THE NEED FOR WELLHEAD PROTECTION: A REVIEW OF GROUND WATER QUALITY IN MISSISSIPPI AND ITS IMPACT ON PUBLIC WATER SUPPLIES

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INTRODUCTION

In Mississippi, over 90% of Mississippians drink ground water daily from public water supply wells. Although ground water from those wells is considered safe through routine testing by the Mississippi Department of Health (MSDH), background levels of man-made chemicals are routinely found in our drinking water sources throughout the state.

Are those levels increasing, decreasing, or staying the same? Currently, historic water quality data is insufficient to make a determination; however, our use of man-made chemicals continues to increase. Also increasing are the number of sites where contaminant releases to ground water are suspected or confirmed.

A relatively new program, Wellhead Protection is designed to identify and manage potential contaminant sources in areas near public water supply wells and offers a significant opportunity to reduce the threat of contamination to our public water supplies.

Status of Ground Water Quality Monitoring in Mississippi

Historically in Mississippi, ground water quality has been addressed in terms of inorganic constituents (iron, calcium, magnesium, chlorides, silica, sodium, potassium, bicarbonate, sulfate, fluoride), pH, color, and hardness. This is because the emphasis has always been on sources of water, rather than the continuing quality of existing water supplies. As a result, most of the ambient data currently available does not address man's impact on ground water quality. Because a comprehensive ground water quality database that includes both organic and inorganic chemicals has never existed within the State of Mississippi, limitations exist in regard to assessing the status of ground water quality in Mississippi from a historic perspective, which would allow for projections and estimates.

Water Quality Monitoring Programs

The Federal Safe Drinking Water Act requires regular testing and analysis of water from both public drinking water wells and systems. The MSDH has the responsibility of performing those water quality analyses in Mississippi. Over 3,000 public water supply wells have been analyzed for a variety of potential contaminants, including volatile organics (VOCs), inorganics, nitrates, nitrites, bacteria, and synthetic organic chemicals.

The Agricultural Chemical (Ag-Chem) Program of the MDEQ has sampled and analyzed ground water from 348 domestic and public drinking water wells, irrigation wells, and aquaculture wells in every county of the state in an effort to evaluate ambient water quality conditions. Approximately, 250 of these wells were domestic (private) drinking water wells. The primary emphasis of this continuing project is to identify pesticide occurrence, however, the occurrence of volatile organic chemicals, inorganics, and nutrients were also analyzed.

The existence of these extensive databases provides the State of Mississippi with significant ambient ground water quality information. However, the use of this data has been limited due to its existence within hard copy files in various regulatory programs. The Ground Water Planning Branch of the MDEQ is currently developing a contaminant detects database using the MSDH water quality analytical database and the Ag-Chem database and has plans to automate this information on a Geographic Information System which will expand the potential uses and users of this data. In the future, the integration of the various regulatory program ground water quality databases will further expand the applications for the ambient ground water quality database to assess the comprehensive effects of regulated sites and/or contaminant source sites on ground water quality.

Contaminant Detects in Public Water Supply Wells and Ag-Chem Monitor Wells.

Since the water quality analytical program was mandated by the federal government during the late 1980s, a total of 15 volatile organic chemicals have been found in over 80 public water supply wells in the state. Contaminant levels that exceed regulatory requirements have been detected in wells from eight different public water supply systems. Those systems furnish potable water to over 30,000 persons. In five of the eight public water supply systems, either new wells have been drilled, alternative water sources have been tapped, or remediation efforts have been pursued in an attempt to ensure a safe drinking water supply for the affected public.

The remaining 65 public water supply wells which yielded contaminants in levels less than the regulatory limit are tested periodically to ensure that contaminant concentrations do not exceed regulatory levels. This monitoring effort has revealed that the occurrence of many types of contaminants may be transient in nature, with alternating samples showing a fluctuation in concentrations and even alternating detects and non-detects. A variety of circumstances could cause such an effect, including changing hydrogeologic conditions, changing contaminant source concentrations, microbiological conditions, and sampling/analytical protocol. Table 1 is a summary of the regulated volatile organic compound detects from public water supply wells during the period January 1989 through September 1994.

The two volatile organic chemicals with the greatest impact were benzene, a constituent of gasoline, and trichloroethylene, which is widely used today in cleaning solvents. Benzene was detected in eleven public water supply wells in systems which serve a total of over 50,000 people. Trichloroethylene has been detected in four public water supply wells in systems that serve a total of over 30,000 people. Detects in five of the wells exceeded regulatory levels, while 13 did not. A significant point can be made regarding the role of exposure, especially when considering the relationship of the small number of public water supply wells with contaminant detects compared to the number of individuals exposed to the contaminant. In the cases of benzene and trichloroethylene contamination, although those contaminants were detected in only 18 of over 3,000 wells (<0.6%), over 80,000 persons connected to those systems were exposed to the contaminants (>3% of the population of the entire state).

Evaluation of the Ag-Chem ground water quality database revealed the occurrence of a total of 39 volatile and other organic chemicals and pesticides detected in 144 of the 348 wells sampled (>40%). Of the 144 wells found to have detectable concentrations of contaminants, seven of the detects were found to contain concentrations exceeding regulatory levels. The most consistent contaminant detected was pentachlorophenol, a wood preservative formerly used in pesticide applications, which was detected in over 34% of the samples analyzed. However, the average level detected was well below the regulatory limit. A volatile organic chemical of concern is methylene chloride which was detected in 17 of the 288 drinking water wells (~5.9%), although only one of the detects exceeded the Safe Drinking Water Act maximum contaminant level. Table 2 is a summary of detected pesticides and other organic compounds revealed by the Ag-Chem sampling program.

As in the case of contaminant detects in the MSDH public water supply water quality database, the role of exposure has a dramatic effect when considering the potential impact on human health. Although no accurate number exists of the number of private wells used in the state, it is estimated the number is in the tens of thousands (possibly as many as 100,000). Therefore, if 50,000 households in Mississippi are using domestic wells for their primary drinking water source, approximately 60,000 persons (assuming 3 persons per well in mainly rural areas x 40% of wells with contaminant detects) have been exposed to contaminated drinking water. There is no required sampling of these wells.

The concern lies in the fact that large amounts of volatile organic and synthetic chemicals are being manufactured and used in Mississippi, as in other states. Prior to the widespread use of petroleum products (fuels, solvents, greases, and oils) and pesticides, these constituents did not generally occur in ground water. However, background levels of contaminants are being found in a number of drinking water wells in the state. Although the percentage of occurrence is small, as well as the average contaminant levels detected, because ground water is the primary source of drinking water in the state, a significant number of persons are being exposed to numerous contaminants. Only through continued sampling and monitoring of the levels of those chemicals can trends be established to determine the existence of increasing or decreasing concentrations. Man-made contaminants are introduced to ground water through a source, either point or non-point, and only when those sources are eliminated will that potential health hazard be removed.

Regulatory Programs and Contaminated Sites in Mississippi

A number of regulatory programs at the MDEQ administer assessment and remediation projects related to ground water contamination. The Underground Storage Tank program oversees the assessment and remediation of over 200 currently active sites where discharges to ground water have occurred. In addition, over 300 sites where ground water contamination was either confirmed or suspected as a result of leaking underground storage tanks have been closed and remediated, with contracted expenses exceeding $28,000,000. The State Uncontrolled Sites and CERCLA programs currently administer over 1,000 sites in Mississippi where contamination has been confirmed or is suspected. Other programs administer the generation, management, and disposal of hazardous and nonhazardous wastes.

As part of the evaluative role of those programs, a significant amount of ground water quality data exists within those programs. Much of that data was gathered from the sampling results of thousands of ground water monitor wells associated with the regulated sites. Although this data is essential for its purpose, its site-specific nature related to known existing or potential points of contamination precludes its use for ambient ground water quality data. As a result, this data was not used for this report. However, on a local scale the use of some of this data might be very helpful.

Case Histories of Contaminated Public Water Supply Systems in Mississippi

Following are four documented contamination events of public water supply wells in Mississippi and the efforts undertaken to provide those systems with a safe source of drinking water.

Town of Wesson

Perhaps the best-known public water supply contamination event in Mississippi occurred in 1987 in the Town of Wesson. Recent media coverage has brought this event to the forefront once again. In 1953, an electrical components manufacturer (Potter Company) established operations on a 10 acre site in the small Copiah County community of Wesson. Dielectric oil containing polychlorinated biphenyls (PCBs) was used in the manufacture of electrical capacitors at the facility. The oil was cleaned from process equipment with a widely-used solvent, trichloroethylene (TCE). PCBs were used from about 1959 to about 1968, and TCE was used from about 1954 to about 1975.

In 1986, Varian Associates, Inc. purchased Pulse Engineering, Inc. of which Potter Company was a subsidiary. At that time, employees expressed concern over how wastes had been handled at the plant. In the past, waste oils and solvents had been dumped into a ditch behind the manufacturing plant. At the time this was done, no regulations existed that prohibited such practices. In response to the situation, the MDEQ initiated a sampling program at the site and during the second half of 1986 detected PCBs and TCE in onsite surface soils, area drainage ditches, and on adjacent residential property. During May 1987, the MDEQ issued an order requiring Potter Company to determine the extent of PCB-contaminated soils, develop a plan to remove the contaminated soils, and install a monitor well.

During August 1987, the Town of Wesson's two public water supply wells, located approximately 2,000 feet east of the plant site, were found to contain significant concentrations of TCE. Citizens of the town were then notified to boil water or use bottled water. Removal of the contaminated soil began during November 1987. In May 1988, the town modified its drinking water aerators to reduce concentrations of TCE. The modification improved water quality, but TCE concentrations still exceeded regulatory limits. During June 1989, the two contaminated wells were abandoned and two new wells were drilled approximately a mile east of town. No detects of TCE have been tested in the public water supply since May 1989.

During the period between September 1992 and April 1993, Potter Company implemented and completed remediation of the contaminated soil. A ground water remediation system became fully operational at the facility during June 1995. Recently, media coverage has centered on occurrences of cancer in four school children in the town. Speculation has attributed the cause of the disease to ingested contaminated ground water. However, data has not substantiated this claim.

Estimated costs for remediation of the water treatment facility and drilling/equipping two new water wells were $500,000. Costs for removal of the PCP-contaminated soil was approximately $2 million. The ground water remediation system is expected to be in operation for approximately 30 years at a considerable expense.

Town of Benton

During 1984, numerous residents of the Town of Benton complained of taste and odor problems in their water. At the time, the town's public water supply was owned by a local resident and consisted of two well fields, one on the north side of town and one on the south side of town. Responding to the complaints, the MDEQ analyzed water samples from both well fields. The north supply wells were found to be contaminated with gasoline constituents and the south supply wells were found to be clean. The north well field was located approximately 500 feet northeast of the intersection of old Mississippi Highway 16 and Mississippi Highway 433, an intersection which represents the center of the town of Benton. At the time, two active retail gasoline outlets existed at this intersection. Because of the contamination, the community was connected to the Central Yazoo Water Association public water supply system.

A remedial investigation was performed in 1985 to define the source and extent of the gasoline contamination, and initial monitor wells were installed and ground water samples collected. Two borings drilled north of the intersection were completed without detection of contaminants. The absence of contaminant detects in the samples taken near the north supply wells were presumed to be due to the cessation of pumping of those wells after connection to the Central Yazoo system. While boring at the third site, 1000 feet south of the intersection near the County Barn, a pronounced odor of gasoline was detected in the drill cuttings. A total of 18 monitor wells drilled during this assessment indicated that two potential contaminant sources existed for the gasoline products detected in both well fields.

During 1990, site reconnaissance revealed that the probable contaminant source site for the northern well field was found to exist at a convenience store which also sold gasoline stored in underground storage tanks and was the closest gasoline storage facility to those wells. The convenience store was located on the north side of the intersection in the center of the town (and south of the initial two monitor wells). The contaminant plume at this site was distorted in the direction of the north well field as a result of ground water withdrawals that had previously occurred.

Site reconnaissance also suggested that leakage from an above ground fuel storage tank that once existed at the County Barn, in addition to poor disposal practices and carelessness, were most likely responsible for the gasoline contamination for the south well field. The active underground storage tanks at that site were not believed to be responsible for the soil and ground water contamination because samples collected near those tanks displayed only very low levels of contamination. Although the above ground storage tank had been removed previously, residual free product in the soil where the tank had been located had apparently continued to be a source for the contamination occurring in the ground water.

Remediation of the contaminated soils was accomplished by removal to an approved landfill, while standard pump-and-treat technology was used to remediate the ground water at the affected sites. Total contracted assessment and remediation costs for this project are approximately $600,000 and operation and maintenance costs for the ground water remediation system currently run approximately $6,000 per month.

City of Columbia

In January 1984, possible contamination of several City of Columbia public water supply wells was reported to the MDEQ by an area resident who was a former OSHA inspector. The MSDH then analyzed water from the City's drinking water wells as a precaution and identified the presence of concentrations of benzene, acetone, methylethylketone, and chloroform. Initially, an abandoned industrial site which operated from January 1975 to March 1977 was suspected as the source of the contamination. Soil and ground water sampling at this site by the MDEQ and USEPA revealed the existence of elevated levels of benzene, methylketone, and acetone. Subsequent soil and ground water sampling suggested that another source(s) other than the former chemical plant at the abandoned industrial site was responsible for the presence of the volatile organic chemicals. Because the site had experienced over 50 years of industrial use and its impact on the human health of nearby residents was a major concern, the site was placed on the National Priorities List (NPL). Over the next several years, USEPA performed two remedial investigations, two removal actions, an endangerment assessment, a feasibility study, and concluded with a Record of Decision (ROD) in the fall of 1989.

During August 1984, the MDEQ required and supervised the removal of 18 underground storage tanks at six upgradient locations near the city's affected public water supply wells. Evidence of leakage discovered during excavation included holes in underground storage tanks, discolored soil, and hydrocarbon odors. Ground water monitor wells were then installed as part of a continuing

monitoring program for the area. During August 1985 and April 1987, concentrations of benzene, toluene, ethylbenzene, 1,2 dichlorobenzene, bis(2-ethyl-hexyl)phthalate, phenol, and acetone were detected. Additional ground water monitor wells were then installed in an effort to determine the continuing source of contamination. Benzene detects continued in City Well #3 through December 1990. Analysis of the additional ground water data combined with reconnaissance of suspected contaminant source sites revealed six sites of concern. Further assessment ensued, until an underground storage tank considered to be the primary source of contamination was determined recently.

Currently, contracted assessment and other costs have totaled approximately $173,000. A ground water remediation system is planned to become operational in the near future at a cost of around $100,000 and will be operated for at least two years at a monthly cost between $2,000 and $5,000.

Smith's Crossing Rural Water Association (RWA)

Ground water samples collected from Well #1 of Smith's Crossing RWA public water supply during July 1988 detected the presence of the volatile organic chemicals benzene, chlorobenzene, and total xylenes in levels exceeding drinking water standards. In response, the MSDH ordered the well out of service and the pumps were shut off by Smith's Crossing RWA. After a period when no pumping occurred, water samples were again analyzed for volatile organics and no contaminants were detected. The well was then placed back into service. Soon volatile organics were again detected in ground water samples taken from the well. During August and September 1990, additional ground water samples from three public and six domestic water supply wells within a one-mile radius of Well #1 were analyzed for the volatile organic compounds. Two of the public water supply wells, City of Agee #6 and #7 (located approximately 2,000 feet south), tested positive for toluene and total xylenes and all three domestic water supply wells (located approximately one mile southwest) tested positive for total xylenes.

During the initial assessment, it was discovered that 20 feet of shaft lubricating oil was present in the well casing, overlying the static water level. It was determined that such a situation was a common occurrence for wells fitted with in-line turbine pumps. Although lubricant oils typically consist of heavier semi-aromatic constituents, volatile aromatic constituents normally associated with lighter petroleum distillate products have been found in a variety of heavy petroleum products.

Reconnaissance of the area around Well #1 revealed that five underground storage tanks and at least three above ground tanks existed at one time within a one-mile radius of the well. North of the well, three inactive underground storage tanks with possible product and an above ground storage tank which was the source of a past product release were reported at a former gasoline station/bulk storage facility which had been abandoned in the mid-1970s. Shortly after the past product release, nearby residents had complained of gasoline odors and tastes in their drinking water.

The reconnaissance also revealed the existence of a number of additional potential contaminant source sites that may have been responsible for the ground water contamination. Two active underground storage tanks were found to exist at a service station adjacent to the former gasoline station/bulk storage facility. A 560 gallon above ground storage tank had formerly been located at a veterinary clinic next to Well #1, and an above ground storage tank had actually been located on the site of Well #1. In addition, an above ground storage tank existed at a residence located approximately one mile south of Well #1 where two of the domestic wells that were sampled existed.

After completion of the environmental assessment, the three inactive underground storage tanks at the abandoned gas station/bulk storage facility were removed and closed in accordance with state regulations. In addition, approximately 80 gallons of lubricating oil was bailed from Well #1, and an aeration system was constructed. Total contracted assessment and remediation costs for the project were approximately $147,600.

Threatened Public Water Supply Systems in Mississippi

A number of public water supply systems are currently threatened by existing contaminants in the aquifer supplying ground water to those systems. In these cases contaminants have been detected in a public water supply well(s) through routine water sampling administered by the MSDH. However, the contaminant levels have not exceeded regulatory limits. Synopses for some of the more threatened systems follow.

City of Corinth

The City of Corinth public water supply system serves a population of over 15,000 residents from approximately 6,300 service connections. During October-November 1992, Coca-Cola Bottling Works of Corinth, Mississippi, was investigated for a reported accidental petroleum release. The facility operates as a soft drink bottling and distributorship on property adjacent to a City of Corinth public water supply well. A 10,500 gallon above ground storage tank with two dispensers are used for refueling purposes at the facility. Additionally, three 2,000 gallon underground storage tanks formerly existed at this site located in two different tank pits. The underground storage tanks were removed from service in June 1990.

During the initial assessment phase, monitor wells were installed to evaluate the impact of the accidental release to the ground water in the area. Four of 14 borings yielded soil samples with petroleum contaminants exceeding regulatory limits. Ground water samples analyzed from six of the 14 wells yielded petroleum contaminants exceeding the regulatory limit. Because of this situation, additional sampling of ground water from the adjacent public water supply well was performed. Trace amounts of gasoline constituents were observed in ground water samples taken from the well. Additional ground water monitor wells were then installed in an effort to fully define the contaminant plume. Subsurface contamination was found to be mainly concentrated in ground water in the vicinity of the upgradient above ground storage tank and had migrated in a northward direction toward the public water supply well.

Currently, plans are being developed to install a ground water remediation system which will cost approximately $150,000 including first year operations and maintenance. Assessment costs were approximately $90,000 and operations and maintenance costs after the first year will run approximately $3,000 per month.

City of Oxford/University of Mississippi

The City of Oxford and the University of Mississippi operate separate public water supply systems which collectively serve a population of over 15,000 residents and students from approximately 6,000 service connections. Ground water quality analyses from public water supply wells owned by both the City of Oxford and the University of Mississippi have revealed repeated occurrences of volatile organic chemicals from the trichloroethylene family, as well as other volatile organic chemicals in multiple wells. Although none of the detects has exceeded regulatory levels, the repeated occurrence of those chemicals suggests the existences of nearby contaminant sources. A preliminary inventory of potential contaminant sources revealed the existence of 176 potential contaminant source sites which could potentially contaminate the city's public water supply.

City of Magee

The City of Magee serves a population of 3,600 residents from approximately 1,360 service connections. The public water supply has also experienced repeated occurrences of volatile organic chemicals in multiple wells as revealed by ground water quality analyses. One of the detects exceeded Safe Drinking Water Act limits. A large petroleum bulk storage facility adjacent to the city's main well field serves as a potential contaminant source of concern for the public water supply. A preliminary inventory has revealed the existence of 86 additional potential contaminant source sites which could serve as contamination sources for the city's public water supply.

City of Brookhaven

The City of Brookhaven provides water to 11,000 residents from 3,850 service connections. Multiple public water supply wells used by the City of Brookhaven have tested positive for volatile organic chemicals in the trichloroethylene family, although none of the samples tested revealed contaminant concentrations exceeding regulatory requirements. A preliminary potential contaminant source inventory revealed the existence of over 160 sites which could be contributing contaminants to the public water supply's aquifer.

Town of Water Valley

The Town of Water Valley serves the drinking water needs for over 4,200 residents from approximately 1,550 service connections. Because of repetitive detects of volatile organic chemicals in one of the city's public water supply wells and the close proximity of the town's waste water impoundment to the town's public water supply with the absence of additional management and monitoring requirements, the town's drinking water supply is considered threatened. In addition to concerns associated with the town's waste water impoundment, a preliminary inventory of potential contaminant sources revealed the existence of 51 sites which could potentially contaminate the town's drinking water supply.

City of Louisville

Louisville Utilities provides drinking water to approximately 9,000 residents of the City of Louisville. Water quality samples taken from one of the city's public water supply wells during 1990 revealed detects of xylene, a non-regulated volatile organic chemical commonly found in gasoline. During 1991, routine sampling by the MDEQ of monitor wells surrounding underground storage tanks revealed detects of gasoline constituents from two sites in the city. An environmental assessment followed which determined the extent of contamination and recommended a ground water remediation program using two remediation units designed to prevent the contaminant plume from impacting the city's wells. Current assessment and remediation costs are approximately $300,000 with operations and maintenance costs running approximately $5,000 per month for each remediation unit.

Role of Wellhead Protection

Concept of Program

Wellhead protection is a common sense program designed to identify and properly manage potential sources of contamination located near public water supply wells. It offers a proactive approach to ground water protection, rather than the traditional and expensive reactive-remediation of contaminated sites approach. The area from which a public water supply well or well field captures its water over a specific period of time is referred to as a Wellhead Protection Area. It represents the area where management of potential sources of contamination will be emphasized to enhance ground water protection.

Development of a local Wellhead Protection plan is accomplished on a step-by-step basis. Initially, a local planning team is formed. This is followed by the performance of a hydrogeological assessment and delineation of Wellhead Protection Areas by the hydrogeologists at the MDEQ and is generally the most time-consuming phase of development. The third step involves inventorying all potential contaminant source sites within the delineated Wellhead Protection Areas. This effort is usually accomplished by the local planning team, MDEQ personnel, volunteers, and local industry representatives. The most important step consists of developing an acceptable and implementable management plan with primary input from the local planning team with guidance provided by MDEQ personnel. Basic elements contained in a management should address education and best management practices regarding the storage and handling of materials capable of contaminating the local drinking water supply. The final step in developing a Wellhead Protection plan involves public water supply-specific contingency planning. Of course, commitment to effectively implement the management plan is essential to assure a local public water supply enjoys the benefits that Wellhead Protection offers.

Mississippi's Wellhead Protection Program has been structured to allow development of local plans requiring a minimum of effort and costs by local operators and/or government. Although the program has only been in existence since September 30, 1993, nine municipalities and eleven water associations in Mississippi have either developed or are in the process of developing Wellhead Protection plans. Within the state, two organizations are actively promoting and assisting public water supplies with the development of local Wellhead Protection plans: the MDEQ and the Mississippi Rural Water Association (MRWA).

Recently, in an effort to assist public water supply systems protect their wells from contamination, the MDEQ has begun to evaluate the additional protection that could be offered through increased monitoring activities, performance requirements, and siting restrictions on regulated facilities or contaminated sites located in Wellhead Protection Areas.

Are Public Water Supply Contamination Events Preventable?

Not all public water supply contamination events are preventable, such as vehicle wrecks and natural disasters; however, a majority of contamination events are preventable. Such contamination events usually are the result of poor management practices, the lack of education concerning ground water quality issues, the absence of needed protective measures, or unlawful activities.

A review of the contamination events affecting the four public water supply systems previously discussed might provide more insight into whether those contamination events could have been avoided through the implementation of an effective local Wellhead Protection plan.

Town of Wesson (hazardous waste generation)

In this case where improper storage and disposal of waste materials occurred on-site, the following management requirements could have significantly reduced the risk of contamination and/or human health risk:

1. Development and use of best management practices for the proper handling and storage of waste materials.

2. Requirement for monitor wells to be positioned between the facility and the town's public water supply wells and sampled regularly.

3. Development and use of an effective educational program focusing on ground water contamination and wellhead protection concerns for the public water supply system.

4. Effective contingency planning in the event contaminants were detected in the system's public water supply wells.

Town of Benton, City of Columbia, Smith's Crossing Water Association (leaking underground storage tanks)

In these cases where leaking underground storage tanks were apparently the source of contamination to public water supply wells, effective management plans could have significantly reduced the risk of contamination and/or human health risk by incorporating the following requirements:

1. Use of double-walled underground storage tanks within a 250 foot radius (Protection Zone 2) of public water supply wells.

2. Increased frequency of monitoring of underground storage tanks within Wellhead Protection Areas.

3. Development and use of an effective educational program focusing on ground water contamination and wellhead protection concerns for each of the public water supply systems.

4. Effective contingency planning in the event contaminants were detected in a system's public water supply wells.

Assessment of the scenarios of the currently threatened public water supply systems previously discussed reveals that management plan protective measures suggested for reducing the contamination risk for the four contaminated systems are also applicable for the threatened systems. In general, the following management requirements can have a significant impact on reducing the risk of contamination of the threatened public water supply wells:

1. Double-walled containment of materials stored in underground storage tanks within a 250 foot radius (Protection Zone 2) of public water supply wells.

2. Additional monitoring wells with more frequent monitoring intervals for potential contaminant source sites which have displayed a propensity for discharging into ground water.

3. Storage of waste fluids in containers and drums on covered, impermeable pads with curbs or berms to prevent accidental releases.

4. Requirement for all above ground storage tanks to meet Spill Prevention, Control, and Countermeasure (SPCC) specifications and submittal of copy of SPCC plan to local public water supply.

5. Development and use of an effective educational program focusing on specific ground water contamination and wellhead protection concerns for each public water supply system.

6. Effective contingency planning in the event contaminants were detected in a system's public water supply well(s) or, if required, ground water monitor well(s).

A review of ground water quality from a well contained in the Ag-Chem database in which pesticide concentrations have continued to exceed the regulatory limit offers evidence of the effect that the role of public education and the use of best management practices can have. An investigation at that site revealed that the contamination was the result of the improper storage of chemicals near the wellhead rather than from general agricultural practices. After clean-up of the area around the well, the contaminant level has gradually declined and is now only slightly above Safe Drinking Water Act standards. Could this contamination event of a domestic well have been prevented? The evidence suggests that if education and proper implementation of best management practices had occurred sooner, the contamination could have been avoided.

Of course, even the best constructed plans can fail, especially when implementation is emphasized less than the planning process. However, certainly a significant reduction in the risk of contamination to a public water supply well will result from proper Wellhead Protection planning.

Cost-Benefit Comparisons

The benefits of avoiding contamination of public water supplies are far greater than the costs of developing and implementing local Wellhead Protection plans. In an effort to evaluate those costs versus benefits, the U.S. Environmental Protection Agency contracted for such a study with the Cadmus Group, which evaluated contamination events in seven public water supplies located in six different states. The results of the study indicated that, on average, dealing with contamination of a ground water supply for drinking water may be 30 to 40 times more costly than to prevent it in the first place and that the ratio of contamination costs to basic prevention costs may be as large as 200:1. The results of the EPA study correlated well with the results of a similar study in the State of Maine by Emery & Garrett Groundwater which concluded that the contamination costs to basic prevention costs ratio ranged from 25 to 45:1 for large public water supply systems. Because of significantly smaller well replacement and treatment facility costs for small public water supply systems, the ratio decreased, ranging from 13 to 15:1.

An assessment of the ratio of contamination costs to basic prevention costs for those public water supply systems in Mississippi which experienced contamination events exceeding regulatory levels yields the following:

COST-BENEFIT COMPARISON FOR CONTAMINATED PUBLIC WATER SUPPLY SYSTEMS IN MISSISSIPPI*

Costs of Contamination	
Assessment:	$120,000
Remediation:	
Soil removal & disposal	$35,000
Ground water remediation	$105,000
Operation & maintenance	$ 90,000
Total	$350,000
Well replacement/facility repair:	$350,000
Basic Wellhead Protection Costs	
Hydrogeological assessment:	NC
Potential contaminant source inventory:	NC
Management plan development:	$10,000
Management plan implementation:	
Costs to public water supply	$4,500
Costs to affected parties	$7,500
Total	$22,000

Costs of Contamination to Basic Wellhead Protection Costs Ratio:

Without well replacement	~16:1
With well replacement	~30:1

* (costs based on gasoline contamination of a shallow well in a system serving less than 10,000 persons)

Costs of contamination were based on actual and projected contracted costs associated with the three public water supply systems which were impacted by leaking underground storage tanks (with contaminant levels exceeding regulatory requirements). In similar cases in other states where gasoline constituents (light non-aqueous phase liquids) are the primary contaminant affecting a system which serves less than 10,000 persons, these costs are considered to be representative. In such a scenario, the costs of contamination to basic wellhead protection costs ratio would be in the 16:1 range. Including well replacement costs for a shallow well and non-extensive facility repair costs increases the cost of contamination to basic wellhead protection costs ratio to over 30:1. In cases where a deep well would need to be replaced, the cost represented above could quadruple, resulting in an increase in the cost of contamination to basic wellhead protection costs ratio 120:1.

Where contamination has occurred with dense non-aqueous phase liquids, such as the Potter site at Wesson, remediation costs could exceed several million dollars, and in such cases the cost of contamination to basic wellhead protection costs ratio could approach or even exceed 200:1.

Conclusion

Residents of Mississipppi who drink ground water (approximately 95 percent) appear to be relatively safe from human health risks caused by the existence of contaminants in ground water. This is based on the low percentage of contaminant detects in public water supply wells which have exceeded regulatory limits.

However, the occurrence of man-made chemicals in ground water is well documented. A total of 39 volatile organic and synthetic chemicals have been found in over 250 domestic, irrigation, and aquaculture wells in low levels. A total of 15 volatile organic chemicals have been found in over 80 public water supply wells, with contaminant levels exceeding regulatory standards in wells in eight public water supply systems. These occurrences do not include toxic inorganics, nitrates,

nitrites, pathogens, radionucliides, that have been detected in low levels in hundreds of public water supply wells.

Five public water supply systems have been impacted to the extent that remediation action, well abandonment, or system abandonment was necessary to address the problem. Additional public water supply systems are threatened by the repeated occurrence of contaminants in their well. Typically, those systems draw their water from wells screened in shallow aquifers located near potential sources of contamination.

All the evidence suggests that it is time to evaluate what we are doing to our drinking water supply and to begin development and implementation of a strategy designed to protect such an essential resource. Wellhead Protection is such a program, specifically designed to significantly reduce the risk of contamination to Mississippi's public water supply wells through the identification and proper management of potential sources of contamination located near public water supply wells.

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