ARSENIC RULE IMPLEMENTATION GUIDANCE

For Maryland Public Water Systems

Maryland Department of the Environment
Water Supply Program
1800 Washington Boulevard, Suite 450
Baltimore, Maryland 21230

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APPENDICES

I. Introduction

On January 23, 2001, the Environmental Protection Agency finalized the Arsenic Rule, which reduced the drinking water maximum contaminant level (MCL) for arsenic from 50 parts per billion (ppb) to 10 ppb. All community and nontransient noncommunity water systems are required to comply with this new standard by January 23, 2006.

The results of previous sampling for arsenic indicate that approximately 51 public water systems in Maryland may have arsenic levels in their finished water that exceed the new standard. This guidance was developed to assist Maryland public water systems in complying with the new requirements.

Sources of arsenic contamination in water

The contamination of a drinking water source by arsenic can result from either natural or human activities. Arsenic is an element that occurs naturally in rocks and soil, water, air, plants, and animals. Volcanic activity, the erosion of rocks and minerals, and forest fires are natural sources that can release arsenic into the environment. Although about 90 percent of the arsenic used by industry in the United States is currently used for wood preservative purposes, arsenic is also used in paints, drugs, dyes, soaps, metals and semi-conductors. Agricultural applications, mining, and smelting also contribute to arsenic releases.

Arsenic occurrence in Maryland

Higher levels of arsenic tend to be found more in ground water sources than in surface water sources. In Maryland, the higher arsenic values (20 – 50 ppb) are found in the deep iron rich sediments of the Coastal Plain. Arsenic dissolves naturally from these sediments and enters the ground water. Naturally-occurring arsenic is found in the Piney Point, Aquia, Federalsburg and Monmouth Aquifers. These aquifers are used by public water systems located in Caroline, Charles, Dorchester, Queen Anne, St. Mary's, and Talbot Counties. Calvert County also has systems with arsenic results between 10 ppb and 20 ppb.

Health Effects

Dissolved arsenic found in Maryland's ground water is generally in inorganic form, as arsenite, As(III), and arsenate, As(V). Most arsenic is present as arsenite, which tends to be more mobile in ground water than arsenate. Arsenite is more difficult to remove than arsenate and has the potential to generate more health concerns. Ingesting inorganic arsenic over many years (chronic exposure) increases the risk of skin cancer and tumors of the bladder, kidney, liver, and lung. It has also been found to cause blood vessel damage, heart problems, darkening of the skin, and nervous system damage. Recently, the National Academy of Sciences (NAS) has reviewed the updated toxicological database for arsenic and has determined that cancer risks from arsenic exposures are greater than previously estimated. This prompted a call to lower the drinking water standard for arsenic in order to protect human health. Reducing arsenic from 50 ppb to 10 ppb will prevent cancerous diseases, as well as numerous cases of non-cancerous diseases, such as skin conditions and heart disease.

II. Compliance Requirements

Applicability

The revised arsenic regulation applies to all community and non-transient non-community water systems.

> **Community Water System (CWS):** Public water systems that serve 15 or more service connections used by year-round residents or that serve 25 or more year-round residents. Previously, community water systems were subject to the 50 ppb standard.
>
> **Non-Transient Non-Community Water System (NTNCWS):** Public water systems that serve 15 or more service connections used by the same people for at least six months a year or serve the same 25 or more people for at least six months a year. NTNCWSs were not required to comply with the 50 ppb standard.

Monitoring Locations

Under the new regulation, CWSs and NTNCWSs are required to collect compliance samples from each point of entry (POE) into the distribution system. A point of entry is the sampling location directly after treatment (if treatment is used). Specific sampling requirements will be included in each system's annual monitoring schedule, which is mailed annually in March.

Routine Monitoring Frequencies

The routine monitoring frequency for arsenic varies depending on whether the source of drinking water is surface water or ground water.

> **Ground Water POEs:** Must collect one sample at each POE once every three years. This monitoring is conducted in three-year increments beginning from the system's initial monitoring year, which will be established by MDE.
>
> **Surface Water POEs:** Must collect one sample at each POE every year.

Increased Triggered Monitoring

Beginning on January 1, 2005, any system with a POE that has arsenic results above 10 ppb must increase the sampling frequency at that POE to quarterly. The system must continue quarterly monitoring at each POE with arsenic results above 10 ppb for at least four quarters. Compliance is based on a running annual average of arsenic results. If at any time the running annual average exceeds the 10 ppb standard, the system is out of compliance. After four consecutive quarterly samples, MDE may determine that the water supply is "reliably and consistently below" the standard, and may return the system to routine monitoring frequency.

The phrase "reliably and consistently below" the standard means that although contaminants have been detected in a water supply, the State has sufficient knowledge of the contamination source and extent of contamination to predict that the maximum

contaminant level will not be exceeded. In determining that a contaminant is reliably and consistently below the maximum contaminant level, MDE shall consider the quality and completeness of data, the length of time covered and the volatility or stability of monitoring results during that time, and the proximity of such results to the maximum contaminant level. Wide variations in the analytical results, or analytical results close to the maximum contaminant level, will not be considered to be reliably and consistently below the maximum contaminant level. If the running annual average at a POE does not exceed the standard but the results are not reliably and consistently below the standard, the system shall continue to sample that POE on a quarterly basis.

Maximum Contaminant Level (MCL) Violation

A system will be immediately out of compliance if any quarterly sample would cause the running annual average to exceed the 10 ppb standard at any sampling point.

Public Notification and Consumer Confidence Reporting (CCR) Requirements

The Arsenic Rule specifies numerous public notification and CCR requirements with mandatory language that water systems must use to inform their consumers about the health risks associated with arsenic. These requirements depend on the level of arsenic detected at a point of entry and whether a water system complies satisfactorily with monitoring and reporting requirements.

Timelines

Water Systems Must Meet the 10 ppb Arsenic MCL by January 23, 2006

All Community and Non-Transient Noncommunity water systems must ensure their drinking water does not have arsenic above 10 ppb by **January 23, 2006**.

Arsenic MCL of 50 ppb Remains in Effect Until January 22, 2006

The arsenic MCL of 50 ppb will remain in effect until January 22, 2006. Community systems will be required to continue monitoring for arsenic under their current monitoring frequency until the 2005 schedules are issued.

Water Systems Must Submit A Plan for Compliance by November 3, 2004

All Community and Non Transient Noncommunity water systems with arsenic results above 10 ppb must submit a comprehensive arsenic compliance plan to MDE by **November 3, 2004**. The compliance plan should include details about current and projected arsenic levels, nontreatment or treatment options and a project timeline.

Eligibility for Reduced Monitoring

If your water system historically has had arsenic levels below the revised MCL, your system may be eligible for a waiver. To qualify for an arsenic waiver, you must have data from three previous sampling periods. This includes data collected during the following compliance periods: 1990 – 1992, 1993 – 1995, 1996 – 1998, 1999 – 2001, 2002 – 2004, and 2005 – 2007. The analytical results from all samples must:

- Have arsenic levels below 10 ppb
- Be collected at each POE

- Be consistent with the analytical methodology and detection limits of the Arsenic Rule (Method Detection Limit <3 ppb)

Once a monitoring waiver is issued, the system must collect and analyze at least one sample during each nine-year compliance cycle. Waivers must be reissued for each nine-year cycle.

III. Exemptions

Federal regulations allow states to offer exemptions to systems, which provide systems with additional time to achieve compliance. In order to be eligible for an exemption, a system must demonstrate that there are compelling reasons preventing the system from achieving compliance by the January 23, 2006 deadline, and that the exemption will not result in an unreasonable risk to public health.

Eligibility for Exemptions

An exemption allows a water system additional time to achieve compliance with the arsenic standard. An exemption can provide water systems with additional years to comply with the new standard depending on the number of people served by the water system and the arsenic concentration present in the system. Systems can apply to MDE for an extension of the January 23, 2006 compliance deadline if they are able to demonstrate that the following conditions exist:

1. The water system is unable to comply with the arsenic MCL because of compelling factors, which may include economic factors.
2. The exemption from the MCL will not result in an unreasonable risk to public health.
3. The water system does not have a reasonably available alternative source of water that can be used to achieve compliance with the arsenic MCL.
4. The water system is unable to make management or restructuring changes that will result in compliance with the MCL or improve the quality of its drinking water before January 23, 2006.
5. Necessary capital improvements cannot be completed before January 23, 2006.
6. The water system needs financial assistance for necessary capital improvements and has entered into an agreement to obtain the financial assistance or the water system has entered into an enforceable agreement to become part of a regional public water system.

Exemption Process

If a water system can provide documentation that indicates compelling reasons why it cannot achieve compliance with the standard by January 23, 2006, the water system may be eligible for an exemption. To apply for an exemption, a system must complete and submit the "Application for Arsenic Exemption" (see Appendix A). **Exemption requests must be submitted to the Maryland Department of the Environment (MDE), Water Supply Program by July 30, 2005**.

MDE will review the information provided by the water system and make a determination whether to grant or deny the exemption request. If MDE grants the exemption request, MDE and the system will enter into a formal agreement with a compliance schedule for making the needed improvements. If MDE denies the exemption request, it will notify the system of the reason(s) for the denial and provide an opportunity to the system to submit additional information to MDE. Public hearings are required to review the proposed schedule prior to approval.

IV. Compliance Options

There are two categories of options that water systems may choose to comply with the new arsenic standard: non-treatment options and treatment options. Non-treatment options such as blending a high arsenic water source with another source that is lower in arsenic, replacing water sources with new sources or becoming consecutive to another water system, tend to be more economical and easier to implement and manage than treatment options. Typically there is a one-time capital cost and minimal maintenance cost associated with the non-treatment options.

Treatment options may include activated alumina (or another type of adsorptive media), reverse osmosis point-of-use (POU) devices, modified lime softening or oxidation/filtration (including greensand filtration). Treatment options are usually more expensive to implement and more complicated to manage than non-treatment options, and may require substantial capital investments. Treatment processes for arsenic are complex and require appropriately trained and certified water system operators.

Non-Treatment Options

Non-treatment options may require lower initial financial investment and less maintenance than treatment options. However, some non-treatment options may require significant changes to the overall configuration and operation of the water system. These options do not involve actively altering the chemistry of water before it is sent to customers. They include:

- Blending the contaminated source with another source that contains lower arsenic levels (a new source may require a new or revised Water Appropriation Permit)
- Modifying source water contributions to a well by altering the well design (an option if the well is screened at multiple depths)
- Replacing water sources (a new source may require a new or revised Water Appropriation Permit)
- Interconnecting to another water system and abandoning wells with elevated arsenic levels

Treatment Options

If a water system cannot comply with the new arsenic standard and non-treatment options are not appropriate, treatment options will need to be explored. Water systems should carefully consider the merits of different treatment options since treatment is typically more expensive to implement and maintain than non-treatment options. Treatment options also may require extensive improvements to existing facilities. Factors such as raw water quality, population served, infrastructure design, operator proficiency and available resources must be taken into account before deciding on a final treatment type. A MDE Water Construction Permit is required prior to installation of new treatment. The permit requires a design to be completed by a registered professional engineer.

Best Available Technologies (BATs) are technologies that EPA has found to be proven through full-scale field conditions. EPA identified seven BATs in the final Arsenic Rule using its listed criteria (66 FR 6976 – 6981). EPA determined these technologies to be

the BATs for the removal of arsenic in drinking water based on a demonstration of efficacy under field conditions taking cost into consideration (40 CFR 141.62(c) and SDWA 1412(b)(4)(D)). All of these BATs are for Arsenic V (Arsenate). Pre-oxidation may be required to convert Arsenic III (Arsenite) to Arsenic V. Appendix B includes a copy of Table ES-1 from EPA's Arsenic Treatment Technology Evaluation Handbook for Small Systems, which provides a short summary of information regarding each arsenic treatment technology. The summary compares system size, optimal quality conditions, operator skills, waste generated, costs and other considerations.

MDE anticipates that Maryland water systems are likely to install a sorption process, membrane process or precipitative process to reduce arsenic levels below the new MCL. A registered professional engineer should evaluate and select the best type of treatment for a water system.

Arsenic III vs. Arsenic V

Arsenic is found in the environment in two forms: Arsenic V (arsenate), and Arsenic III (arsenite). Arsenic V is the oxidized state commonly found in surface water and some ground water sources. Arsenic III is not oxidized and is found in ground water sources. Most of the arsenic in Maryland is found in ground water and occurs in the Arsenic III state. The Best Available Technologies for compliance identified by EPA are recommended for removing arsenic in the Arsenic V state. In order to use these technologies to remove Arsenic III, the Arsenic III must be oxidized to the Arsenic V state prior to treatment. Pre-oxidation technology includes chlorination, potassium permanganate and ozone.

Best Available Technologies for Arsenic Removal

Technology	Percentage Arsenic Removal	Affordability by size (number of service connections)
Activated Alumina	95	All size categories
Coagulation/Filtration	95	>500 Not BAT for systems with fewer than 500 service connections
Ion Exchange	95	All size categories
Lime Softening	90	Central: 501-3,300 and 3,301-10,000 Not BAT for systems with fewer than 500 service connections
Reverse Osmosis	>95	Central: 501-3,300 and 3,301-10,000 POU: All size categories
Electrodialysis	85	> 10,000
Oxidation/Filtration	80	All size categories

Oxidant Comparison for Arsenic Removal[1]

Effective Oxidants	Ineffective Oxidants
Chlorine	Chlorine Dioxide
Hypochlorite	Chloramines
Permanganate	UV light alone
Ozone	
Solid Phase Media (Filox and Others)	

Contaminants That Inhibit Oxidation of As (III)
Sulfide
Total Organic Carbon
Iron - Fe (II)

Sorption Process (Activated Alumina)

The sorption process utilizes an adsorptive medium, either activated alumina or iron-based, of very small grains which are packed into one or more large pressure vessels. Water is continuously passed through the vessel(s) until the medium is exhausted, when it is simply disposed of and replaced with fresh medium or the media is regenerated. The alumina media can be disposed of in a normal landfill without regeneration.

Key considerations:

- Optimal pH = 5.5 – 8.3; activated alumina is more economical at the low end of the pH range
- Low operator skill required
- Low water loss
- Medium cost
- Spent media and backwash water do not generate hazardous wastes
- Point of Use (POU) treatment is feasible (warning lights and automatic shut-off valves required)

Membrane Process (Reverse Osmosis)

Reverse osmosis uses high pressure to force water through a membrane with microscopic holes that prevent arsenic and other large contaminants from passing through. For systems serving fewer than 100 connections and an average population of less than 300, POU treatment may be a reasonable option.

POU devices are typically installed under the kitchen sink and are considered to be cost-effective. The devices must each be tested at the normal frequency (once per year for surface water, once every three years for ground water) to determine if they comply with current standards.

[1] Ghurye, G. and D. Clifford, 2000, *Laboratory study on the oxidation of As III to As V*. Proceedings, AWWA Water Quality Technology Conference.

Key considerations:

- Ease of installation
- Treats only water used for human consumption (typically about 2% of a system's total flow)
- Low initial capital costs
- Reduces engineering costs associated with construction of full-scale treatment
- Mechanical warnings (lights) are required to warn the customer of failure
- High monitoring and administrative costs

Precipitation Process (Oxidation/Filtration)

This technology oxidizes naturally occurring iron, which binds to arsenic and is then removed by filtration.

Key considerations:

- Optimal pH = 5.5 – 8.5
- Optimal Iron levels > 0.3 mg/L
- Medium operator skill required
- Medium costs
- Wastes generated are the backwash water and sludge
- Disposal of backwash water may require a ground water or NPDES discharge permit

V. Operator Certification

Water systems will need to ensure that the operators are certified with the appropriate classification for arsenic treatment. The following table provides information regarding operator classification:

Classification of Water Treatment Plants

Plant Class[2]	Type of Treatment
G	No Treatment – or – Passive Treatment
1	Chlorine Disinfection
2	Corrosion Control – or – Aesthetic Treatment
3	Contact Oxidation with Filtration – or – Ion Exchange
4	Conventional Treatment
5	Site Specific

Plant Classes G, 1 and 2 are not appropriate certifications for arsenic treatment processes.

Plant Class 3 – Contact Oxidation with Filtration – or – Ion Exchange

Water treatment plants included in this classification contain at least one of the following processes used for removing regulated primary or secondary contaminants such as iron, manganese, arsenic, or nitrate:

1) Contact oxidation (e.g., chlorine, potassium permanganate, or hydrogen peroxide) with filtration (e.g., pressure sand or greensand filters); or
2) Ion exchange.

Plant Class 4 – Conventional Treatment

Water treatment plants included in this classification contain at least one of the following processes:

1) Complex iron and manganese removal using a coagulant and may include the following unit operations:
    i) aeration and/or chemical oxidation;
    ii) coagulation/flocculation;
    iii) sedimentation/clarification; and
    iv) filtration.
2) Conventional and package surface water plant processes.

[2] *A Water Treatment Plant is always classified according to the unit process(es) with the highest classification.

Plant Class 5 – Site Specific

Water treatment plants included in this classification are alternative technologies not covered by the above classifications and *may* contain at least one of the following processes:

1) Cartridge/pleated filters used for GWUDI and surface water sources;
2) Diatomaceous earth;
3) Membrane filtration (e.g., reverse osmosis, ultrafiltration, or nanofiltration);
4) GAC filtration (for VOC control);
5) Activated alumina (for radionuclide control or arsenic removal); or
6) Ozone disinfection.

For more information on operator certification, or to obtain an application, please contact the Board of Waterworks and Waste Systems Operators at (410) 537-3167 or visit MDE's website at www.mde.state.md.us.

VI. Arsenic Waste Disposal

All arsenic treatment technologies produce waste in the form of liquid residuals (e.g. brine, concentrates, filter rinse, and/or backwash), solid residuals (e.g. spent media, membranes, and/or dewatered sludge), or both. These residuals contain concentrated arsenic and other contaminants that require proper disposal.

Any system that generates a waste must determine whether the waste is hazardous. Systems that produce hazardous waste must comply with the Resource Conservation and Recovery Act (RCRA) disposal regulations. Under RCRA, arsenic is a hazardous waste when:

- A liquid waste stream contains more than the federal toxicity characteristic of 5.0 mg/L of arsenic.
- A solid waste stream fails the toxicity characteristic leaching procedure (TCLP) (i.e. the liquid extraction contains more than 5.0 mg/L of arsenic).

Since removal technologies frequently remove other contaminants in addition to arsenic, your waste residual may also have concentrated levels of co-occurring contaminants such as lead, barium, or radionuclides. The removal of co-occurring contaminants may create disposal problems even when the arsenic level in your waste residuals is not high enough to trigger a hazardous waste classification. Water systems should thoroughly test their wastes prior to making disposal decisions.

Hazardous Waste Disposal

Anyone who produces solid waste is responsible for characterizing that waste to determine whether it constitutes hazardous waste. Although systems are encouraged to characterize the specific waste stream they are creating, it may be possible to estimate whether the waste will meet the definition of hazardous waste by using data from similar waste streams. During the development of the Final Arsenic Rule, EPA tested many of the waste streams generated by the BATs and found them to contain arsenic levels between 0.050 mg/L (activated alumina and lime softening) and 1.0 mg/L (iron coagulation plant), thus making them non-hazardous. EPA provides guidance for characterizing hazardous waste; see Section VIII of this guidance.

Solid Waste Disposal

If the solid waste produced by arsenic removal technologies, such as spent media or filters, has been tested and is not a hazardous waste, it can be safely disposed in a municipal landfill. The solid waste should be drained of any liquid and must not be drippy or runny. For example, if the waste were placed on a slightly inclined surface, the waste should be dry enough that liquid does not run down the surface.

Liquid Waste Disposal

Any public water system that discharges wastewater to the ground or subsurface via a disposal system such as a drainfield or seepage pit must obtain a ground water discharge

permit. Backwash or other wastewater may not be discharged if arsenic or any other contaminant in the wastewater exceeds its maximum contaminant level.

Discharge permits have associated application fees and annual fees (these fees are waived for Municipal facilities), as well as operation and monitoring requirements, which typically include testing of wastewater quality prior to its onsite discharge. The frequency of required testing is dependent upon the quantity of wastewater being discharged. In addition, the issuance of discharge permits includes public participation requirements, which provide the public opportunities to request both informational meetings and formal hearings. Advertisements are placed in a local newspaper informing the public of these opportunities for participation. In all cases, the applicant bears the cost of the newspaper advertisements, and the costs of satisfying requirements for wastewater testing specified in the permit.

The estimated turnaround time for issuance of a Groundwater Discharge Permit for a new facility is 9 months. Permits can be expedited if requested, but requests for informational meetings and formal hearings can delay permit processing. More information about Groundwater Discharge Permit issuance, along with permit application forms, can be found online at: http://www.mde.state.md.us/Permits/WaterManagementPermits.

VII. Funding Resources

In order to comply with the Arsenic Rule, many systems will need to obtain financial assistance for the construction of arsenic treatment facilities. Currently, there are a variety of methods a water system can use to finance water treatment facility construction and operation expenses. These methods range from obtaining grants or loans to issuing bonds.

Water Quality Financing Administration (WQFA)

WQFA assists in the financing of capital infrastructure costs for public and private community water systems needing to achieve or maintain compliance with the Safe Drinking Water Act and amendments of 1996. The Administration offers affordable below-market-rate loans to eligible borrowers, while ensuring the perpetuity of the Revolving Loan Funds.

> **Drinking Water Revolving Loan Fund (DWRLF)** was created during the 1993 session of Maryland General Assembly for the purpose of providing below-market-rate loans for drinking water projects. This loan fund receives federal funding from the United States Environmental Protection Agency (EPA) under the Capitalization Grants for State Revolving Funds federal assistance program. (See Appendix C)
>
> **Bonds** - The Administration is also empowered to issue bonds subject to approval of the State Board of Public Works and Secretary of the Maryland Department of the Environment (Department). Bonds issued by the Administration do not constitute a debt or pledge of the full faith and credit of the State or any political subdivision thereof, other than the Administration. The bonds are paid solely from the revenue; money or property of the Administration pledged therefore under its Indenture of Trust dated March 1, 1990, as amended (Indenture) between the Administration and its trustee bank.
>
> **Financial Advisory Services** available through the WQFA assist borrowers in determining affordable **user rate structures** and **modeling the fiscal impact** of the proposed loan on the borrower's financial capacity.

For additional information regarding the DWRLF Loan Programs, please contact Jag Khuman, Director, Water Quality Financing Administration by: Phone: (410) 537-3119 or E-Mail: jkhuman@mde.state.md.us

Rural Utilities Service of the United States Department of Agriculture (RUS)

RUS and EPA have financial programs that assist eligible communities, including small and rural communities to obtain safe and affordable drinking water. The RUS Water and Environmental Programs (WEP) assist eligible applicants in rural areas and cities and towns of up to 10,000 people. Loan and grant funds may be used to develop, improve, or upgrade water, wastewater, solid waste disposal, and storm drain systems.

For additional information regarding WEP Loan and Grant Programs, please contact James E. Waters, Community & Business Programs Director 4607 South Dupont Highway, Post Office Box 400, Camden, Delaware 19934. Phone: (302) 697-4324, TTY: (302) 697-4303, FAX: (302) 697-4388, Email: *Jim.Waters@de.usda.gov.* See Appendix D.

Community Development Block Grants
This program offers grants to disadvantaged cities, urban counties, and states to develop viable urban communities. Phone: (202) 708-1112, Web: www.hud.gov/offices/cpd/communitydevelopment/programs/stateadmin/stateadmincontact.cfm

Public Works and Infrastructure Development Grants
These grants help distressed communities overcome barriers that inhibit the growth of their local economies. Phone (202) 482-5081, Web: www.doc.gov/eda/HTML/1c_regloffices.htm

National Bank for Cooperatives Loan Program (CoBank)
CoBank provides loans to larger, creditworthy rural utilities. Phone: (800) 542-8072, Web: www.cobank.com

VIII. Technical Resources

This section includes a list of contact organizations and their helpful documents.

Maryland Department of the Environment
Web: www.mde.state.md.us

Water Supply Program
Phone: (410) 537-3702

Board of Waterworks and Waste Systems Operators
Phone: (410) 537-3167

Water Quality Financing
Phone: (410) 537-3119

Ground Water Permits Program
Phone: (410) 537-3778

Hazardous Waste Program
Phone: (410) 537-3343

Solid Waste Program
Phone: (410) 537-3318

U.S. Environmental Protection Agency (EPA)
Web: http://www.epa.gov/safewater/ars/implement.html
EPA Hotline: (800) 426-4791

1. Implementation Guidance for the Arsenic Rule: EPA#s 816/D-01/002, 816/D-02/005, and 816/D-02/018
2. The Arsenic Treatment Technology Evaluation Handbook for Small Systems: EPA# 816/R-03/014
3. Case Studies – Arsenic Treatment Technologies: EPA 816/F-03/012, EPA 816/F-03/013, EPA 816/F-03/014 and EPA 816/F-03/015
4. Design Manual: Removal of Arsenic from Drinking Water by Ion Exchange: EPA 600/R-03/080
5. Design Manual: Removal of Arsenic from Drinking Water by Adsorptive Media: EPA 600/R-03/019
6. Draft Guidance for Implementing a Point-of-Use or Point-of-Entry Treatment Strategy for Compliance with the Safe Drinking Water Act
7. Technologies and Costs for Removal of Arsenic From Drinking Water: EPA 815/R-00/028
8. Arsenic Rule Implementation Research Program: http://www.epa.gov/ORD/NRMRL/arsenic/research.htm

American Water Works Association (AWWA)
Web: http://www.awwa.org/bookstore
Phone: (303) 794-7711 or (800) 926-7337

1. Demonstration of Emerging Technologies for Arsenic Removal, Vol. 1: Bench-Scale Testing: ISBN 1-58321-310-4; Catalog Number 90974.
2. Water Quality and Treatment: A Handbook of Community Water Supplies: ISBN 0-07-001659-3; Catalog Number 10008

National Drinking Water Clearinghouse
Web: http://www.nesc.wvu.edu/ndwc
Phone: (800) 624-8301 or (304) 293-4191

1. On Tap, "All About Arsenic," Summer 2002, Volume 2, Issue 2
2. Tech Brief: Point-of-Use/Point-of-Entry Systems (POU/POE) (Order #DWFSOM31)
3. Tech Brief: Ion Exchange and Dimineralization (Order #DWFSOM46)
4. Tech Brief: Membrane Filtration (Order #DWFSOM43)

National Academy of Sciences
Phone: 800-624-6242
http://www.nap.edu/books/0309063337/html/index.html

1. Arsenic In Drinking Water (1999): 0-309-06333-7

2. Arsenic In Drinking Water: 2001 Update: 0-309-07629-3

Maryland Geological Survey

Web: http://www.mgs.md.gov/

Phone: 410-554-5505

Bolton, David W., 2003. *Interim Report: Summary of Ground-Water Arsenic Concentrations in the Major Aquifers of the Maryland Coastal Plain.*