.

5.5 SOCIOECONOMIC RESOURCES

This section provides a general description of how the socioeconomic environment would be impacted by each of the seven alternatives evaluated. Socioeconomic resource categories evaluated are described below.

Municipal and Private Water Supplies

Alternative components may have the potential to impact the quality of water supplies in such a way as to render them unpalatable or require communities to incur higher treatment costs. Alternatives also may alter the quantity of water which is available for municipal and private water supplies.

Important evaluation factors in this category include treated water safe yield benefits for RRWSG jurisdictions, potential water supply benefits for non-RRWSG jurisdictions, magnitude of existing withdrawals from water sources, changes in surface water or groundwater availability for other existing or potential future water users, and potential changes in the quality of surface water or groundwater used for municipal or private water supply.

Recreational and Commercial Fisheries

This category addresses the potential impacts to recreational and commercial fisheries which may occur as a result of project implementation.

Other Water-Related Recreation

This category describes the potential positive and negative impacts to water-related recreation which may occur as a result of project implementation.

Aesthetics

The magnitude of aesthetics alterations is determined by such factors as the relative uniqueness of aesthetic characteristics that are altered or created, distance that the structures are visible, their height, the materials used in construction, the extent and magnitude of changes in vegetation along shorelines, and the extent of other physical/chemical alterations that may, for example, cause algal blooms and/or odor problems. Aesthetic impacts may also result from changes in air quality and noise levels; however, these impacts have been evaluated separately. Therefore, the primary focus of this aesthetic impact category is on the degree of potential visual impact from each of the alternative components. This analysis is based on impacts within the project viewsheds, which are the estimated areas from which observers are likely to see the construction activities and structures associated with each alternative.

Parks and Preserves

This category identifies the potential impacts to parks and preserves which could result from implementation of the evaluated alternatives.

Land Use

This category addresses potential impacts to existing land use and impacts to proposed future land use.

Noise

This category discusses the noise impacts of each alternative component. A specific discussion of noise impacts attributable to each alternative component is included.

Infrastructure

This category identifies the impacts each alternative component would have on elements of infrastructure including transportation, utilities, and navigation. Evaluation of impacts involved describing the direct impacts on existing roads and traffic patterns, comparing anticipated power needs and wastewater generation to available utility capacities, and describing potential navigational impacts on affected navigable waterways.

Other Socioeconomic Impacts

Potential socioeconomic impacts which could result from implementation of alternative components are addressed in this section. This section focuses on potential socioeconomic impacts resulting from the proposed reservoirs. Potential impacts resulting from other physical features of alternatives, such as pipelines, pump stations, and wells, are not specifically addressed in this section. It is likely that the preferred alternative will include construction of a water supply reservoir, and it is assumed that the construction of any reservoir would result in the greatest socioeconomic impacts, as compared to other physical features of an alternative (i.e., pipelines, pump station, wells, etc.). Therefore, for this analysis, the degree of socioeconomic impact which could result from reservoir development is deemed indicative of the degree of impact of the entire alternative component.

5.5.1 Ware Creek Reservoir with Pumpover from the Pamunkey River

Municipal and Private Water Supplies

River withdrawals associated with this alternative should not cause any appreciable water quality changes in the Pamunkey River.

It is possible that the large (120 mgd capacity) municipal water supply withdrawal associated with this alternative could limit the availability of the Pamunkey River as part of a proposed Hanover County water supply project. In 1992, Hanover County submitted a permit application to construct the Crump Creek Reservoir in Hanover County. Since that time, the permit application was modified to endorse a side-hill reservoir project. The proposed project has since been deemed not feasible.

The permit application has been administratively withdrawn and is no longer considered active. As of October 1996, the USCOE has no active permit applications from Hanover County for a water supply project (K. Kimidy, USCOE, personal communication, 1996). Nonetheless, the County has entered into an agreement with the City of Richmond for future water supply development and is continuing to investigate potential water supply alternatives focusing on Pamunkey Basin sources. Pamunkey River withdrawals for Lower Peninsula use would compete with any future Pamunkey River water supply projects for Hanover County.

Owing to conditions set forth in a December 1983 Agreement between James City and New Kent counties, New Kent County has the option to purchase an ownership interest of up to 30 percent of the Ware Creek Reservoir capacity. Based on safe yield analysis for this alternative, this equates to as much as 2.2 mgd of the raw water safe yield being available to New Kent County. This water allocation represents an important potential benefit for New Kent County which is not a current member of the RRWSG.

The Columbia and Yorktown Aquifers would be afforded recharge by direct and indirect seepage from the reservoir. This would be a beneficial impact, assuming that the water stored in the reservoir remains of good quality. However, if the water quality of the Ware Creek Reservoir deteriorates as a result of intense development in the watershed then reservoir seepage could have some detrimental impact on groundwater quality.

Substantial municipal water supply benefits would be derived from interconnecting the new Pamunkey River withdrawal and Ware Creek Reservoir with the existing Lower Peninsula water systems.

Recreational and Commercial Fisheries

Potential impacts from intake structures include the entrainment and impingement of fish eggs and larvae. Use of wedge-wire screens with very low entrance velocities and very small openings would greatly reduce these potential impacts.

Potential impacts due to reduced Pamunkey River flows should be inconsequential.

The loss of coastal marshes, such as those within the reservoir area, would result in the decrease in nursery and feeding grounds for young fish and juveniles of commercial importance (USEPA, 1992).

The semi-anadromous White Perch would lose valuable spawning habitat since the dam would block this estuarine perch from freshwater spawning areas above the dam site (USEPA, 1992). The decline of this species may impact higher trophic levels.

The anadromous Striped Bass would also suffer impacts due to conversion of current Striped Bass nursery habitat to a reservoir impoundment.

Once completed, Ware Creek Reservoir would provide 1,238 acres of valuable open water habitat for freshwater fish. Species currently present in the drainage area would populate the reservoir. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program in cooperation with the VDGIF would include supplementary stocking of forage and game species to augment natural populations.

Direct impacts to invertebrate species of commercial importance are not anticipated. However, adverse indirect effects to invertebrate species through greatly reduced freshwater flow and increased salinities in Ware Creek would be possible.

Any impacts to recreational or commercial fisheries resulting from pipeline construction should be minimal and temporary.

<u>Other Water-Related Recreation</u>

Intake

Potential impacts to water-related recreation are anticipated to be minimal due to the small acreage of impact to forested lands at the intake site (approximately 3 acres) and the vast area remaining in the Pamunkey River basin which can be used for recreation. Water depth in the Pamunkey River, which is important for recreational uses, would not be measurably impacted by withdrawals since the proposed intake is located in tidal waters. Hunting in the area may be disturbed during construction of the pump station and noise generated from operation of the pump station may cause localized disturbance of waterfowl.

Reservoir

Upon construction of the reservoir, 350 acres of recreational facilities are planned for development in the watershed, in association with the Stonehouse Community. Planned recreational facilities include: two golf courses; nine park systems including: playgrounds, five swimming pool complexes, and six tennis court complexes; a tennis center; a recreational vehicle storage area; and a community center (Stonehouse, Inc., 1991).

New open water area created by the reservoir could be used for several recreational activities including boating, fishing, sailing, swimming, and hunting; however, certain restrictions may be applied to hunting in the vicinity of the reservoir by James City and New Kent counties. Reservoir development would result in reduced land area for hunting; however, the open water created by the reservoir may increase the number of game and waterfowl species which use the area.

Land adjacent to the reservoir could be used as picnic areas, camping sites, and nature trails. Anticipated recreational needs for this area, as identified in the ***Virginia Outdoors Plan*** (VDRC, 1989), include canoeing areas, outdoor swimming areas, camp sites, and hiking trails, which the watershed could be designed to provide. The reservoir would be stocked with fish and a fisheries management plan would be implemented to provide long-term sport fishing benefits.

Pipeline

No recreational facilities would be impacted by the pipeline route. The pipeline could result in temporary disturbances to hunting in forested areas along the pipeline route. However, lands affected by pipeline construction would be restored, where possible, following construction.

Aesthetics

Intake

Construction and operation of the proposed Pamunkey River pumping station would create minor aesthetic impacts since houses are located as close as 300 feet from the project area. However, architectural and landscaping treatment would be designed to minimize visual impacts, as well as to minimize the propagation of sound.

The pumping station would also be visible to boats passing up and down the Pamunkey River in the vicinity of the intake. Vegetation cleared for construction of the intake line may also disrupt the visual continuity of the shoreline. However, much of the land in the immediate vicinity of the proposed pumping station site has already been cleared for agricultural use and structures exist nearby. For the most part, the pumping station would modify an already disturbed visual environment and, with appropriate landscaping and architectural treatment, should not overly detract from the scenic beauty of the river near the intake.

Reservoir

A dramatic shift in the scenic character of the area would occur from replacement of the hardwood swamp and emergent wetlands with an open lake. However, this new open water habitat could be considered an aesthetic resource by residents. Short-term impacts to residents in the area would result from landscaping, air quality, and noise. However, once construction is completed, long-term noise or air quality impacts would be of a greatly reduced magnitude. Odor is not expected to be a problem since the proposed river pumpover would be used to keep the reservoir full and thus minimize periods when the reservoir would be severely drawn down and more likely to develop odor problems.

The proposed dam location could cause the delisting of Ware Creek from the Nationwide Rivers Inventory (USCOE, 1987). Therefore, this alternative could preclude a waterway on the Inventory from eventually being listed as a Wild and Scenic River.

New open water created by the reservoir would create an aesthetic resource for residents and visitors to the Stonehouse Community.

Special design and landscaping of the dam area would be used to minimize the impact to the surrounding visual beauty. Where possible, the buffer strip required by James City County's watershed protection ordinance would be left uncleared to reduce visual impacts and ensure slope stability.

Pipeline

A total of 107 houses were identified within 300 feet of the proposed pipeline route. Pipeline installation would require a right-of-way to be cleared, and then restored, where possible, to a natural condition. Disruption of the aesthetic amenities along the transmission route would be greatest during construction.

Parks and Preserves

No direct impacts to existing parks or preserves are anticipated as a result of intake, reservoir, or pipeline construction associated with this alternative.

Nine parks are planned throughout the reservoir drainage area in association with the Stonehouse Community.

Land Use

Due to the remoteness of the proposed Pamunkey River intake site from development, the placement of a pumping station would cause only limited impacts on existing land uses. Impacts would be limited to the disturbance of approximately 1.5 acres of forested land and 1.5 acres of agricultural land.

Additional land uses may be disturbed by construction of an access road to the proposed intake site. It is anticipated that impacts associated with these activities would be minor.

New electrical transmission lines may be required to power the pump station, which could require the dedication of new rights-of-way. Land uses within these areas would also be impacted.

While the construction of an intake at Northbury is not consistent with existing plans for future use of the area, development at the site is not precluded. Due to the designation of the site as a CBPA, development would be required to be conducted in compliance with the provisions of the Act.

The 3-acre pump site is also located within an AFD. While intake construction would preclude use of this small area for agriculture or forestry, this area represents only 0.01 percent of the 25,066 acres of AFD land in New Kent County.

Although approximately 625 acres of forest would be lost through clearing operations and subsequent inundation, this represents less than 1 percent of the forested land within James City and New Kent counties.

All development at the reservoir site would be required to comply with the provisions of the Chesapeake Bay Preservation Act.

Approximately 126 acres of the York River AFD in New Kent County would be impacted by clearing operations and subsequent inundation. This represents 0.5 percent of the total 25,066 acres of AFD land in New Kent County. While reservoir construction would preclude use of this acreage for agriculture or forestry, the area of impact is small in relation to the remaining AFD land in the county. In addition, the open water reservoir area would still provide a valuable natural and ecological resource, which would fulfill part of the purpose of an AFD. Approximately 120 acres of the Barnes Swamp AFD would be impacted in the reservoir area. This represents 0.68 percent of the approximately 17,597 acres of AFD land in James City County.

Existing and future land uses within a reservoir buffer area may also be impacted by implementation of this project. These areas would be maintained in their natural state to protect the water quality of the reservoir. Therefore, it is likely that future development within these areas would be precluded.

The total land area encompassed by the pipeline ROW would be approximately 159 acres. Use of this strip would temporarily remove agricultural land within that area from its current land use. Forested areas along the pipeline route would be cleared, and reforestation would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land disturbance in any one area along the route, and the restoration, where possible, of affected land, pipeline construction should not cause unacceptable impacts to existing or future land use.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Total noise levels during construction of the Ware Creek Reservoir could be excessive since highway traffic from Interstate 64 crossing this site would increase typical background noise levels. Long-term impacts on ambient noise levels would result from the operation of pumping stations.

Infrastructure

The Ware Creek Reservoir alternative would inundate three existing state routes and require potential abandonment of a fourth state route. The estimated 100-year flood pool elevation of Ware Creek Reservoir would also come within ½ to 1 foot of flooding a low point on Interstate 64. In addition, based on the extent of planned development associated with the Stonehouse community, there would be an increase in long-term traffic volumes around the Ware Creek Reservoir.

The Ware Creek Reservoir would require 13 miles of new or upgraded electrical transmission lines for connection of new pump stations to suitable existing power sources and use considerable electric power. Secondary energy impacts in the Ware Creek Basin, as a result of the planned development associated with the Stonehouse community, would also be noticeable. The Ware Creek Reservoir intake and dam construction would have potential impacts on recreational navigation within the Ware Creek basin.

Other Socioeconomic Impacts

No families would be displaced by construction of the proposed Ware Creek Reservoir. Growth-inducing impacts of the proposed reservoir are already evident in the northern portion of James City County, where the Stonehouse Community is being developed. Increased business and employment activity associated with reservoir construction would have a beneficial impact on the local economy.

An analysis was conducted to estimate the impact of the proposed withdrawal on salinity concentrations in the Pamunkey River (see Report I, ***Pamunkey River Salinity Intrusion Impact Assessment for Black Creek Reservoir Alternative*** (Malcolm Pirnie, 1995) which is incorporated herein by reference and is an appendix to this document). The study concluded that natural Pamunkey River salinity fluctuations greatly exceed any salinity changes that are predicted due to the proposed RRWSG withdrawals (see Section 5.2.2). The modeling study demonstrated that the RRWSG's proposed withdrawals would not affect the upstream limits of detectable salinity intrusion. However, the withdrawals would cause small increases in the frequency of given levels of salinity intrusion at points which already are periodically exposed to comparable salinity levels. As a result, additional analysis has been conducted to identify the potential impacts of predicted salinity shifts on irrigation of crops along the Pamunkey River.

Small salinity shifts would be expected to have more impact in reaches of the river where salinity levels are higher. Therefore, to provide a worst-case scenario analysis, the potential impacts to the most downstream Pamunkey River irrigation withdrawal location from the proposed Northbury intake site were examined. Based on 1995 irrigation withdrawal data obtained from the Virginia Department of Environmental Quality (C.S. Torbeck, VDEQ, personal communication, 1996) and information obtained from the Virginia Agricultural Extension Service (M. Day, VAES, personal communications, 1996b and 1997; P. Davis, VAES, personal communication, 1996c), the most downstream irrigator is Davis Farm. Davis Farm is located in New Kent County on the Pamunkey River across from Sweet Hall (see Figure 5-4C). The Davis Farm grows produce including watermelon, cantaloupe, and pumpkins (P. Davis, VAES, personal communication, 1996c).

A literature review was conducted to identify the salinity threshold level at which these crops may experience adverse effects. Salinity affects plants by limiting the availability of crop water. A review of available literature indicated that the threshold level at which some crops begin to experience negative impacts from salinity is approximately 0.45 to 0.50 ppt (Wescot and Ayers, 1984; FAO, 1985).

As defined in the Pamunkey River MIF (see Section 3.3.3), it is assumed for this analysis that irrigation occurs primarily during the months of April through September. Table 5-12E presents predicted salinity changes for the spring, summer, and autumn seasons at the nearest salinity model transect to the Davis Farm (located at Pamunkey River Mile 14.9). Maximum salinity data are presented to provide a worst-case scenario, although the Pamunkey River MIF would preclude withdrawals during low-flow periods when maximum salinities typically occur.

Under all three scenarios, maximum salinity levels at River Mile 14.9 exceed the salinity tolerance range for plants (0.45 -0.50 ppt) which was identified in the literature review. Predicted maximum salinity levels at River Mile 14.9 for the 551-month simulation period were shown to increase most substantially under the Cumulative Effects Scenario (which assumes RRWSG and all other anticipated withdrawals from the Pamunkey River). However, the incremental impact of RRWSG withdrawals only resulted in 0.01 to 0.03 ppt increases in the predicted maximum seasonal salinity levels.

5.5.2 Black Creek Reservoir with Pumpover from the Pamunkey River

Municipal and Private Water Supplies

Potential impacts to municipal and private water supplies from the proposed Pamunkey River withdrawal are discussed in Section 5.5.1.

The Black Creek Reservoir drainage area lies entirely within New Kent County. As such, New Kent County may acquire an option to purchase a portion of the Black Creek Reservoir capacity. For purposes of the safe yield analysis for this alternative, a host jurisdiction allowance of 3 mgd was assumed. This water allocation represents a considerable potential benefit for New Kent County which is not a current member of the RRWSG.

There would also be a beneficial impact to local groundwater users as a result of the proposed reservoir. The Yorktown Aquifer would be afforded recharge by direct and indirect seepage from the reservoir.

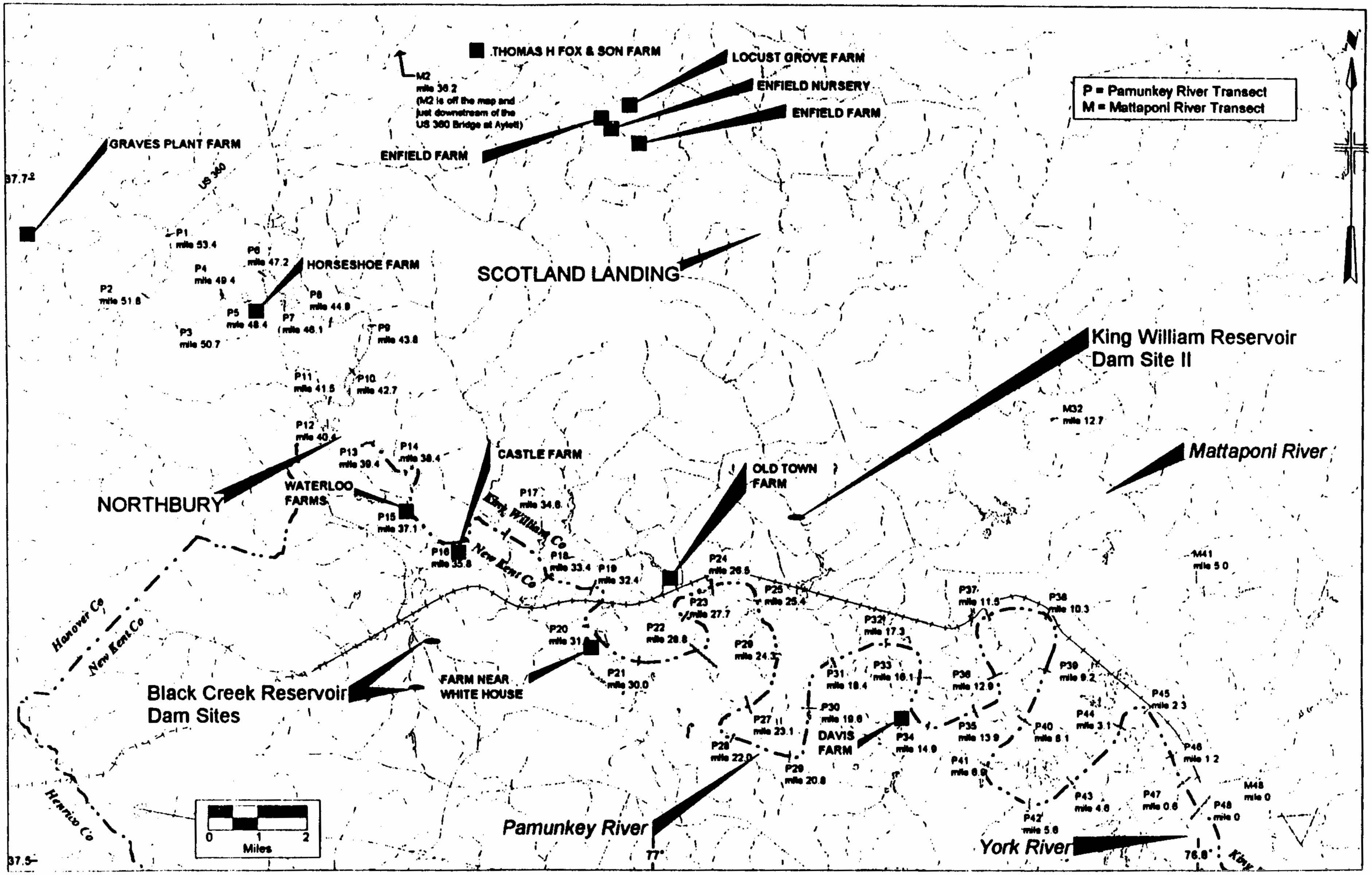

FIGURE 5-4C

MALCOLM PIRNIE

SELECTED PAMUNKEY AND MATTAPONI RIVER BASIN IRRIGATION WITHDRAWAL LOCATIONS

NOVEMBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY

TABLE 5-12E

PREDICTED CHANGES IN MAXIMUM PAMUNKEY RIVER SALINITY LEVELS NEAR DAVIS FARM (PAMUNKEY RIVER MILE 14.9)

(551-Month Simulation - Oct 1941 through August 1987)

Scenario	Maximum Salinities (ppt)		
	Spring	Summer	Autumn
1	0.58	3.50	4.95
2	0.59	3.53	4.98
3	0.73	4.01	5.43

Source: Appendix Report I. ***Pamunkey River Salinity Intrusion Impact Assessment for Black Creek Reservoir Alternative*** (Malcolm Pirnie, 1995)

Notes: Scenario 1 = Baseline
Scenario 2 = Incremental Effects
Scenario 3 = Cumulative Effects
Spring months are defined as March, April, and May
Summer months are defined as June, July, and August
Autumn months are defined as September, October, and November

Substantial municipal water supply benefits would be derived from interconnecting the new Pamunkey River withdrawal and Black Creek Reservoir with the existing Lower Peninsula water systems.

Recreational and Commercial Fisheries

Potential impacts to recreational and commercial fisheries at the Pamunkey River intake site are described in Section 5.5.1.

Once completed, Black Creek Reservoir would provide 910 acres of valuable open water habitat for freshwater fish. Species currently present in the drainage area would populate the reservoir. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program in cooperation with the VDGIF would include supplementary stocking of forage and game species to augment natural populations.

The proposed minimum reservoir release of 1.2 mgd represents 32 percent of the estimated combined average streamflow at the two dam sites, and is expected to be sufficient to maintain good quality fishery habitat in the lower reaches of Black Creek.

Any impacts to recreational or commercial fisheries resulting from pipeline construction should be minimal and temporary.

Other Water-Related Recreation

Intake

Potential impacts to water-related recreation in the vicinity of the proposed intake site at Northbury on the Pamunkey River are identified in Section 5.5.1.

Reservoir

Upon construction of the reservoir, new open water areas could provide water-related recreation in the basin including boating, fishing, canoeing, swimming, sailing, and hunting. However, hunting in the vicinity of the reservoir may be regulated by New Kent County. Reservoir development would result in reduced land area for hunting; however, the open water created by the reservoir may increase the number of game and waterfowl species which use the area. The reservoir would be stocked with fish and a fisheries management plan would be implemented to provide long-term sport fishing benefits. Anticipated future recreational needs for this area, as identified in the ***Virginia Outdoors Plan*** (VDRC, 1989), include hunting areas, camping sites, outdoor swimming areas, and picnic areas, which the watershed could be designed to provide.

If the reservoir is constructed, New Kent County may designate portions of the watershed as public parks, which would likely include recreational facilities.

Pipeline

Impacts to forested areas along the pipeline route could result in temporary disturbances to hunting in the area. However, lands affected by pipeline construction would be restored, where possible, following construction.

Aesthetics

Intake

Aesthetic impacts due to construction and operation of the proposed Pamunkey River intake and pumping station are discussed in Section 5.6.1.

Reservoir

A dramatic shift in the scenic character of the area would occur from the replacement of hardwood swamp and emergent wetlands with an open lake. However, this new open water habitat would create an aesthetic resource for residents. Short-term impacts to residents in the area would result from landscaping, air quality, and noise. However, once construction is completed, long-term noise or air quality impacts would be of a greatly reduced magnitude. Odor is not expected to be a problem since the proposed river pumpover would be used to keep the reservoir full and thus minimize periods when the reservoir would be severely drawn down and more likely to develop odor problems.

The dams would be specially designed and landscaped to minimize impacts to the surrounding visual features. Wherever possible, a buffer strip would be left uncleared to reduce visual impacts and ensure slope stability.

Pipeline

A total of 62 houses were identified within 300 feet of the proposed pipeline route. Pipeline installation would require a right-of-way to be cleared, and then restored, where possible, to a natural condition. Disruption of the aesthetic amenities along the transmission route would be greatest during construction.

Parks and Preserves

No negative impacts to parks or preserves are anticipated as a result of intake, reservoir, or pipeline construction associated with this alternative.

If the Black Creek Reservoir is constructed, it is possible that New Kent County may designate portions of the watershed as public parks.

Land Use

Potential land use impacts anticipated at the proposed Pamunkey River intake site are described in Section 5.5.1.

Although there would be a loss of approximately 546 acres of forest through clearing operations and subsequent inundation, this represents less than 1 percent of the forested land in New Kent County. At least three existing houses would be displaced by reservoir construction. At least three additional houses within the proposed reservoir buffer areas could also be displaced.

In general, construction of the reservoir is consistent with local land use plans for the area, which designate the region as remaining rural in nature in the future.

All development at the reservoir site would be required to comply with the provisions of the Chesapeake Bay Preservation Act.

Approximately 376 acres of the Pamunkey River AFD would be impacted by clearing operations and subsequent inundation. This represents only 1.5 percent of the total 25,066 acres of AFD land within New Kent County. While reservoir construction would preclude use of this acreage for agriculture or forestry, the area of impact is small in relation to the remaining AFD land in the county. In addition, the open water reservoir area would still provide a valuable natural and ecological resource, which would fulfill part of the purpose of an AFD.

Existing and future land uses within a reservoir buffer area may also be impacted by implementation of this project. These areas would be maintained in their natural state to protect the water quality of the reservoir. Therefore, it is likely that future development within these areas would be precluded.

The total land area encompassed by the pipeline ROW would be approximately 119 acres. Use of this strip would temporarily remove agricultural land within that area from its current land use. Forested areas along the pipeline route would be cleared, and reforestation would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land disturbance in any one area along the route, and restoration, where possible, of affected land, pipeline construction should not cause unacceptable impacts to existing or future land use.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Long-term impacts on ambient noise levels would result from the operation of pumping stations.

Infrastructure

The Black Creek Reservoir alternative would inundate portions of one state route. It would require 15 miles of new or upgraded electrical transmission lines for connection of new pump stations to suitable existing power sources.

The intake structure on the Pamunkey River would have a potential impact on commercial and/or recreational navigation due to the shallow and narrow river conditions at Northbury. The dam site, however, would not have a substantial impact on navigation.

Other Socioeconomic Impacts

Potential impacts to irrigators in the Pamunkey River Basin resulting from proposed Pamunkey River withdrawals are addressed in Section 5.5.1.

While the Black Creek Reservoir alternative would displace three or more families, this alternative could also result in many positive socioeconomic impacts, especially during construction when business activity in the area would be increased. Like any publicly-owned reservoir project, however, this alternative would reduce the County's property tax revenues by removing the project area from private ownership. It is estimated, as a worst-case scenario, that the annual tax revenue loss would be $83,267.

The proposed reservoir project is estimated to impact 79 acres of agricultural land and 546 acres of forested land. While these acreages would no longer be available for agricultural or silvicultural uses, the loss of these resources would represent less than 1 percent of the total forested, open space and agricultural areas in the County. Abundant resources within the County would remain available for economic development.

Providing additional water supply is likely to induce residential, commercial and industrial growth, and growth-related impacts, in New Kent County. Studies of existing reservoirs in the southeastern United States have shown that residential development around reservoirs is strongly influenced by: accessibility to existing road networks, schools, and employment areas; availability of utility systems; and proximity to business districts and major urban centers (Burby, 1971).

The proposed Black Creek Reservoir project area is located in close proximity to major transportation corridors, population centers, employment areas, and existing utility systems. It is easily accessible to existing local and regional roads (e.g., State Route 249 and Interstate 64), schools (New Kent Elementary School), and employment areas in Richmond, Henrico County, and the Bottoms Bridge commercial center. A County-owned water system is presently available in the Quinton area. As part of a host jurisdiction agreement between New Kent County and the RRWSG, the County would be given access to additional quantities of water if this project is developed. Sewer service is generally unavailable, with virtually all homes served by septic tanks. However, a wastewater treatment plant is planned to serve a new 350-home subdivision adjacent to the existing Kenwood Farms subdivision. According to the VDEQ, a VPDES permit was recently reissued for this plant, which would discharge treated wastewater to the Clopton Swamp drainage basin (D. Osborne, VDEQ, personal communication, 1995).

New Kent County is located in close proximity to the Richmond metropolitan area. Many people living in the County commute to Richmond for work (RRPDC, 1992). New Kent appeals particularly to those who want to live in a primarily rural environment, and the County's population is expanding as people migrate from the nearby metropolitan area. Population and business growth are expected to receive an extraordinary boost from Colonial Downs, a horse racetrack facility which is currently under construction.

The Black Creek watershed is currently undergoing residential development. Field studies conducted for this document indicate that there are at least four residential subdivisions within the Black Creek watershed (i.e., Clopton Forest, Kenwood Farms, Essex Hills and Marl Springs), some of which border the proposed reservoir site. The majority of the lots within these existing subdivisions are four to five acres in size. There are still large areas of undeveloped land surrounding Black Creek, and the area appears to have a high potential for future development. The aesthetic and recreational benefits of a reservoir would make the Black Creek area an even more attractive place to live.

5.5.3 King William Reservoir with Pumpover from Mattaponi River

Municipal and Private Water Supplies

River withdrawals associated with this alternative should not cause any great water quality changes in the Mattaponi River.

Mattaponi River basin waters are not used to a substantial degree at this time. To Malcolm Pirnie's knowledge, the only recent proposal for sizeable additional withdrawals from the Mattaponi River basin was by Spotsylvania County. The County submitted a permit application to the USCOE for a proposed reservoir on the Po River, which is a tributary to the Mattaponi River. If constructed, operation of the reservoir could have eventually reduced mean flow downstream of the dam by up to 8.4 mgd (Hayes, Seay, Mattern & Mattern, 1989). However, federal agencies indicated a strong opposition to this project based on its environmental impacts (R. Poeske, USEPA-Region III, personal communication, 1992). Subsequently, Spotsylvania County applied for and received a permit from the USCOE in February 1995 for the Hunting Run Reservoir Project, which is located entirely within the Rappahannock River Basin.

Owing to conditions set forth in the *King William Reservoir Project Development Agreement* (King William County and City of Newport News, 1990), the County has an option to reserve up to 3 mgd of the King William Reservoir capacity. This allowance represents a considerable potential benefit for King William County, which is not a current member of the RRWSG.

There would also be some beneficial impact to local groundwater users as a result of the proposed reservoir. The Yorktown Aquifer would be afforded recharge by direct and indirect seepage from the reservoir.

Substantial municipal water supply benefits would be derived from interconnecting the new Mattaponi River withdrawal and King William Reservoir with the existing Lower Peninsula water systems.

The RRWSG has considered the effect of withdrawals on the use of the Mattaponi River for future wastewater discharges. Currently there are no permitted wastewater discharges within the Mattaponi River basin near Scotland Landing. With the proposed withdrawal in place, permitted wastewater discharges would have to comply with the State's Public Water Supply (PWS) Standards. These standards could mean additional treatment if metal levels are elevated in wastewater. This could occur if untreated industrial wastes were received by a sewage treatment plant. Additional treatment could also be required if nutrient levels (e.g., ammonia, nitrate, or phosphorus) are elevated in wastewater. However, effluent nutrient limits are likely to become more strict anyway as work continues to meet Chesapeake Bay Agreement goals, and since discharge permits are renewed every 5 years, requiring compliance with new effluent limitations.

State PWS standards would apply within a zone that the State would establish following a public comment process. However, State regulations do allow permittees to demonstrate that less strict water quality standards should apply to their discharges in PWS zones. The proposed PWS boundaries are developed on a case-by-case basis by the VDH and VDEQ. Disinfection requirements would also apply to permitted sewage discharges which are within 15 miles upstream or one tidal excursion downstream (approximately 2.7 miles) from the water supply intake.

The State has also received nominations for "exceptional waters." Within designated exceptional waters, new or increased pollutant discharges will not be allowed. If so designated, this would limit wastewater discharges much more than PWS standards and disinfection requirements. The Chesapeake Bay Foundation nominated the Mattaponi River and other Coastal Plain rivers for exceptional waters status; however, that nomination was later withdrawn (J. Gregory, VDEQ, personal communication, 1996).

WHY?

The withdrawal of water from the Mattaponi River and discharge into the proposed King William Reservoir (in the Pamunkey River basin) would constitute an interbasin transfer of water. The rights of water users along the Mattaponi River in Virginia are protected by the riparian doctrine of water use which is defined in Section 2.8.2. Its applicability to the King William Reservoir alternative is discussed herein.

As described in Section 3.4.15, the proposed King William Reservoir project is designed to operate as a flood-skimming project, with water being withdrawn from the Mattaponi River primarily during periods when the flow is above prescribed minimum instream flowby (MIF) levels and, therefore, should not affect the availability of the resource for use by other water users. The withdrawal of surface water by a municipality for water supply, particularly if the water is transferred to another watershed (as is the case with the proposed project), is not a recognized use of right under the riparian doctrine. However, because the project would rely on surplus water not needed by riparian users in the Mattaponi River, the proposed interbasin transfer would not violate any other landowner's riparian rights.

*

Under the riparian doctrine, owners of riparian land have legal claims only for those amounts of water that they can use at present or in the foreseeable future, based on reasonable projections. Riparian owners located on the Mattaponi River between the downstream boundary of the intake site and the confluence with the York River would have standing to enforce their riparian rights, but they would be entitled to relief only if they could show that the diversion caused them an actual injury. It is likely that other owners have potential standing to enforce riparian rights. These include owners on: Cohoke Creek below the proposed dam, the Pamunkey River below its confluence with Cohoke Creek, and the York River. However, any owner with potential standing would have to prove actual injury from the diversion.

Due to the nature of the proposed project, which would primarily withdraw surplus water, injury to other water users should not occur. If other users were adversely affected, however, the remedies provided under the riparian doctrine (typically damages for "inverse condemnation") would be available to anyone who could prove injury.

Recreational and Commercial Fisheries

Potential impacts from the intake structures include the entrainment and impingement of fish eggs and larvae. Use of wedge-wire screens with very low entrance velocities and very small openings would greatly reduce these potential impacts.

Potential impacts due to reduced Mattaponi River flows should be inconsequential. Once completed, the King William Reservoir alternative would provide freshwater fish approximately 2,284, 2,222, 1,909, and 1,526 acres of valuable open water habitat for KWR-I, KWR-II, KWR-III, and KWR-IV, respectively. Most species currently present in the drainage area would populate the reservoir. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program in cooperation with the VDGIF would include supplementary stocking of forage and game species to augment natural populations.

Temporary construction-related impacts to fisheries in Cohoke Millpond could be minimized by the use of turbidity curtains surrounding areas of construction. This would appreciably reduce potential impacts due to sedimentation during dam construction and reservoir clearing operations.

The proposed normal reservoir releases, which would average 3 mgd and 2 mgd, respectively, for the KWR-II and KWR-IV configurations, represent one-third or more of average estimated flow at the dam sites. These releases are expected to be sufficient to maintain good quality fishery habitat in Cohoke Millpond and the lower reaches of Cohoke Creek.

Any impacts to recreational or commercial fisheries resulting from pipeline construction should be minimal and temporary. Impacts to recreational or commercial fisheries in the Pamunkey River should not occur due to pipeline construction (directional drilling techniques will be used).

Other Water-Related Recreation

Intake

Water depth in the Mattaponi River, which is important for recreational uses, would not be measurably impacted by withdrawals since the proposed intake is located in tidal waters. Due to the remoteness of the proposed Mattaponi River intake site from development, the only disturbances to recreation from the pump station would be a disruption to hunting during construction. Also, noise generated from operation of the pump station may cause localized disturbance of waterfowl.

If the reservoir is constructed, King William County may develop a recreational area located in the vicinity of the intake structure (King William County and City of Newport News, 1990).

Reservoir

Upon implementation of this alternative, King William County may develop up to five sites as recreational areas adjacent to, and with access to, the reservoir. These sites would allow swimming, fishing, and boating (excluding the use of internal combustion engines) in the reservoir (King William County and City of Newport News, 1990). Other water-related activities, such as canoeing, sailing, and hunting, could also be included in the reservoir recreation plan; however, certain restrictions may be placed on hunting in the vicinity of the reservoir by King William County. Reservoir development would result in reduced land area for hunting; however, the open water created by the reservoir may increase the number of game and waterfowl species which use the area. The reservoir would be stocked with fish and a fisheries management plan would be implemented to provide long-term sport fishing benefits.

Land adjacent to the reservoir could be used for picnic areas, camping sites, and nature trails. Projected water-related recreational needs for this area, as identified in the *Virginia Outdoors Plan* (VDRC, 1989), include hunting areas, swimming areas, and picnic and camping sites, which the watershed could be designed to provide.

Impacts to Cohoke Millpond could include siltation during reservoir construction. This could cause temporary impacts on fishing in the pond. However, environmental controls would be used during construction to minimize any impacts to Cohoke Millpond from increased turbidity in Cohoke Creek.

Pipeline

Impacts to forested areas along the pipeline route may temporarily disturb hunting in the area. However, lands affected by pipeline construction would be restored, where possible, following construction.

The Pamunkey River crossing would be accomplished using directional drilling techniques. These drilling techniques can be accomplished from the shore and should not affect fishing in the Pamunkey River. Noise generated during construction could temporarily disturb waterfowl in the vicinity of the river crossing.

Aesthetics

Intake

No houses were identified in the immediate vicinity of the proposed Mattaponi River intake and pumping station site at Scotland Landing. Nevertheless, these proposed facilities would include architectural and landscaping treatment designed to minimize visual impacts, as well as to minimize the propagation of sound.

The pumping station may be visible to boats passing up and down the Mattaponi River in the vicinity of the intake. Any vegetation cleared for construction of the intake line could also disrupt the visual continuity of the shoreline. Most of the land in the immediate vicinity of the proposed pumping station site is forested and no structures were identified within 500 feet of the site. Therefore, the area appears quite pristine as viewed from the river. In view of these potential visual impacts, appropriate landscaping and architectural treatment would be used to help minimize any detraction from the scenic beauty of the river near the intake.

Reservoir

A dramatic shift in the scenic character of the area would occur from the replacement of hardwood swamp and emergent wetlands with an open lake. However, this new open water habitat would create an aesthetic resource for residents. Short-term impacts to residents in the area would result from landscaping, air quality, and noise. However, once construction is completed, long-term noise or air quality impacts would be of greatly reduced magnitude. Odor is not expected to be a problem since the proposed river pumpover would be used to keep the reservoir full and thus minimize periods when the reservoir would be severely drawn down and more likely to develop odor problems.

The dam area would be specially designed and landscaped to minimize impacts to the surrounding visual features. According to watershed protection provisions of the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), building, land disturbing activity, and clearing or vegetation removal would be severely restricted within the reservoir buffer areas. These provisions would help enhance and preserve the positive aesthetic values associated with the new reservoir.

Pipeline

A total of 45 houses were identified within 300 feet of the proposed pipeline route. Pipeline installation would require a right-of-way to be cleared, and then restored, where possible, to a natural condition. Disruption of the aesthetics along the transmission route would be greatest during construction.

Parks and Preserves

No negative impacts to existing parks or preserves are anticipated as a result of intake, reservoir, or pipeline construction associated with this alternative.

If the reservoir is constructed, it is possible that King William County may designate portions of the watershed as public parks. The County may develop up to five recreational sites adjacent to, and with access to, the reservoir.

Land Use

Due to the remoteness of the proposed Mattaponi River intake site from development, the placement of a pumping station would cause only limited impacts on existing land uses. Impacts would be limited to the disturbance of approximately 3 acres of forested land.

Additional land uses may be disturbed by construction of an access road to the proposed intake site. It is anticipated that impacts associated with these activities would be minor.

New electrical transmission lines may be required to power the pump station, which could require the dedication of new rights-of-way. Land uses within these areas would also be impacted.

While the construction of an intake and pump station at Scotland Landing is not consistent with existing plans for future use of the area, development at the site is not precluded. Due to the designation of the site as a CBPA, development would be required to be conducted in compliance with the provisions of the Act.

The maximum area of forest that would be lost through clearing operations and subsequent inundation is 1,648 acres for KWR-I. Even as a worst-case scenario; however, this represents only 1.5 percent of the 111,832 acres of forested land within King William County.

Reservoir construction at the King William County site would be consistent with local land use plans for the region. These plans designate the area as remaining primarily rural in nature and protected as a conservation area through the Chesapeake Bay Preservation Act. All development at the reservoir site would be required to comply with the provisions of the Act.

Existing and future land uses within a reservoir buffer area may also be impacted by implementation of this project. These areas would be maintained in their natural state to protect the water quality of the reservoir. Therefore, it is likely that future development within these areas would be precluded.

The total land area encompassed by the proposed pipeline ROW ranges from 94 to 104 acres for the four reservoir configurations. Use of the selected ROW would temporarily remove agricultural land within that area from its current land use. Forested areas along the pipeline route would be cleared, and reforestation would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land disturbance in any one area along the routes and the restoration, where possible, of affected land, pipeline construction should not cause unacceptable impacts to existing or future land use.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Long-term impacts on ambient noise levels would result from the operation of pumping stations.

Infrastructure

The King William Reservoir alternative would inundate portions of one state route. Energy requirements would only require 2.5 miles of new or upgraded electrical transmission lines.

The reservoir intake structures would not interfere with navigation due to the depth of the Mattaponi River at Scotland Landing. The associated dam would also not interfere with navigation on the river.

Other Socioeconomic Impacts

No families would be displaced by construction of the proposed King William Reservoir. This alternative would result in many positive socioeconomic impacts, particularly during construction when business activity in the area would be increased. Like any publicly-owned reservoir project, however, this alternative would reduce the County's property tax revenues by removing the project area from private ownership. It is estimated, as a worst-case scenario, that the annual tax revenue loss would be $147,280. However, this impact would be mitigated through lease payments made to the County by the City of Newport News as defined in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990).

Very little agricultural land is expected to be impacted by the proposed project. However, each configuration of the proposed reservoir project is estimated to impact forested land. While the forested acreages presented in Table 4-62 would no longer be available for agricultural or silvicultural uses, the loss of these resources would represent less than 1 percent of the total agricultural, forested and open space areas in the County. Abundant resources within the County would remain available for economic development.

This reservoir project is not expected to promote much new residential or business growth, because the site lacks important factors for attracting residential, commercial, or industrial development to the area.

The proposed King William Reservoir project area is relatively inaccessible to population centers, major employment areas, and existing regional roads (e.g., Interstate 64) which provide access to major urban centers. Central water and sewer service are not available in the immediate reservoir area; and are not expected to be made available in the future, since the County expects most of its future development to occur in the vicinity of U.S. Route 360 and in areas northwest of U.S. Route 360 (King William County, 1994). Under the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), the County would have an option to withdraw up to 3 mgd from the reservoir. The County does not currently intend to develop a central water system to take advantage of this new source of raw water. It is more likely that the water source would be used to attract industry to the County (King William County, 1994).

There has been very little development in the Cohoke Creek watershed; and there are no known occupied residential or commercial structures within the proposed King William Reservoir area or buffer zone. The average size of land parcels located, in whole or in part, within the proposed reservoir pool area or buffer zone for KWR-II is approximately 74 acres, confirming that the area is very rural in nature.

While development of a reservoir might have some growth-inducing impacts, there are mechanisms in place to prevent extensive development in the King William Reservoir watershed. The area is zoned "Agricultural-Conservation" and the entire watershed is designated "General Chesapeake Bay Preservation Area" on the County's Future Land Use Plan (King William County Planning Department, September 1991). The ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990) provides for the recreational use of the reservoir and watershed development. Recreational development of the reservoir by the County may include swimming, fishing, and some boating. The County has agreed to implement a watershed protection program, which would include provisions for a special purpose watershed protection district and the establishment of buffer zones along perennial and intermittent streams. A minimum 100-foot buffer around the reservoir would be acquired by the County and leased to the City of Newport News. The County's watershed protection program would require that new construction be set back another 100 feet beyond the 100-foot buffer zone leased to the City. These provisions would greatly restrict development in close proximity to the reservoir.

An analysis was conducted by VIMS to estimate the impact of the proposed withdrawal on salinity concentrations in the Mattaponi River (see Report J, ***Tidal Wetlands of the Mattaponi River: Potential Responses of the Vegetative Community to Increased Salinity as a Result of Freshwater Withdrawal*** (Hershner et al., 1991) which is incorporated herein by reference and is an appendix to this document). The study concluded that natural salinity fluctuations greatly exceed any salinity changes that are predicted due to the proposed withdrawals (see Section 5.2.2). The modeling study demonstrated that the RRWSG's proposed withdrawals would not affect the upstream limits of detectable salinity intrusion. However, the withdrawals, in combination with other existing and reasonably foreseeable consumptive water uses, would cause small increases in the frequency of given levels of salinity intrusion at points which already are periodically exposed to comparable salinity levels. As a result, additional analysis has been conducted to identify the potential impacts of predicted salinity shifts on irrigation of crops along the Mattaponi River.

Small salinity shifts would be expected to have more impact in reaches of the river where salinity levels are higher. Therefore, to provide a worst-case scenario analysis, the potential impacts to the most downstream Mattaponi River irrigation withdrawal location from the proposed Scotland Landing intake site were examined. Based on 1995 irrigation withdrawal data obtained from the Virginia Department of Environmental Quality (C.S. Torbeck, VDEQ, personal communication, 1996) and information obtained from the Virginia Agricultural Extension Service (M. Day, VAES, personal communications, 1996b and 1997), the most downstream reporting irrigator is Enfield Farm. Enfield Farm is located in King William County on the Mattaponi River, just downstream of the

Walkerton bridge (see Figure 5-4C). Its primary crops are corn, soybeans, and turf grass (M. Day, VAES, personal communication, 1996a).

A literature review was conducted to identify the salinity threshold level at which these crops may experience adverse effects. Salinity affects plants by limiting the availability of crop water. A review of available literature indicated that the threshold level at which some crops (e.g., corn) begin to experience negative impacts from salinity is approximately 0.45 to 0.50 ppt (Wescot and Ayers, 1984; FAO, 1985). Specifically, the salinity threshold levels for the crops grown at Enfield Farm are listed below:

Crop	Salinity Threshold (ppt)
Corn	0.44-0.50
Soybeans	2.3
Grass	1.7-3.4

Source: Maas and Hoffman, 1977.

As defined in the Mattaponi River MIF (see Section 3.3.3), it is assumed for this analysis that irrigation occurs primarily during the months of April through September. Predicted salinity changes for these months at the nearest downstream salinity model transect to Enfield Farm (located at Mattaponi River Mile 27.9), are presented in Table 5-12F. Maximum salinity data are presented to provide a worst-case scenario, although the Mattaponi River MIF would preclude withdrawals during low-flow periods when maximum salinities typically occur.

Under baseline conditions (no withdrawals), maximum salinity levels at River Mile 27.9 are below the salinity tolerance range for plants (0.45-0.50 ppt) which was identified in the literature review, as well as the threshold tolerance for specific crops grown at Enfield Farm. Predicted maximum salinity levels at River Mile 27.9 for the 540-month simulation period were shown to increase slightly under withdrawal conditions (which assumes RRWSG withdrawals in addition to all other existing and reasonably foreseeable consumptive uses), but are still below the crop tolerance threshold levels identified for plants. In addition, the predicted maximum salinities are below the specific crop tolerance range for plants grown at Enfield Farm. Therefore, impacts to irrigators are not anticipated as a result of predicted salinity changes from the proposed Mattaponi River withdrawal at Scotland Landing.

5.5.4 Fresh Groundwater Development

Municipal and Private Water Supplies

This alternative would provide a moderate treated water safe yield benefit. This alternative could provide 4.4 mgd (11 percent) of the Lower Peninsula's projected Year 2040 treated water supply deficit of 39.8 mgd. However, this alternative would also cause groundwater drawdown and groundwater quality impacts.

TABLE 5-12F

PREDICTED CHANGES IN MAXIMUM MATTAPONI RIVER SALINITY LEVELS NEAR ENFIELD FARM (MATTAPONI RIVER MILE 27.9)

(540-Month Simulation - Oct 1942 through September 1987)

With Withdrawals	Maximum Salinities (ppt)					
	April	May	June	July	August	September
No	0.00	0.00	0.00	0.02	0.17	0.29
Yes	0.00	0.00	0.00	0.03	0.19	0.33

Source: ***King William Reservoir Alternative - Preliminary Report on Aquatic Resource Issues*** (Malcolm Pirnie, 1989).

Notes: "No Withdrawals" is equivalent to baseline conditions.
"With Withdrawal" assumes RRWSG withdrawals in addition to all other existing and reasonably foreseeable consumptive uses in the Mattaponi River Basin.

Recreational and Commercial Fisheries

The small land disturbances associated with this alternative should not negatively impact recreational fisheries at Diascund and Little Creek reservoirs if proper sedimentation and erosion control measures are followed. Because groundwater withdrawals would occur when reservoir drop to 75 percent of capacity, this alternative would have some limited beneficial impacts on recreational fisheries by preventing more severe reservoir drawdowns than would otherwise occur.

Other Water-Related Recreation

No impacts to recreation are anticipated as a result of implementation of this alternative.

Aesthetics

Any negative aesthetic impacts associated with this alternative component would likely be associated with construction and would thus be minor and temporary. In addition, the proposed groundwater withdrawal and transmission facilities would include architectural and landscaping treatment to minimize the impact to visual surroundings, as well as to minimize the propagation of sound.

Parks and Preserves

No impacts to parks or preserves are anticipated as a result of implementation of this alternative.

Land Use

The area of impact for well placement and placement of transmission pipeline to the reservoir would be minimal.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Long-term impacts on ambient noise levels would result from the operation of groundwater wells.

Infrastructure

Transportation and navigation impacts as a result of the Fresh Groundwater alternative are expected to be negligible, and only limited impacts on energy resources would occur. However, approximately 17 miles of new or upgraded electrical transmission lines would be required for connections to suitable existing power sources.

Other Socioeconomic Impacts

Potential socioeconomic impacts could occur with this alterative in the form of increased water rates to consumers. These impacts could result form the costs incurred by the water purveyor in developing the additional supply. For the 4.4-mgd treated water safe yield benefit calculated for this alternative component, the Year 1992 present value of life cycle costs is $9.9 million. This is equivalent to $2.2 million per mgd of treated water safe yield benefit for this alternative.

While this alternative has been identified as being practicable with respect to cost, it is likely that the cost of water supply development to the purveyors will be passed on to the consumer in the form of increased rates.

5.5.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Municipal and Private Water Supplies

This alternative would provide a moderate treated water safe yield benefit. This alternative could provide 5.7 mgd (14 percent) of the Lower Peninsula's projected Year 2040 treated water supply deficit of 39.8 mgd. However, this alternative would also cause groundwater drawdown and groundwater quality impacts.

Recreational and Commercial Fisheries

The proposed groundwater withdrawal locations are spread evenly across the Lower Peninsula. Therefore, any local groundwater impacts to the Coastal Plain aquifer system and the surface water bodies which recharge the aquifer would be minimized. As a result, impacts to recreational and commercial fisheries should be negligible.

All concentrate discharges would occur in areas where elevated salinity levels (i.e., polyhaline and mesohaline conditions) already exist; therefore, impacts to species of recreational or commercial value are not anticipated due to potential changes in salinity levels.

Disturbances due to stream crossings would be temporary and minimal.

Other Water-Related Recreation

Development of the Site 4 facilities would be in an area of Newport News Park which is not subject to recreational policies; therefore, construction in the area would not affect existing recreation in the park.

Assuming a maximum right-of-way disturbance width of 40 feet, approximately 6.9 acres of the York County New Quarter Park would be affected by construction of the concentrate discharge pipeline for Site 2. Recreational facilities in this area could be temporarily affected during pipeline construction, but would be restored to their previous state. As a result, impacts to recreation at this park are anticipated to be minimal and temporary in nature.

Although the concentrate discharge pipeline for Site 2 would also cross the Colonial National Historic Parkway, no impacts to recreation are anticipated. The pipeline would be bored under the roadway to avoid traffic and no access to the site would exist from the parkway.

Aesthetics

The RO treatment facilities would be designed to minimize objectionable visual impact to houses and buildings located in close proximity to the project area. After construction is completed, long-term visual impacts would likely be offset to some degree by architectural design and landscaping features incorporated into the facilities.

Construction of the concentrate discharge pipelines would temporarily affect many houses in close proximity to the pipeline routes. However, after construction is completed, the cleared pipeline right-of-way would be restored, where possible, to a natural condition.

Any aesthetic impacts to the Colonial Parkway, York County New Quarter Park, or Newport News Park are anticipated to be minimal and temporary in nature.

Parks and Preserves

Development of the Site 4 facilities would affect areas within Newport News Park. Affected areas within this park would include a maximum of 1 acre for well development and RO facility construction, and approximately 2.3 acres of temporary disturbance for construction of the concentrate discharge pipeline (2,500 feet of pipeline within the park; assumed maximum right-of-way width of 40 feet). While these areas are located within the park, they are not subject to recreational policies set forth by the City of Newport News Department of Parks and Recreation (NNDPR, 1992). As a result, development of the well and associated facilities would not have any impact on the operation of the park for its intended purposes.

Assuming a 40-foot maximum right-of-way width, approximately 6.9 acres (7,500 linear feet) of the York County New Quarter Park would be affected by concentrate discharge pipeline constructed for the Site 2 facilities. This area would be temporarily disturbed for pipeline construction and then restored, where possible, to a more natural condition. As a result, the impacts to the park are anticipated to be minimal and temporary in nature.

Although the concentrate discharge pipeline for the Site 2 facilities would cross the Colonial National Historical Parkway, impacts to the resource are not anticipated. The pipeline would be bored under the Parkway, to minimize the potential for impacts to the resource.

Land Use

Groundwater development would require a total disturbance of 5 acres for well development and construction of the associated RO treatment plants. Because of the proposed location of the wells and RO plants at existing finished water storage and distribution locations within urbanized areas, and the minimal area of disturbance, the impacts to existing land uses at those sites are deemed minimal.

The total land area encompassed by the pipeline ROW would be approximately 65 acres. Reforestation of cleared areas would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land requiring disturbance in any one area along the route; no impacts to existing structures; and the restoration, where possible, of affected land construction should not cause unacceptable impacts to existing or future land uses.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Total noise levels during construction of the concentrate discharge pipelines could be excessive since traffic tie-ups in highly populated residential areas could increase typical background noise levels. Long-term impacts on ambient noise levels would result from the operation of groundwater wells.

Infrastructure

Transportation and navigation impacts as a result of the groundwater Desalination Alternative are expected to be negligible. Potential impacts on energy resources would also be minor.

Other Socioeconomic Impacts

The potential socioeconomic impacts of increased water rates to consumer could also occur if this alternative is implemented. These increased water rates are likely to result due to the additional costs incurred by the water purveyor in developing additional supply. For the 5.7-mgd treated water safe yield benefit calculated for this alternative component, the Year 1992 present value of life cycle costs is $34.2 million. This is equivalent to $6.0 million per mgd of treated water safe yield benefit for this alternative.

While this alternative has been identified as being practicable with respect to cost, it is likely that the cost of water supply development to the purveyors will be passed on to the consumer in the form of increased rates.

5.5.6 Additional Conservation Measures and Use Restrictions

Municipal and Private Water Supplies

This alternative would allow for Lower Peninsula water systems to provide 7.1 to 11.1 (18 to 28 percent) of the Lower Peninsula's projected Year 2040 treated water supply deficit of 39.8 mgd.

Recreational and Commercial Fisheries

The implementation of additional conservation measures and use restrictions should have no adverse impacts on fish species of recreational or commercial importance.

Other Water-Related Recreation

The implementation of additional conservation measures and use restrictions on the Lower Virginia Peninsula could result in negative impacts to recreation at existing reservoirs. Irrigation in the reservoirs' watersheds may be halted which would impair the physical appearance of the watersheds and lower their aesthetic value. Private and public recreational facilities reliant on non-essential water use; such as swimming pools, golf courses, parks, and fields for sporting events; could also be adversely affected.

Aesthetics

Implementation of this alternative on the Lower Virginia Peninsula could result in negative aesthetic impacts at existing reservoirs. For example, irrigation in the reservoirs' watersheds would likely be discontinued and could impair the physical appearance of the watersheds, thus lowering visual aesthetic values. Aesthetic benefits derived from private and public recreational facilities reliant on non-essential water use; such as swimming pools, golf courses, parks, and fields for sporting events; could also be negatively impacted.

Parks and Preserves

Implementation of this alternative on the Lower Peninsula could result in negative impacts to parks preserves. It is likely that irrigation of parks within the area would be limited. This would result in negative impacts to the physical appearance of parks.

Land Use

The implementation of additional conservation measures and use restrictions would limit outdoor usage for parks and residential areas. Commercial and industrial facilities could also be adversely affected by use restrictions. In particular, businesses which rely on large quantities of treated water (e.g., car washes and beverage manufacturers) might have to reduce production or otherwise limit their operations. However, these potential impacts would only occur during extended drought periods when use restrictions are in effect.

Noise

The implementation of this alternative would have no adverse impact on ambient noise levels.

Infrastructure

The implementation of this alternative would not cause impacts to infrastructure.

Other Socioeconomic Impacts

Implementation of additional conservation measures and use restrictions could result in varying degrees of socioeconomic impacts, depending on the degree of use restrictions which are implemented. Under Tier 1, which would involve voluntary restrictions on water use, there would be very few socioeconomic impacts. Because the restrictions are voluntary, those water users which would suffer appreciable socioeconomic impacts by restricting water use would not be likely to minimize their usage. The water purveyor, however, would be impacted, as the decrease in regional water usage would represent decreased revenues to the water purveyor.

With Tier 2 use restrictions in effect, there would be greater socioeconomic impacts. This tier focuses on the elimination of nonessential uses of water, such as outdoor watering, and can result in socioeconomic impacts to some users. Landowners who irrigate their real estate might be affected if the restrictions are in place long enough to detract from the appearance of their land. This could in turn, result in fewer sales of their property. Owners of golf courses and other recreational areas might suffer from decreased revenues as a result of mandatory use restrictions because they would not be able to keep their facilities maintained as necessary to promote their use. The water purveyor would also be impacted to a greater degree by reduced revenues under this tier.

5.5.7 No Action

Municipal and Private Water Supplies

If the No Action alternative were taken, there would be severe adverse impacts on municipal and private water supplies. Cumulative impacts would result from existing water supply sources being relied on more and more heavily to meet increasing demand. Surface water reservoirs would be drawn down more severely and for more prolonged periods. It is likely that more frequent and more severe water quality problems would also be experienced in the reservoirs. In the event of a drought as severe as the controlling drought modeled for safe yield analyses, existing surface water supplies could be completely depleted under demand conditions projected for the mid-1990s.

Some existing groundwater users are not currently withdrawing the maximum amount allowed by their permits. Wells owned or operated by the James City Service Authority, York County, New Kent County, Stonehouse, Inc., Ford's Colony, Governor's Land, BASF, and others could be relied on more heavily if no action is taken to increase available water supplies. The USGS has simulated the withdrawal of groundwater at permitted maximums and found that cumulative impacts could include dewatering of limited western portions of some aquifers and an increase in the potential for salt water encroachment (Laczniak and Meng, 1988).

Recreational and Commercial Fisheries

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to fish species of recreational importance due to the increased frequency and severity of drawdowns in existing reservoirs. Also, lower water levels may limit access to existing boat docks, boat ramps, and fishing docks, thereby reducing recreational fishing opportunities.

This alternative should not impact commercial fisheries since the major impact would be to species inhabiting existing water supply reservoirs, and these reservoirs are not used for commercial fishing.

Other Water-Related Recreation

If no action is taken to increase the Lower Virginia Peninsula's water supply, water-related recreation within the region would be negatively impacted. Continued drawdown of the reservoirs would reduce open water space available for recreational activities and detract from the aesthetic value of the reservoirs. Reducing the water levels substantially could also adversely affect recreational fish species that inhabit the reservoirs. It is possible that some existing boat docks, boat ramps, and fishing docks could become less usable for recreational purposes.

Aesthetics

If no action is taken to increase the Lower Virginia Peninsula's water supply, aesthetic attributes of the existing reservoirs could be adversely impacted. For example, continued and more severe drawdown of the reservoirs would reduce open water space, expose lake bottoms, and detract from the visual appearance of the reservoirs. In addition, there would be longer periods when the reservoirs would be severely drawn down and more susceptible to developing odor problems.

Parks and Preserves

If no action were taken to augment the existing water supply on the Lower Peninsula, existing parks within the region could be negatively impacted. Increasingly severe reservoir drawdowns would negatively impact local parks such as Newport News Park (adjacent to Lee Hall Reservoir) and Waller Mill Park (adjacent to the City of Williamsburg's Waller Mill Reservoir). Reservoir bottoms that are inundated under normal conditions would be exposed at greater frequencies, which would negatively affect the use of the parks for their intended purposes.

No impacts to existing preserves in the region are anticipated as a result of the No Action alternative.

Land Use

If no action is taken by local purveyors to develop additional water supplies, there would be no negative impacts to existing land uses as a result of water supply development. However, new land use development and associated economic benefits could be precluded as a result of insufficient water supplies.

Noise

If no action was taken, there would be no adverse effect on ambient noise levels.

Infrastructure

If the No Action alternative was taken, resulting impacts on infrastructure would be negligible.

Other Socioeconomic Impacts

If no action were taken to provide additional sources of raw water supply to the Lower Peninsula, considerable socioeconomic impacts would occur. It is possible that growth-limiting measures would be implemented to conserve the existing water supply. For example, water purveyors could place moratoriums on new hook-ups. This would result in the cessation of new industries and other water users locating in the region due to a lack of treated water supply to meet their needs. The curtailment of new development would also take away potential new sources of revenue for the region which is generated by development (e.g., state and local income taxes, state sales taxes, municipal and county property taxes, and water user charges). While new sources of this revenue would be eliminated, government expenditures for public services would continue to rise, leading to fiscal problems in the local government. These fiscal impacts could be mitigated by the government either by increasing tax rates, or through cutbacks in services (e.g., police and fire protection, schools, etc.).

Each of the solutions which government may implement to minimize their financial burdens is likely to result in its own adverse impacts. An increase in taxes could result in increased reliance on public assistance, out-migration, delinquent payment of property taxes, and real estate foreclosures. Secondary impacts from public service reductions could include an increase in crime, lower quality education, and unemployment. Future water shortages would jeopardize the health and safety of customers when supplies become inadequate to meet the demands of sanitary facilities and fire protection.

5.6 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

The majority of potential adverse impacts resulting from the seven alternatives could be mitigated or minimized. However, some impacts could not be avoided. Unavoidable adverse impacts to environmental resources are listed below in general terms, for each of the seven evaluated alternatives.

Substrate

All three reservoir alternatives would involve removal of substrate at the intake and outfall locations. The Fresh Groundwater Development (FGD) alternative would involve removal of substrate at the pipeline outfall locations. The Brackish Groundwater Development (BGD) alternative would involve removal of substrate at the concentrate discharge pipeline outfalls. For each alternative, permanent impacts would involve less than 0.4 acres of substrate.

Water Quality

All three reservoir alternatives would result in increased phosphorus loading to Diascund Creek Reservoir (DCR). For the Black Creek Reservoir (BCR) alternative, this impact would be most pronounced when Pamunkey River withdrawals are pumped directly to DCR, bypassing BCR. For the Ware Creek Reservoir (WCR) alternative, increased phosphorus loading to WCR and elimination of the tidal freshwater zone of Ware Creek would also occur.

The FGD alternative would result in increased levels of chloride, bicarbonate, sodium, sulfate, fluoride, and possibly phosphorus in DCR and Little Creek Reservoir (LCR). The BGD alternative would add concentrate to polyhaline (18 to 30 ppt salinity) and mesohaline (5 to 18 ppt salinity) to oligohaline (0.5 to 5 ppt salinity) water bodies.

Under the No Action alternative, the frequency and severity of excessive dissolved nutrient conditions in existing reservoirs would increase.

Hydrology

Implementation of the WCR alternative would impound 37.1 miles of channels and would impound tidal waters. The basin wide cumulative average streamflow reduction at Year 2040 is projected to be 8.8 percent.

The construction of the BCR alternative would impound 13.7 miles of channels and would reduce basin wide cumulative average streamflow at Year 2040 by 9.9 percent. Construction of the King William Reservoir (KWR) alternative (KWR II configuration) would impound 26.5 miles of channels and would reduce basin wide projected cumulative streamflow at Year 2040 by 6.4 percent.

The FGD alternative may reduce the yield of existing wells in the project vicinity. Implementation of the BGD alternative could result in a slight drawdown in the Middle and Lower Potomac aquifers. The No Action alternative would result in continued stress on limited surface water and groundwater sources and would dewater limited western portions of some surface aquifers.

Groundwater Resources

Implementation of FGD alternative would result in reduced groundwater availability and reduced yield of existing wells in the project vicinity. The FGD alternative could result in the saltwater encroachment. Implementation of the Groundwater Desalination or Additional Conservation Measures and Use Restrictions alternatives may result in aquifer drawdown. The No Action alternative increases the potential for saltwater encroachment.

Soil and Mineral Resources

Implementation of the three reservoir alternatives and the FGD alternative would result in permanent loss of soils within the project areas and well sites, respectively.

Air Quality

Implementation of the BGD alternative would result in elevated levels of air pollution expected from increased traffic flows. Minor and temporary dust and elevated hydrocarbon pollutants occurring during construction at the WCR and BCR alternatives could impact nearby residents.

Endangered, Threatened, and Sensitive Species

The construction of the WCR, BCR, and KWR (KWR II configuration) would result in the inundation of approximately 590 acres, 285 acres, and 574 acres, respectively, of wetlands and open water habitat.

The implementation of the WCR and KWR alternatives would result in the permanent loss of the federally-listed threatened and state-listed endangered Small Whorled Pogonia populations located within the reservoir pool areas.

Fish and Invertebrates

The implementation of the WCR alternative would close access to anadromous fish in Ware Creek. The WCR alternative would also impact present habitat by changing salinity distribution and would eliminate some fish and invertebrate species currently inhabiting the Ware Creek system. Implementation of the BCR and KWR alternatives would eliminate some of the fish and invertebrates currently existing in the Black Creek system and Cohoke Creek system, respectively. The BGD alternative would result in minor impacts to fish and invertebrates from the concentrate pipeline discharges. The No Action alternative would result in increased drawdown of existing reservoirs which would negatively impact fish and invertebrate habitat.

Other Wildlife

The implementation of the WCR, BCR, and KWR (KWR II configuration) alternatives would result in the loss of 648 acres, 625 acres, and 1,648 acres, respectively, of terrestrial habitat within the reservoir pool areas. Reservoir construction would convert the terrestrial habitat within the pool area to open water habitat. Construction of the WCR alternative would result in the loss of a 98 nest Great Blue Heron rookery. The KWR alternative would result in the loss of a 17 nest Great Blue Heron rookery. The FGD and BGD alternatives would temporarily displace terrestrial species during construction. Continued drawdown of existing reservoirs resulting from the No Action alternative could impact existing wildlife species.

Wetlands/Vegetated Shallows

The construction of the WCR alternative site would result in the permanent loss of 590 acres of tidal and nontidal wetlands and open water habitat. Implementation of the BCR and KWR (KWR II configuration) alternative sites would result in the permanent loss of 285 acres and 574 acres, respectively, of existing nontidal wetlands and open water habitat. The FGD and BGD alternatives would provide impacts to wetlands located at the associated outfall structures. Groundwater drawdown and drawdown of existing reservoirs resulting from the No Action alternative would result in adverse impacts to wetland habitat.

Mud Flats

Implementation of the BGD alternative would negatively impact mud flats in the vicinity of the concentrate discharge outfalls. The No Action alternative would result in dewatering during extended drawdown periods in the existing reservoirs.

Archaeological and Historical Sites

Construction of the WCR and KWR alternatives would provide ~~the largest~~ number of impacts to identified cultural resources. Prehistoric sites located within the BCR impoundment areas would also be directly impacted by project construction.

Municipal and Private Water Supplies

The implementation of the FGD and BGD alternatives would cause minor groundwater drawdown and groundwater quality impacts. The No Action alternative would result in severe impacts on municipal and private water supplies.

Recreational and Commercial Fisheries

Implementation of the WCR alternative would result in the closure of Ware Creek to anadromous fisheries including Striped Bass. The No Action alternative would provide negative impacts to recreational and commercial fisheries due to existing reservoir drawdown.

Other Water-Related Recreation

All three reservoir alternatives would reduce the land available for hunting. Implementation of the Additional Conservation Measures and Use Restrictions alternative would negatively impact private and public recreational facilities reliant on non-essential water use (e.g., swimming pools, golf courses, parks, and fields for sporting events). The No Action alternative would result in adverse impacts to water-related recreation due to existing reservoir drawdowns.

Aesthetics

All three reservoir alternatives would result in the loss of unique and pristine wetlands. Construction of the three reservoir alternatives would affect aesthetics during construction and in the vicinity of nearby houses. Implementation of the BGD alternative results in the temporary and long term visual impact to nearby houses. The No Action alternative would result in negative impacts to the existing reservoirs.

Parks and Preserves

The Additional Conservation Measures and Use Restrictions alternative would result in irrigation restrictions and resulting impacts to parks and preserves identified in Section 5.5. As a result of reservoir drawdown, implementation of the No Action alternative would impact parks and preserves associated with existing reservoirs such as Newport News Park (adjacent to Lee Hall Reservoir) and Waller Mill Park (adjacent to the City of Williamsburg's Waller Mill Reservoir).

Land Use

Land disturbance associated with the WCR alternative would negatively impact 1,400 acres of forested and wetland areas and inundate 249 acres of agricultural/forestal districts. Implementation of the BCR alternative would negatively impact 1,032 acres of forested and wetland areas and inundate 379 acres of agricultural/forestal districts. The BCR alternative would displace at least three houses. Construction of the KWR alternative (KWR II configuration) would result in the impact of 2,322 acres of forested and wetland areas.

The total land disturbance associated with the BGD alternative is approximately 5 acres at the well locations and 65 acres impacted by the pipeline right-of-way. Additional Conservation Measures and Use Restrictions would result in negative impacts to parklands, residential areas, and businesses. The No Action alternative would severely limit future land use development in the region.

Noise

All three reservoir alternatives would result in increased noise levels associated with the pump stations. Noise generated by the WCR alternative could be excessive due to combination with Interstate-64 traffic. Implementation of the FGD and BGD alternatives would result in long term noise impacts resulting from operation of groundwater wells.

Infrastructure

Construction of the WCR and BCR alternatives would result in minor and temporary impacts to navigation in the Pamunkey River. The WCR alternative would dam navigable waters of Ware Creek and impact recreational navigation. Construction of the WCR would require modification of 4 roads (including I-64) and abandonment of portion of Route 606. The BCR would require modifications to one road. Implementation of the KWR would result in minor and temporary impacts to navigation in the Mattaponi River and modification of one road.

Socio-Economics

The BCR alternative would require the displacement of at least three houses. Implementation of the FGD and BGD alternatives would increase costs incurred by water purveyors. Implementation of Additional Conservation Measures and Use Restrictions would provide negative impacts to Lower Peninsula water users and the No Action alternative would constrain future economic growth in the region.

5.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Impacts would result from each of the evaluated alternatives which cannot be mitigated or replaced in the future. With the exception of the Additional Conservation Measures and Use Restrictions and No Action alternatives, all of the alternatives would require the same types of resource inputs. These include substrate, land areas and wildlife habitat, water, and capital resources and labor. The amount used for each alternative may vary considerably depending on the resource.

No resources would be irreversibly or irretrievably committed for the Additional Conservation Measures and Use Restrictions or No Action alternatives. The irreversible and irretrievable impacts for the remaining alternatives are described below in general terms.

Substrate areas at the proposed intake sites and/or outfall locations for the evaluated alternatives would be committed to the project.

The three reservoir alternatives would commit land areas and wildlife habitat (excluding wetlands) at the proposed pump stations and within the reservoir pool area to the project. Areas along the pipeline routes would be restored to a natural state following pipeline construction, and would not be irretrievably committed. Land areas and wildlife habitat (excluding wetlands) at the proposed well locations for the FGD and BGD alternatives would be committed to the project.

Implementation of one of the three reservoir alternatives would irretrievably commit river withdrawals from the Pamunkey River or Mattaponi River to the project. Average Year 2040 river withdrawals of 25 mgd (3.2 percent of Pamunkey River flow) would be irretrievably committed to the WCR alternative. The BCR alternative would irretrievably commit average Year 2040 river withdrawals of 33.3 mgd (4.4 percent of Pamunkey River flow) to the project. Average Year 2040 river withdrawals of 31.6 mgd (6.5 percent of the Mattaponi River flow) would be irretrievably committed to the KWR project (KWR-II Configuration). The FGD and BGD alternatives would irretrievably commit groundwater withdrawals to the projects.

All of the alternatives would require capital resources and labor for the construction of the project. These resources would be irretrievably lost through project implementation. However, the overall benefit of the project to the Lower Peninsula is expected to outweigh these losses.

5.8 RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Short-term impacts primarily occur during the construction phase of the projects and then are dissipated following construction. In comparison to these short-term impacts, the most evident long-term benefit of these projects would be the availability of additional water supply for the Lower Virginia Peninsula.

During construction of the reservoir alternatives and BGD alternative, increased erosion and turbidity could occur temporarily within the project area drainage basin and outfall location. Substrate, soils, and streams crossed by the pipelines would also be temporarily disturbed during project construction.

With the exception of the Additional Conservation Measures and Use Restrictions and No Action alternatives, all of the alternative project areas would experience short-term disruption from increased air emissions, noise, and traffic.

The three reservoir alternatives would cause a direct loss of wetlands. It is estimated that the WCR alternative would impact 590 acres of tidal and nontidal wetlands, the BCR alternative would impact 285 acres of nontidal wetlands, and the KWR-II configuration would impact 574 acres of nontidal wetlands. Mitigation of these wetlands would require replacement of similar wetland types and functions to compensate for the wetland loss. Mitigative measures would also include development of a biologically productive lacustrine habitat within the reservoir capable of supporting a diversity of fish and wildlife species.

All of the project alternatives would have impacts that would result in long-term changes in productivity. Silviculture production would be lost permanently in the project areas. Agricultural/forestal district lands would be permanently impacted at the project sites. Terrestrial habitats would be permanently changed at the reservoir sites, and temporarily disturbed at the FGD and BGD locations. Preservation and restoration of terrestrial habitats would compensate for the upland losses. Loss of silviculture production within the upland buffer of the KWR alternative could result in a positive change in habitat productivity with the implementation of the alternative compared to pre-project conditions.

The No Action alternative would result in drawdown of existing reservoirs resulting in a loss of aquatic and terrestrial habitat and ecological productivity.

Upon construction of one of the three reservoir alternatives, recreational facilities may be developed adjacent to, and with access to, the reservoir. These sites would allow swimming, fishing, and boating (excluding the use of internal combustion engines) in the reservoir. The Additional Conservation Measures and Use Restrictions and No Action alternatives could result in negative impacts to water-related recreation.

The long-term benefit provided by the three reservoir alternatives, the FGD alternative, and the BGD alternative would be the availability of an additional water supply to the Lower Virginia Peninsula. Although the FGD, BGD, and Additional Conservation Measures and Use

Restrictions alternatives would result in a financial impact to Lower Peninsula consumers, the No Action alternative would negatively impact economic growth of the Lower Peninsula.

The availability of an additional water supply would serve projected needs that result from future land use development and would facilitate new commercial development, thereby increasing employment over the long-term. Therefore, the short-term impacts and use of resources by the proposed additional water supply is consistent with the enhancement of long-term productivity for the Lower Peninsula.

5.9 ADDITIONAL REGIONAL NEEDS

5.9.1 Introduction

The RRWSG's water supply planning focuses on the water needs of the Lower Peninsula jurisdictions represented by the RRWSG members. However, the water needs of other jurisdictions (i.e., the Counties of New Kent, King William, and Gloucester and the Town of West Point) may also be relevant and important to this study effort.

Each of the three practicable reservoir alternatives considered in this document would be located outside the boundaries of the core planning area. The King William Reservoir Project would involve a new reservoir in King William County, plus new pipeline and pumping facilities in King William and New Kent Counties. The Black Creek and Ware Creek Reservoir Projects would both involve new reservoirs located entirely or partially within New Kent County, plus new pipeline and pumping facilities in New Kent County.

To develop a project located entirely or partly outside of the core Lower Peninsula planning area, various local consents and conditional use permits and other approvals would be required from the host jurisdictions under various provisions of Virginia state law. Such approvals are often conditioned upon the provision of water to the host jurisdiction. For example, the City of Newport News has executed Project Development Agreements which guarantee King William County and New Kent County up to 3 and 1 mgd of raw water safe yield, respectively, if the King William Reservoir Project is developed. Because the "host" jurisdictions are likely to look to the RRWSG to supply all or part of their needs from the RRWSG's project, it is necessary to estimate those jurisdictions' future water supply needs to determine whether any individual reservoir project will produce enough water to meet both the hosts' and the RRWSG's needs.

The RRWSG also has identified two other jurisdictions – Gloucester County and the Town of West Point – which, although not part of the core planning area or potential host jurisdictions, have water supply needs that are not likely to be met through independent or other regional water supply development efforts. Gloucester County, in particular, has recently expressed an interest in participating with the RRWSG regional study.

King & Queen County and Hanover County were also considered for inclusion in an expanded regional study area. In 1994, the City of Newport News, on behalf of the RRWSG, invited both localities to participate in discussions concerning an expanded project concept (City of Newport News, 1994a; City of Newport News, 1994b). King & Queen County did not respond to the invitation. Hanover County's position is discussed below.

Over the past several years, Hanover County has actively pursued development of Pamunkey River withdrawals to supply a new off-stream storage reservoir. In 1992, Hanover County submitted a permit application to the USCOE to construct the Crump Creek Reservoir in Hanover County. Due to environmental considerations associated with the Crump Creek Reservoir project, the County began investigating a side-hill reservoir project which could have less environmental impact than the Crump Creek Reservoir project. The original permit application was modified in 1994 to endorse a side-hill reservoir project. The County teamed with the City of Richmond to study and evaluate this new concept (City of Richmond and Hanover County, 1994). These additional studies indicated that the proposed project was not feasible. The County's permit application has since been administratively withdrawn and is no longer considered active (K. Kimidy, USCOE, personal communication, 1996). As of October 1996, the USCOE has no active permit applications from Hanover County for a water supply project (K. Kimidy, USCOE, personal communication, 1996). However, due to continuing actions by the County to secure a future water supply, Hanover County's needs have not been included in the RRWSG's study of additional regional needs.

The future water supply needs of the following areas have been projected through the Year 2040 and are discussed in subsequent sections:

- New Kent County
- King William County
- Gloucester County
- Town of West Point

Figure 5-5 shows the locations of these areas. More detailed analyses of water supply, demand, and deficits for these areas are described in the ***New Kent County Potable Water Supply Needs Assessment*** (Malcolm Pirnie, 1995) and technical memoranda for each of the other areas. These documents are included in Appendix K, which is incorporated herein by reference and is an appendix to this document.

5.9.2 New Kent County

The New Kent County Department of Public Works currently owns 14 wells and serves eight local service areas within the County. Seven of the County-owned well systems serve residential subdivisions and one serves the County courthouse complex. The rest of the County is served by individual private wells.

Based on review of the VDH Water Description Sheets for the New Kent County systems, the total estimated safe yield of the existing operating systems is 500,200 gpd (0.5 mgd).

Population projections for the County were adopted from projections made by the New Kent County Planning Department, which are documented in ***Draft Comprehensive Land Use Plan, New Kent County, Virginia*** (RRPDC, 1992). This report projects population to the Year

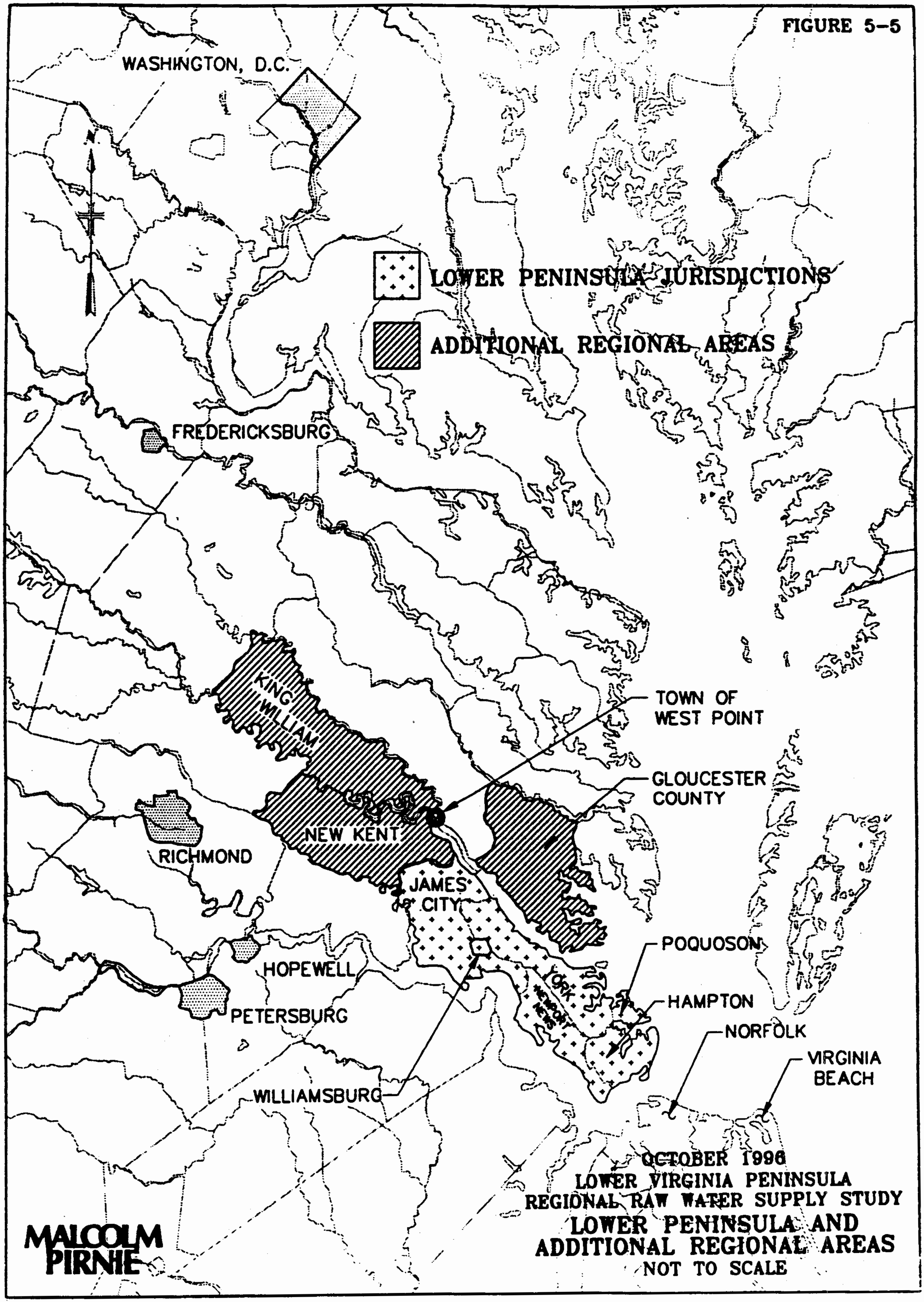

FIGURE 5-5

OCTOBER 1996
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
LOWER PENINSULA AND
ADDITIONAL REGIONAL AREAS
NOT TO SCALE

2010. A linear extrapolation of the Year 1980 to Year 2010 projections was used to estimate population through the Year 2040. The resulting population projections which have been adopted for this analysis are presented in the table following this page.

Not all of the County's population is served by public water systems. Review of VDEQ Regulation 11 Water Withdrawal Reports filed in 1993 for systems in New Kent County indicated that approximately 1,871 people were served by centrally-supplied water systems in 1993. For reasons explained in Appendix K, it is assumed that the percentage of New Kent County's population served by public water supply systems will increase to 70 percent (21,600 people) in the Year 2040. The forecasts of population to be served are presented on the following table.

POPULATION AND POPULATION SERVED ESTIMATES - NEW KENT COUNTY

Year	Population	Population Served
1990	10,445	1,871
2000	14,400	4,300
2010	19,500	8,300
2020	23,000	12,000
2030	26,600	16,400
2040	30,200	21,600

The methodologies used to project New Kent County's potable water demands are described in Appendix K. Demand projections with conservation for the following four water demand categories are presented in Table 5-14:

- Residential
- Commercial, Institutional and Light Industrial
- Heavy Industrial
- Unaccounted-for Water

New Kent County's water needs in the Year 2040 are projected to be 9.6 mgd. Based on this projected demand and the estimated safe yield of the existing operating systems (0.5 mgd), the Year 2040 deficit in New Kent County would be 9.1 mgd.

A separate independent study of demand projections was prepared for New Kent County in 1994 by Greenhorne & O'Mara. This report is included with Appendix K and included a Year 2010 demand projection of 9.2 mgd. There is precedent for this type of explosive growth in water demand as evidenced by recent rapid growth in such Virginia communities as Virginia Beach, Stafford County, and Henrico County.

TABLE 5-14

SUMMARY OF NEW KENT COUNTY POTABLE WATER DEMAND PROJECTIONS*

Year	Residential Demand (mgd)	Commercial Demand (mgd)	Heavy Industry Demand (mgd)	Unaccounted-for water Demand (mgd)	Total Demand (mgd)
1993	0.12				0.12
2000	0.29	1.70	0.56	0.16	2.71
2010	0.56	2.78	0.99	0.33	4.65
2020	0.80	3.85	1.32	0.52	6.50
2030	1.10	4.93	1.66	0.76	8.44
2040	1.45	5.23	1.99	0.96	9.63

* Detailed analysis included in Appendix K.

5.9.3 King William County

King William County currently owns two wells at one location which serve King William County schools and additional wells which serve the Courthouse area. Its remaining demands are presently served by privately-owned water systems or individual groundwater wells. Based on review of the VDH Engineering Description Sheet for the well system which serves the schools, the estimated safe yield of the school wells is 15,000 gpd. No VDH Description Sheets are available for the Courthouse well system.

Population projections for the County were adopted from projections made by the Virginia Employment Commission (VEC) from the period 1990 to 2030. Projections were rounded to the nearest hundred. A linear extrapolation of the Year 1990 to Year 2030 projections was used to estimate population through the Year 2040. The resulting population projections which have been adopted for this analysis are presented in the following table.

The County does not currently provide potable water to any of its residential population and has no near-terms plans to develop a public water system to serve residential areas (King William County, 1994). Residents are served by private water companies or private wells. For water supply planning purposes, however, the potential for the County to begin providing public water service at some later date during the 50-year planning period should be considered.

It is assumed that a maximum of 50 percent of the total population of King William County will be served by public water supplies in the Year 2040. This assumes that growth will continue to be centered in the current growth areas (Route 360 - Route 30 junction), and that the County will develop a water system to meet those needs by the Year 2010. The total population served in the Year 2040 is estimated to be 9,300. Estimates of population served for the planning period are presented on the following table.

POPULATION AND POPULATION SERVED ESTIMATES - KING WILLIAM COUNTY		
Year	**Population**	**Population Served**
1990	10,913	0
2000	12,700	0
2010	14,100	1,400
2020	15,600	4,700
2030	17,000	6,800
2040	18,700	9,300

Methodologies used to project King William County's water demands are described in the technical memorandum for King William County included in Appendix K. Demand projections with conservation for the following four water demand categories are presented in Table 5-16:

TABLE 5-16

SUMMARY OF KING WILLIAM COUNTY POTABLE WATER DEMAND PROJECTIONS*

Year	Residential Demand (mgd)	Commercial Demand (mgd)	Heavy Industry Demand (mgd)	Unaccounted-for water Demand (mgd)	Total Demand (mgd)
1990	0.00				0.00
2000	0.00	0.39	0.52	0.00	0.91
2010	0.09	0.58	0.84	0.11	1.63
2020	0.31	0.77	1.16	0.20	2.44
2030	0.46	0.96	1.48	0.29	3.18
2040	0.62	1.15	1.80	0.40	3.97

* Detailed analysis included in Appendix K.

- Residential
- Commercial, Institutional and Light Industrial
- Heavy Industrial
- Unaccounted-for Water

King William County's water needs in the Year 2040 are projected to be 4.0 mgd. Unless a water system is developed before that time, the Year 2040 deficit would also be 4.0 mgd.

5.9.4 Gloucester County

Although Gloucester County lies north of the York River, it is closely tied to the Lower Peninsula. Gloucester County's population has increased dramatically in the past twenty years as it has become a bedroom community for the more urbanized Newport News-Hampton area. This upward population trend is expected to continue, as the capacity of the Route 17 bridge between York and Gloucester Counties was recently expanded. Gloucester County has become a member of the Hampton Roads Sanitation District, and it is served by a new trunk sewer line. Evidencing further that its future is tied to the Lower Peninsula rather than the Middle Peninsula, Gloucester County has recently joined the Hampton Roads Planning District Commission, in which the northside and southside Hampton Roads jurisdictions are members.

Gloucester County owns four groundwater wells: three deep wells and one radial collector well. None of these wells are currently being used due to water quality problems, but the radial collector well is on standby (Gloucester County, 1994b). The County's demands are being met by the Beaverdam Swamp Reservoir, which replaced the groundwater systems that previously served Gloucester Courthouse and Gloucester Point.

The VDH estimates that these four wells have a combined yield of 524,000 gpd. However, safe yield of the existing well system is limited by its pump capacity to 519,200 gpd (0.52 mgd). The Beaverdam Swamp Reservoir can supply 2.5 mgd of raw water (Gloucester County, 1994a), and the treatment plant has a design production capacity of 2.0 mgd. The County limits the plant's operations to 1.9 mgd in order to reduce the number of operators required at the plant. Based on this restriction, and assuming 3 percent treatment plant losses and a 1.5 maximum day demand (or peaking) factor, the existing reliable system delivery capacity of the plant to meet average day demands is 1.2 mgd. Therefore, the existing reliable system delivery capacity of the Gloucester County systems including the four wells and the treatment plant, is 1.7 mgd.

It would be possible for the County to modify the existing conditions which limit the safe yield of its system (i.e, increase well pump capacity and increase the production capacity of the water treatment plant) to increase its safe yield to 2.9 mgd. With additional well pump capacity, the well safe yield could be increased to a maximum of 524,000 gpd. With additional treatment capacity, the safe yield of the reservoir system could be increased to 2.4 mgd (2.5 mgd source safe yield with assumed 3 percent treatment plant losses).

Population projections developed for Gloucester County by the Hampton Roads Planning District Commission (HRPDC, 1994) from the Year 1990 to the Year 2015 (rounded to the nearest hundred) were used in projecting the County's future water de nds. A linear extrapolation of these projections was used to estimate population throug the Year 2040, assuming a County buildout population of approximately 81,400 in the Year 2040. The resulting population projections adopted for this analysis are presented in the table below.

Not all of the population within the County is currently served by public water. County billing data do not provide a reliable estimate of the population served in a given year. However, a recent survey of customers conducted by the County Department of Public Utilities indicated that there are approximately 8,500 people in residences served by the water system (Gloucester County, 1995). Estimates of population served throughout the planning period are presented in the table below:

POPULATION AND POPULATION SERVED ESTIMATES - GLOUCESTER COUNTY		
Year	**Population**	**Population Served**
1990	30,131	8,500
2000	43,800	13,100
2010	53,700	21,500
2020	62,800	31,400
2030	72,000	43,200
2040	81,400	57,000

Water demand projection methodologies used to project Gloucester County's demands are described in the technical memorandum for Gloucester County included in Appendix K. Demand projections with conservation for the following four water demand categories are presented in Table 5-18:

- Residential
- Commercial, Institutional and Light Industrial
- Heavy Industrial
- Unaccounted-for Water

Gloucester County is projected to have a Year 2040 water demand of 7.9 mgd. The estimated safe yield of the existing system is 1.7 mgd. Removal of the present limitations on the system would result in a system safe yield of 2.9 mgd. Assuming that the County would remove the limitations in the near future to increase its yield, the Year 2040 deficit would be 5.0 mgd.

5.9.5 Town of West Point

The Town of West Point is currently served by two wells with a permitted withdrawal of approximately 1.1 mgd (Town of West Point, 1994). A third well was recently constructed to provide an interconnected well system and serve as a back-up well. The well is capable of

TABLE 5-18

SUMMARY OF GLOUCESTER COUNTY POTABLE WATER DEMAND PROJECTIONS*

Year	Residential Demand (mgd)	Commercial Demand (mgd)	Heavy Industry Demand (mgd)	Unaccounted-for water Demand (mgd)	Total Demand (mgd)
1994	0.53				0.53
2000	0.88	0.90	0.27	0.15	2.20
2010	1.44	1.20	0.50	0.26	3.40
2020	2.10	1.50	0.72	0.40	4.73
2030	2.89	1.80	0.95	0.58	6.22
2040	3.82	2.10	1.18	0.79	7.89

* Detailed analysis included in Appendix K.

pumping up to 675 gpm (G. Beasley, VDH, personal communication, 1996). As of January 1997, the Town had not applied for a permit amendment to increase the permitted withdrawal (V. Newton, VDEQ, personal communication, 1997). Elevated storage facilities provide 600,000 gallons of storage. Based on review of the VDH Engineering Description Sheet for the Town of West Point well system, the estimated safe yield of the existing system is 528,000 gpd (0.53 mgd).

The Town's population projections for the Year 1990 to the Year 2030, which are documented in ***A Comprehensive Plan, Town of West Point, Virginia*** (Town of West Point Planning Commission, 1994), were used in projecting its future water demands. A linear extrapolation of these projections was used to estimate population through the Year 2040. The resulting population projections adopted for this analysis are presented in the following table.

It is estimated that the Town of West Point currently provides public water service to 99 percent of its population (Town of West Point Planning Commission, 1994; SWCB, 1988). It is assumed that the population served will remain at 99 percent throughout the planning period. Estimates of population served for the planning period are presented in the following table.

POPULATION AND POPULATION SERVED ESTIMATES - TOWN OF WEST POINT		
Year	**Population**	**Population Served**
1990	2,938	2,950
2000	3,300	3,300
2010	3,600	3,600
2020	3,800	3,800
2030	4,000	4,000
2040	4,300	4,300

Methodologies used to project the Town of West Point's water demands are described in the technical memorandum for the Town of West Point included in Appendix K. Demand projections with conservation for the following four water demand categories are presented in Table 5-20:

- Residential
- Commercial, Institutional and Light Industrial
- Heavy Industrial
- Unaccounted-for Water

TABLE 5-20

SUMMARY OF WEST POINT POTABLE WATER DEMAND PROJECTIONS*

Year	Residential Demand (mgd)	Commercial Demand (mgd)	Heavy Industry Demand (mgd)	Unaccounted-for water Demand (mgd)	Total Demand (mgd)
1993	0.22	0.10	0.07	0.04	0.43
2000	0.24	0.11	0.07	0.05	0.48
2010	0.25	0.13	0.08	0.05	0.50
2020	0.25	0.14	0.08	0.05	0.52
2030	0.27	0.15	0.08	0.05	0.55
2040	0.29	0.16	0.08	0.06	0.59

* Detailed analysis included in Appendix K.

The Town of West Point is projected to have a Year 2040 water demand of 0.6 mgd. The estimated safe yield of the existing system is 0.5 mgd. Therefore, the Year 2040 deficit is estimated to be 0.1 mgd.

5.9.6 Summary of Additional Regional Needs

A summary of the supply, demand, and deficit projections for these additional areas is presented in Table 5-21. Although none of the additional regional areas identified in Table 5-21 is currently experiencing a water deficit, each is projected to experience a deficit by the Year 2040. The projected Year 2040 deficits of the outlying jurisdictions are as follows:

Jurisdiction	Projected Deficit (mgd)
New Kent County	9.1
King William County	4.0
Gloucester County	5.0
Town of West Point	0.1

Any or all of these localities may wish to obtain raw water and/or treated water from a regional water supply project.

5.9.7 Additional Impacts

If the outlying jurisdictions do not contract to obtain water from a regional project, they will likely pursue individual local water supply projects (additional groundwater wells or reservoir projects). If surface water supplies are selected, additional wetlands areas could be affected.

The most likely water supply development option for Gloucester County appears to be one of several off-stream storage reservoir alternatives. In the ***Final Environmental Impact Statement - Gloucester County's Water Supply Reservoir on Beaverdam Swamp*** (USCOE, 1985), alternatives to Beaverdam Swamp Reservoir included reservoirs on Harper Creek or Carvers Creek. These reservoir alternatives were said to impact estimated wetland areas of 222 and 136 acres, respectively. Corresponding raw water safe yield benefits of these reservoir alternatives would be 2.5 mgd with Dragon Swamp pumpovers, and 1.25 mgd or less without pumpover augmentation. Moreover, withdrawals from Dragon Swamp may not be available due to institutional and environmental constraints.

Other Gloucester County options were either considered impracticable or determined to have limited potential for success. Groundwater desalination is considered infeasible by Gloucester County based on cost and a variety of reliability problems. Groundwater

TABLE 5-21

SUPPLY, DEMAND AND DEFICIT PROJECTIONS FOR ADDITIONAL REGIONAL AREAS

Jurisidiction	Supply (mgd)	Demand (mgd)	Deficit [B] (mgd)
1990			
New Kent County	0.50	0.12	-0.38
King William County	A	0	0
Gloucester County	1.70	0.47	-1.23
Town of West Point	0.53	0.43	-0.10
2000			
New Kent County	0.50	2.71	2.21
King William County	A	0.91	0.91
Gloucester County	2.90	2.20	-0.70
Town of West Point	0.53	0.48	-0.05
2010			
New Kent County	0.50	4.65	4.15
King William County	A	1.63	1.63
Gloucester County	2.90	3.40	0.50
Town of West Point	0.53	0.50	-0.03
2020			
New Kent County	0.50	6.50	6.00
King William County	A	2.44	2.44
Gloucester County	2.90	4.73	1.83
Town of West Point	0.53	0.52	-0.01
2030			
New Kent County	0.50	8.44	7.94
King William County	A	3.18	3.18
Gloucester County	2.90	6.22	3.32
Town of West Point	0.53	0.55	0.02
2040			
New Kent County	0.50	9.63	9.13
King William County	A	3.97	3.97
Gloucester County	2.90	7.89	4.99
Town of West Point	0.53	0.59	0.06

A The County does not currently have a water supply system which serves the general County. This analysis assumes that the County would develop a water system to meet its future needs.

B Negative deficit values represent a water supply surplus.

augmentation of Beaverdam Swamp Reservoir would produce a limited safe yield benefit and water quality problems would be likely.

One of the RRWSG's practicable reservoir alternatives, the King William Reservoir Project, offers the potential to meet some of the additional regional needs identified in Section 5.9, without impounding additional wetlands in a new basin. This is due to the reservoir's potential storage capacity being more than three times that of the other reservoir alternatives.

The RRWSG has conducted safe yield analysis for the King William Reservoir with Mattaponi River Pumpover alternative for four configurations (see Table 3-4A). This analysis indicates that if the dam were sited at dam sites KWR-II or KWR-I, rather than at the currently proposed KWR-IV dam site, the project could supply between 2.2 and 3.9 mgd of additional treated water safe yield benefit beyond that which is needed to meet the RRWSG's projected Year 2040 needs. As this analysis indicates, the King William Reservoir with Mattaponi River Pumpover alternative (KWR-II or KWR-I configurations) could serve additional regional demands, while avoiding the greater adverse impacts of constructing an additional reservoir to service these projected demands. In the interest of preserving this option, the City of Newport News and King William County are considering reserving lands for possible future reservoir expansion that would extend downstream of the currently proposed KWR-IV dam site. Until such time as a permitted expansion of the reservoir might occur, the reserved land would serve as a wildlife preservation area and corridor.

In Section 5.9 of the Supplement, a two river pumpover scenario (i.e., Mattaponi and Pamunkey Rivers) was discussed as a possible means of enhancing the King William Reservoir Project (KWR-II configuration) to supply the needs of a larger region. The RRWSG has no plans at this time to develop such an enhanced King William Reservoir Project. However, at the USCOE's direction, the RRWSG has evaluated a two river pumpover scenario for a smaller King William Reservoir that would meet the projected needs of the RRWSG (see Section 3.4.32.4).

5.10 ENVIRONMENTAL JUSTICE

In February 1994, President Clinton issued Executive Order 12898 entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The order requires each Federal agency to: "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations...." In addition, a Presidential memorandum which accompanied the Executive Order requires federal agencies to "analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by NEPA."

To evaluate the potential for environmental justice impacts resulting from the proposed King William Reservoir project, the socioeconomic characteristics of the reservoir project area (King William and New Kent Counties) was compared to the Lower Peninsula area which would be receiving King William Reservoir water (the Lower Peninsula jurisdictions, including Newport News, Hampton, Poquoson, Williamsburg, James City County and York County). (King William and New Kent Counties would also receive water pursuant to host jurisdiction agreements.)

Socioeconomic characteristics of the jurisdictions in which the reservoir would be located and those which would be receiving the resource are presented in Table 5-22.

The reservoir project area (King William and New Kent Counties) has a minority population which is at or above the state average of 23 percent. This includes an aggregate Native American population of 355 (U.S. Census of Population, 1990). In comparison, the percentage of the total minority populations, including Native Americans, in the Lower Peninsula varies with each jurisdiction. The minority populations in Newport News and Hampton well exceed the state average. Minority populations represent 34 percent of the total Lower Peninsula population, which includes a total Native American population of 1,201 (U.S. Census of Population, 1990). This percentage of minority populations exceeds that estimated for the reservoir project area, and the total Native American population in the RRWSG is nearly four times as great as in the reservoir project area. As a result, the proposed project would transfer water from an area with a lower percentage of minority populations and fewer Native Americans to an area with a higher percentage of minority populations and a larger number of Native Americans. Minority populations in each of the Lower Peninsula jurisdictions and in the reservoir project area counties are listed in Table 5-23.

The poverty population of the reservoir areas is less than the statewide average. However, in the Lower Peninsula, the poverty population exceeds the statewide average in two of its jurisdictions (Newport News and Hampton). The population in the Cities of Newport News and Hampton represents 75 percent of the total population in the Lower Peninsula. Therefore, it is concluded that the proposed project would transfer water from an area with a lower poverty population to an area with a higher poverty population.

The data presented in Table 5-22 concerning unemployment indicate that the reservoir project area has low unemployment rates in relation to the statewide average. The Lower Peninsula, however, experiences unemployment rates higher than the statewide average in three of its jurisdictions (Newport News, Hampton and Williamsburg). The remaining jurisdictions within the Lower Peninsula have unemployment rates at or near the statewide average. Based on the data presented in Table 5-22, the proposed project would transfer water from an area with lower unemployment to an area with higher unemployment.

Two Commonwealth of Virginia recognized Native American tribes in King William County were evaluated for potential environmental justice impacts due to their proximity to the proposed King William Reservoir project area. The Mattaponi and Pamunkey Indian Reservations are located on opposite sides of the reservoir site, each within 5 miles of the reservoir or intake sites. Although reservoir construction activities, including clearing, excavation, building operations, and transportation, are expected to increase the short-term noise levels in the vicinity of the project area, there should be no discernable impact to either reservation. The displacement of reservation residences from construction would not occur. In addition, the maintenance and operation of the reservoir is not expected to adversely affect reservation tribal members or the Native American culture on the reservations. Reservoir activities would be confined to the reservoir buffer area and intake site, and along the pipeline route configuration. These project components are not located on reservation land.

An evaluation of the predicted noise levels produced by the proposed 75 mgd Mattaponi River pump station at Scotland Landing was conducted. The projected levels are based on a proposed pump station building location approximately 150 feet from the south shoreline of the

TABLE 5-22

SOCIOECONOMIC CHARACTERISTICS OF AFFECTED JURISDICTIONS

Jurisdiction	Minority Pop. (%)	Poverty Pop. (%)[1]	Average Per Capita Income	1989 Median Household Income	Unemployment Rate (%)
Reservoir Project Area [2]					
King William County	32	7.1	$13,294	$33,676	2.8
New Kent County	23	3.6	$14,993	$38,403	3.3
Group Average[3]	28	5.4	$14,125	$35,988	3.0
Receiving Jurisdictions					
Newport News	37	12.2	$12,711	$27,469	6.8
Hampton	42	8.8	$12,099	$30,144	6.7
Poquoson	3	2.3	$16,930	$43,236	3.1
Williamsburg	19	5.9	$11,822	$25,393	4.9
York County	19	4.0	$15,742	$40,363	4.4
James City County	20	4.2	$18,139	$39,785	3.7
Group Average [3]	34	9.1	$13,384	$31,135	6.1
State of Virginia	23	7.7	$15,713	$33,328	4.5

Source: USDC, 1990. U. S. Census of Population.

(1) Poverty data are presented as percentages of all families below the poverty level.

(2) King William County and New Kent County would also receive water pursuant to host jurisdiction agreements.

(3) Group averages are calculated as weighted averages based on each jurisdiction's estimated 1990 population.

TABLE 5-23

MINORITY POPULATIONS IN AFFECTED JURISDICTIONS

Jurisdiction	Native American Population	Other Minority Population	Total Minority Population
Reservoir Project Area [1]			
King William County	219	3,316	3,535
New Kent County	136	2,231	2,367
Group Total	355	5,547	5,902
Receiving Jurisdictions			
Newport News	579	63,048	63,627
Hampton	392	55,252	55,644
Poquoson	24	253	277
Williamsburg	25	2,137	2,162
York County	112	7,823	7,935
James City County	69	6,986	7,055
Group Total	1,201	135,499	136,700

Source: USDC, 1990. U. S. Census of Population.

(1) King William County and New Kent County would also receive water pursuant to host jurisdiction agreements.

river. At this location the Mattaponi Indian Reservation is approximately 3.5 miles south of the pump station site.

For a water pump station, the majority of noise will be produced by the electric pump motors that will operate continuously for extended periods of time. In addition, short duration noise of generally higher levels may be produced by a diesel engine driven emergency electrical generator and air compressors. These noise levels will not normally be continuously produced, except in the case of the emergency generator during a commercial power outage. On average, the higher noise levels produced by the intermittently operated equipment are expected to occur during the day for an average of 4 hours per week.

The USCOE imposed a noise limit of 54-64 decibels (dB) at 100 feet from the structure for the City of Virginia Beach's Lake Gaston Project pump station at Pea Hill Creek on Lake Gaston. The Lake Gaston Pump Station is located within 120 feet of the open water of Pea Hill Creek.

Assuming a noise limit of 54 dB at 100 feet were imposed on the Mattaponi River pump station, the resulting sound pressure level at the Mattaponi Indian Reservation was calculated based on the inverse square law. Use of this relationship is appropriate for outdoor locations away from other buildings, paved or hard ground surfaces, or other sound reflecting surfaces. The relationship does not account for the additional drop in sound levels that can occur over large distances due to atmospheric absorption.

Day-night sound levels are used by the USEPA to account for the generally greater annoyance caused by sound during the night. The day-night sound level is calculated by averaging noise levels over a 24-hour day, but with a 10-dB additional weighting added to the actual sound levels that occur between 10 p.m. and 7 a.m.

Assuming the Mattaponi Indian Reservation is 18,000 feet from the pump station, sound pressure and day-night sound levels of 9dB and 15 dB, respectively, were predicted. These values are well below the noise levels identified by the USEPA as requisite to protect public health and welfare. As stated in ***Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*** (USEPA, 1974), a 55-dB noise level for outdoor activity interference was identified as the lowest outdoor sound threshold.

The Mattaponi and Pamunkey Indian Reservations are adjacent to the Mattaponi and Pamunkey Rivers, respectively. The water quality of the rivers should not be substantially affected by freshwater river withdrawals. Potential salinity intrusion impacts were analyzed in detail in Report J, ***Tidal Wetlands on the Mattaponi River: Potential Responses of the Vegetative Community to Increased Salinity as a Result of Freshwater Withdrawal*** (Hershner et.al., 1991) which is incorporated herein by reference and is an appendix to this document. Neither reservation is currently using river water for irrigation. Although Pamunkey Indian Reservation tribal members have recently harvested crabs for commercial gain, predominant Mattaponi and Pamunkey River uses by the reservations are related to water recreation activities. Existing fishing, hunting or boating activities in the vicinity of the reservations are expected to persist unaffected by the project river withdrawals. Increases in regional recreational areas would also be provided by the proposed reservoir.

The Pamunkey Reservation operates a shad fish hatchery in conjunction with the Virginia Marine Resources Commission. The fish hatchery has been restocking the York River basin with shad almost continuously since 1918. The Mattaponi Reservation also possesses a viable shad hatchery operation. Shad is an integral component of each reservation's tribal culture. Shad habitat in the Mattaponi and Pamunkey River systems should not be altered by Mattaponi River withdrawals. The proposed Scotland Landing intake site is located several miles upstream of the Mattaponi Reservation. In addition, the intake structure is designed to minimize impingement and entrainment of anadromous fish eggs and larvae. The maximum through-screen velocities will comply with the National Marine Fisheries Service recommendation of 0.25 fps and very small screen openings (1 millimeter slots) will be used.

In accordance with the King William Reservoir Project Development Agreement, King William County will also acquire a continuous revenue stream from the lease of the reservoir land to the RRWSG (King William County and City of Newport News, 1990). This additional County revenue would possibly be used to enhance community projects, libraries, and schools. These facilities are available to reservation constituents.

Based on the analysis presented above, the proposed King William Reservoir project would not result in any "disproportionately high and adverse human health or environmental effects... on minority populations and low-income populations," as mandated in Executive Order 12989, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." In addition, the project would not be exclusively transferring water from one area to another. It is a regional project, providing water to all communities of the Lower Peninsula, as well as New Kent and King William Counties.

6.0 LIST OF PREPARERS

Study investigations were conducted by the RRWSG, Malcolm Pirnie scientists and engineers, and subcontractors with a wide variety of academic and professional training and experience. The following USCOE personnel, Malcolm Pirnie personnel, and subcontractor staff were primarily responsible for the preparation of this document and its appendices:

Name	Training/ Expertise	Experience (Years)	Primary Responsibility
USCOE Personnel			
Pamela K. Painter	B.S. Geology M.S. Geological Oceanography Environmental Assessments Environmental Impact Statements Wetlands Evaluation	16	Environmental Scientist and **USCOE Project Manager**
Malcolm Pirnie Personnel			
Millard P. Robinson, Jr.	B.S. Civil Engineering M.S. Civil Engineering Water Resources	23	**Project Officer**
Bruce W. Schwenneker	B.A. Biology M.A. Biology Ph.D. Biology Aquatic Ecology Wetlands Evaluation Habitat Evaluation	18	**Project Manager**
Paul E. Peterson	B.S. Biology M.E.M. (Environmental Management) Water Resources	9	**Project Leader**
James G. Pimblett	B.S. Civil Engineering M.S. Civil Engineering Hydraulics Design	8	Demand Forecasting, Conceptual Engineering
Andrea B. Terry	B.S. Biology M.E.M. (Environmental Management) Water Resources	6	Conservation, Parks, Refuges, Cultural Resources, Land Use, Socioeconomics
R. Thomas Sankey	B.S. Geography M.A. Geography Wetlands Evaluation Habitat Evaluation	9	Wetlands, Mudflats
T. Britt McMillan	B.S. Geology M.S. Geology Water Quality Assessments Computer Modeling	12	Water Quality, Groundwater Modeling

Name	Training/ Expertise	Experience (Years)	Primary Responsibility
Rebecca W. Dorsey	B.S. Zoology Wetland Evaluation Habitat Evaluation	5	Wildlife, Fisheries, Endangered Species, Wetland Evaluation
Michael S. D'Annucci	B.A. History/Business Administration M.E.M. (Environmental Management) M.E. Civil Engineering	5	Wetland Mitigation, Editorial Review
Kathryn B. Sweeney	B.S. Biology M.A. Biology	5	Recreation, Endangered Species, Wetland Evaluations and Mitigation, Aesthetics
William H. Street	B.S. Commerce M.E.M. (Environmental Management) M.P. Environmental Planning	5	Wetland Delineation, Wetland Mitigation
Mariellen J. Soltys	B.S. Biology Wetlands Evaluation Endangered Species	6	Endangered Species, Wildlife
Ronald E. Harris	B.S. Geology Groundwater Hydrology Water Resources Geophysics	15	Groundwater Resources
Anthony D. Gruber	B.S. Marine Science M.S. Civil Engineering	9	Substrate, Soils
Edward N. Antoun	B.S. Civil Engineering M.S. Civil Engineering Computer Modeling Hydraulics	5	Safe Yield Analysis
Susan T. Murdock	Associate in Arts and Forest Technology B.A. Biology	7	Wetland Delineation
Hope Yendersin	A.A.S. Natural Resources B.S. Natural Resources	5	Wetland Evaluation
Floyd W. Hatch	B.S. Applied Geography in Natural Resource Management and Environmental Studies M.S. Environmental Science	31	Wetland Delineations and Wetland Evaluation
Edward F. Rogers, III	B.S. Chemical Engineering Air Quality	9	Air Quality, Noise
James P. Noonan	B.S. Civil Engineering M.S. Environmental Engineering Hydraulic Analysis Design	22	Conceptual Engineering
Mark A. Thompson	B.S. Chemistry Water Treatment Membrane Processes	16	Desalination Processes

Name	Training/ Expertise	Experience (Years)	Primary Responsibility
Richard W. Carsia	B.S. Marketing Management A.A.S. Drafting Design	11	AutoCADD Mapping
Glenn M. Tillman	A.S. Biology B.A. Geology Water Treatment Water Distribution	15	Editorial Review
Robert H. Reinert	M.E. Mechanical Engineering Water Design Project Management	38	Technical Review
John C. Henningson	B.A. Biology M.S. Environmental Engineering Environmental Management	29	Technical Review
Anthony M. Russo	B.S. Biology M.S. Environmental Biology Environmental Assessments	14	Technical Review

Subcontractor Staff

Name	Firm/Institution/Organization	Primary Responsibility
Jerome D. Traver	MAAR Associates	Phase I Cultural Resource Survey Principal Investigator
Lauren C. Archibald	MAAR Associates	Phase I Cultural Resource Survey Architectural Historian
Carl H. Hershner, Ph.D.	Virginia Institute of Marine Science	Salinity Study
James E. Perry, Ph.D.	Virginia Institute of Marine Science	Sensitive Joint-Vetch Surveys
Garrie D. Rouse	Rouse Environmental Services	Sensitive Joint-Vetch Surveys
Donna M. E. Ware, Ph.D.	The College of William & Mary	Small Whorled Pogonia Surveys
William Saunders, Ph.D.	The College of William & Mary	Small Whorled Pogonia Surveys
Virginia Crouch	The Nature Conservancy	Small Whorled Pogonia Surveys
Allen Plocher, Ph.D.	Old Dominion University	Wetland Delineations
Suzanne Ruck	Independent Subcontractor	Wetland Evaluation
Michelle Moody	Independent Subcontractor	Wetland Evaluation
Joseph C. Mitchell, Ph.D.	The University of Richmond	Herpetological Survey
David R. Basco, Ph.D.,P.E.	Old Dominion University	Sediment Transport Study

7.0 PUBLIC INVOLVEMENT

Throughout the project planning process, the USCOE was consulted. The USCOE required that the federal advisory agencies be involved in the identification of practicable alternatives and, further, with the evaluation of practicable alternatives relative to environmental impact. Throughout the study process, there has also been an active exchange of information and ideas between involved regulatory agencies, environmental organizations, and the RRWSG. This exchange has included single- and multi-agency briefing meetings, distribution of project briefing materials, and numerous written and oral communications.

Prior to August 1, 1990, this information exchange was considered a "pre-scoping" activity, since the USCOE had not yet issued a formal Public Notice to solicit public comment on the scope of the Environmental Impact Statement (EIS) which would be required. It was agreed by the USCOE, USEPA, and USFWS that a detailed assessment of the project, in the form of an EIS, would be required because of the scale and complexity of the projects proposed.

The USCOE issued a Public Notice on August 1, 1990 requesting public comments on the scope of study for a draft EIS (DEIS). This Public Notice initiated the official "scoping" process. A Notice of Intent to prepare a draft EIS was also issued by the USCOE and appeared in the Federal Register on July 30, 1990.

Pre-scoping and scoping comments were provided by the agencies, organizations, and individuals listed below. These comments are included as an appendix to the ***Phase I Summary Report*** (Malcolm Pirnie, 1991).

- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Virginia Deputy Secretary of Natural Resources
- Virginia Council on the Environment
- Virginia Department of Conservation and Recreation - Division of Natural Heritage
- Virginia Department of Conservation and Recreation - Division of Planning and Recreation Resources
- Virginia Department of Game and Inland Fisheries
- Virginia Department of Health
- Virginia Department of Transportation

- Virginia Institute of Marine Science
- Virginia State Water Control Board
- Chesapeake Bay Estuarine Research Reserve System
- Environmental Defense Fund
- National Wildlife Federation
- Southern Environmental Law Center
- Pamunkey Indian Reservation
- Mr. George A. Beadles, Jr.

In December 1990 the USCOE issued a summary of the scoping process and a ***Conceptual Scoping Outline for the Lower Peninsula's Raw Water Supply Draft EIS*** (W. H. Poore, Jr., USCOE - Norfolk District, personal communication, 1990). Thirty-one of the alternatives evaluated in this report were identified during the EIS scoping process as having the potential of providing a source of raw or treated water, or reducing the need for future water supplies.

On February 4, 1994, the Norfolk District, USCOE announced the availability of a DEIS for the RRWSG's proposed long-term public water supply for the Lower Virginia Peninsula. The USCOE held a Public Hearing on the DEIS on March 8, 1994. The comment period on the DEIS closed on April 20, 1994. Based on the record of the Public Hearing and other written comments received, the USCOE on June 8, 1994, announced its decision to prepare a Supplement to the DEIS. On August 1, 1994, the USCOE provided formal, written instructions to the RRWSG regarding additional studies and analyses required for preparation of the Supplement (A.M. Perkins, USCOE, personal communication, 1994).

On December 29, 1995, the Norfolk District, USCOE announced the availability of a Supplement to the DEIS for the RRWSG's proposed long-term public water supply for the Lower Virginia Peninsula. The USCOE, Virginia Department of Environmental Quality, King William County, and RRWSG participated in a public information meeting on the Supplement on February 29, 1996. The comment period on the Supplement closed on March 13, 1996. Based on written comments received, the USCOE on May 13, 1996 provided formal, written instructions to the RRWSG regarding additional studies and analyses required for preparation of the Final EIS (FEIS). (R.H. Reardon, USCOE, personal communication, 1996).

The following is a list of Agencies and Organizations to which the DEIS and Supplement were sent:

U. S. Environmental Protection Agency
U. S. Department of Commerce
U. S. Department of Interior
U. S. Fish and Wildlife Service

U. S. Department of Energy
U. S. Department of Agriculture
U. S. Department of Transportation
National Marine Fisheries Service
Advisory Council of Historic Preservation
Virginia Department of Agriculture and Consumer Services
Virginia Marine Resources Commission
Virginia Department of Health
Virginia Department of Environmental Quality - Waste Division
Virginia Department of Environmental Quality - Water Division
Virginia Department of Environmental Quality - Air Division
Virginia Department of Environmental Quality - Division of
Intergovernmental Coordination
Virginia Department of Mines, Minerals and Energy
Virginia Department of Forestry
Virginia Department of Transportation
Virginia Institute of Marine Science
Virginia Department of Game and Inland Fisheries
Virginia Department of Conservation and Recreation - Division of
Natural Heritage
Virginia Department of Conservation and Recreation - Division of
Planning and Recreation Resources
Virginia Department of Historic Resources
Chesapeake Bay Foundation
Chesapeake Bay Local Assistance Department
Hampton Roads Planning District Commission
Mattaponi Tribe
Upper Mattaponi Tribe
Pamunkey Tribe
Chesapeake Bay Estuarine Research Reserve System
Southern Environmental Law Center
National Wildlife Federation
National Audubon Society
Nature Conservancy
Environmental Defense Fund
Sierra Club
Alliance for the Chesapeake Bay
Mattaponi and Pamunkey Rivers Association
City of Hampton
City of Newport News
City of Poquoson
City of Williamsburg
Hanover County
James City County
King and Queen County
King William County
New Kent County
York County
Hampton Public Library

Heritage Library
James City County Public Library
Newport News Public Library
Pamunkey Regional Library
Poquoson Public Library
Williamsburg Regional Library
York County Public Library

All of the letters received during the comment periods for the DEIS and the Supplement to the DEIS are included in Volume II of this FEIS Main Report. Numbers appear in the right margins next to each comment requiring a response. At the end of each letter, the comments are addressed in their numerical order.

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