ASSESSMENT OF NONPOINT SOURCE POLLUTION IMPACTS ON GROUNDWATER IN THE HEADWATERS OF THE NORTH FORK OF THE KENTUCKY RIVER BASIN

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EXECUTIVE SUMMARY

ASSESSMENT OF NONPOINT SOURCE POLLUTION IMPACTS ON GROUNDWATER IN THE HEADWATERS OF THE NORTH FORK OF THE KENTUCKY RIVER BASIN

SECTION 319 NONPOINT SOURCE PROJECT - FFY 1998

The goals of this project were to assess nonpoint source (NPS) impacts on groundwater primarily from improper or "straight pipe" sewage disposal and secondarily from coal mining in a portion of the North Fork of the Kentucky River Basin in Letcher County. The Kentucky Geological Survey estimates 70% of the residents use groundwater as the source of drinking water (Carey and Stickney, 2001). The area has well documented problems related to the discharge of untreated domestic waste directly to surface water through "straight pipes", but the impacts to groundwater are less well known.

Most of the soils in Letcher County are unsuitable for conventional on-site septic systems (USDA-SCS, 1965). The area's highly dissected topography concentrates the population in the stream valleys, where close spacing of homes and small lot size makes the use of conventional septic systems impossible or ineffective for most existing homes. Low incomes and high unemployment have limited the use of expensive alternate on-site disposal systems. Because of these factors, wells are vulnerable to NPS pollution, especially if they are poorly constructed or maintained.

To solicit participation in this project, door-to-door surveys were conducted on Crams Creek, Pine Creek, and Bottom Fork roads. Participants' wells or springs were inspected and property was surveyed for potential sources of NPS pollution. Participants were counseled

individually and provided information on water quality, analytical results, well maintenance, and any other pertinent environmental issues.

Eighty-seven wells and springs serving an estimated 350 persons were included in the study: 31 properly constructed drilled wells, 40 drilled wells that did not meet current standards, nine shallow hand-dug wells, and seven water supply springs (including two mine adits.) Field-tests for nitrate-N, nitrite-N, ammonia-N, detergents, phosphate, pH, conductivity, soluble iron and manganese were conducted on all wells and springs and several samples were confirmed by laboratory analysis. Twenty participants opted for additional biological testing for total coliform, *E. Coli* and fecal coliform bacteria. Caffeine (and metabolites) were analyzed on wells and springs with significant bacteria contamination.

Although detections of nitrate-N and ammonia-N indicate NPS impacts, probably from straight pipe discharge of wastes, no pervasive or widespread NPS pollution of groundwater was found in this study. However, groundwater is threatened locally by numerous potential NPS sources. Other important concerns for groundwater users are substandard well and distribution system construction and inadequate system maintenance and disinfection. The project demonstrated that on-site inspection by trained personnel is a viable method to promote the protection and appropriate use of this resource.

Hand-dug wells showed little indication of NPS pollutants such as NO_3^-, NO_2^-, PO_4^-, Fe, Mn, or low pH from septic systems or mining, but bacteria were significantly higher in these wells than in drilled wells. Bacterial contamination is common in hand-dug wells because these wells produce shallow soil water where bacteria flourish and because these wells are inherently difficult or impossible to disinfect and seal.

Eight samples (9%) collected in the study contained detectable quantities of nitrate-N, but none exceeded the nitrate-N Maximum Contaminant Level (MCL) for drinking water of 10.0 mg/L. Fifty percent (50%) of the hand-dug wells compared to only 13% of the properly constructed wells contained nitrate-N. Ammonia-N was detected in 16 of 83 samples, or 19.3%. Anionic surfactants, an indicator of soaps, detergents, and oil and gas drilling foams were indicated by field tests in eight, or 9.2% of wells.

Residents claim that coal mining has impacted groundwater quantity in the area, but water quantity was beyond the scope of this investigation. However, for the limited parameters included in this study, no widespread impacts on water quality from mining were noted.

ASSESSMENT OF NONPOINT SOURCE POLLUTION IMPACTS ON GROUNDWATER IN THE HEADWATERS OF THE NORTH FORK OF THE KENTUCKY RIVER BASIN

SECTION 319 NONPOINT SOURCE PROJECT - FFY 1998

Introduction and Background

The primary goals of this project were to assess nonpoint source impacts on groundwater in a portion of the North Fork of the Kentucky River Basin (Figure 1), and to share that information with local citizens and officials. The area included in the study is generally east of Whitesburg in Letcher County, on Cram Creek, Pine Creek and Bottom Fork roads (Figure 2). Groundwater is especially important in this area because wells and springs are the primary source of domestic drinking water (Kentucky Department for Environmental Protection (DEP) Consolidated Groundwater Database, 2001). In addition, public water lines are not scheduled for installation in the near future (Letcher County officials and the Mountain Association for Community Economic Development (MACED) North Fork Task Force, personal communication, 1999).

The study area lies within the Eastern Kentucky Coal Field physiographic province on the north side of Pine Mountain. The topography consists of steeply incised, narrow valleys, with narrow ridges and elevations range from about 1200 ft. to more than 2000 ft. above sea level. The area is underlain by Pennsylvanian age clastic sedimentary rocks (sandstone, siltstone, shale and clay) with significant coal beds. Regional dip is to the northwest at approximately 120 feet per mile. The Pine Mountain overthrust fault system is the approximate southeast border of the study area. The proximity of this major structural feature makes the geology of the study area complex, characterized by folding, faulting and steep dips. The complex geology combined with the standard bedrock “open hole” well construction that interconnects aquifers made correlating the well samples to a particular geologic unit virtually impossible. In this physiographic province, drilled wells typically produce water from fractured formations, including coal beds, though significant inter-granular porosity is known to occur in some sandstones. Shallow hand-dug wells produce local soil water and springs in this study reportedly produce from the Mississippian-age limestone, except for the two mine adits, which are constructed into Pennsylvanian coals and clastic sedimentary rocks.

Well-documented straight pipes discharge raw sewage to the surface and to surface streams in the study area, and although effects upon surface water quality are well known, the impacts to groundwater are less studied. One to three thousand straight pipes are estimated to exist in Letcher County (MACED, 1999). Since groundwater and surface water are conjunctive, contamination can spread between these systems. Because groundwater provides the base flow for the streams, including the North Fork of the Kentucky River and its headwaters, any groundwater contaminated by straight pipes may contribute to surface water pollution.

Most of the soils in Letcher County are unsuitable for conventional on-site septic systems (USDA-SCS, 1965). In addition, the highly dissected topography of the region tends to concentrate the population in the stream valleys where close spacing of homes and small lot size, combined with poor soils, have made the use of conventional septic systems impossible or ineffective. Low incomes and high unemployment have also hampered the installation of suitable on-site disposal systems for these homes. Because of these factors, groundwater and wells are susceptible to nonpoint source pollution, especially if the wells are improperly constructed and maintained, including periodic disinfection.

Letcher County officials and the Mountain Association for Community Economic Development (MACED) North Fork Task Force (personal communication, 1999) reported the Health Department found more than 90% of the groundwater-based drinking water supplies they tested in Letcher County tested positive for coliform bacteria. However, as shown by O'Dell and O'dell, (1997), their data consist only of total coliform bacteria, which is ubiquitous at the earth's surface and is therefore not a good indicator of NPS pollution. Health department bacteria sampling results throughout the state also are biased because sampling is only conducted in response to complaints. In addition, wells and distribution systems, which are commonly poorly maintained by private system owners, historically have not been disinfected before sampling. Further, Quality Assurance/Quality Control (QA/QC) procedures must be rigidly followed in order to collect and deliver viable bacteria samples. Well and spring samples may be compromised by exceeding holding times, improper sampling, handling, storage, and shipment. A large percentage of positive bacteria results are estimated to be the result of inadequate QA/QC and contaminated distribution systems rather than contaminated groundwater (see Burlingame and O'Donnell, 1994). For these reasons, the Division of Water proposes that much of the historical bacteriological data collected throughout the state is unreliable indicators of groundwater quality.

In order to properly assess true groundwater quality and the potential impact of nonpoint source pollution (and not artifacts of the distribution system), investigators in this study followed strict QA/QC procedures. Distribution systems were inspected to eliminate them as possible sources of contamination, and fresh, untreated groundwater was collected for analysis. In addition to total coliform, E. coli and fecal coliform bacteria, and nutrients were also analyzed.

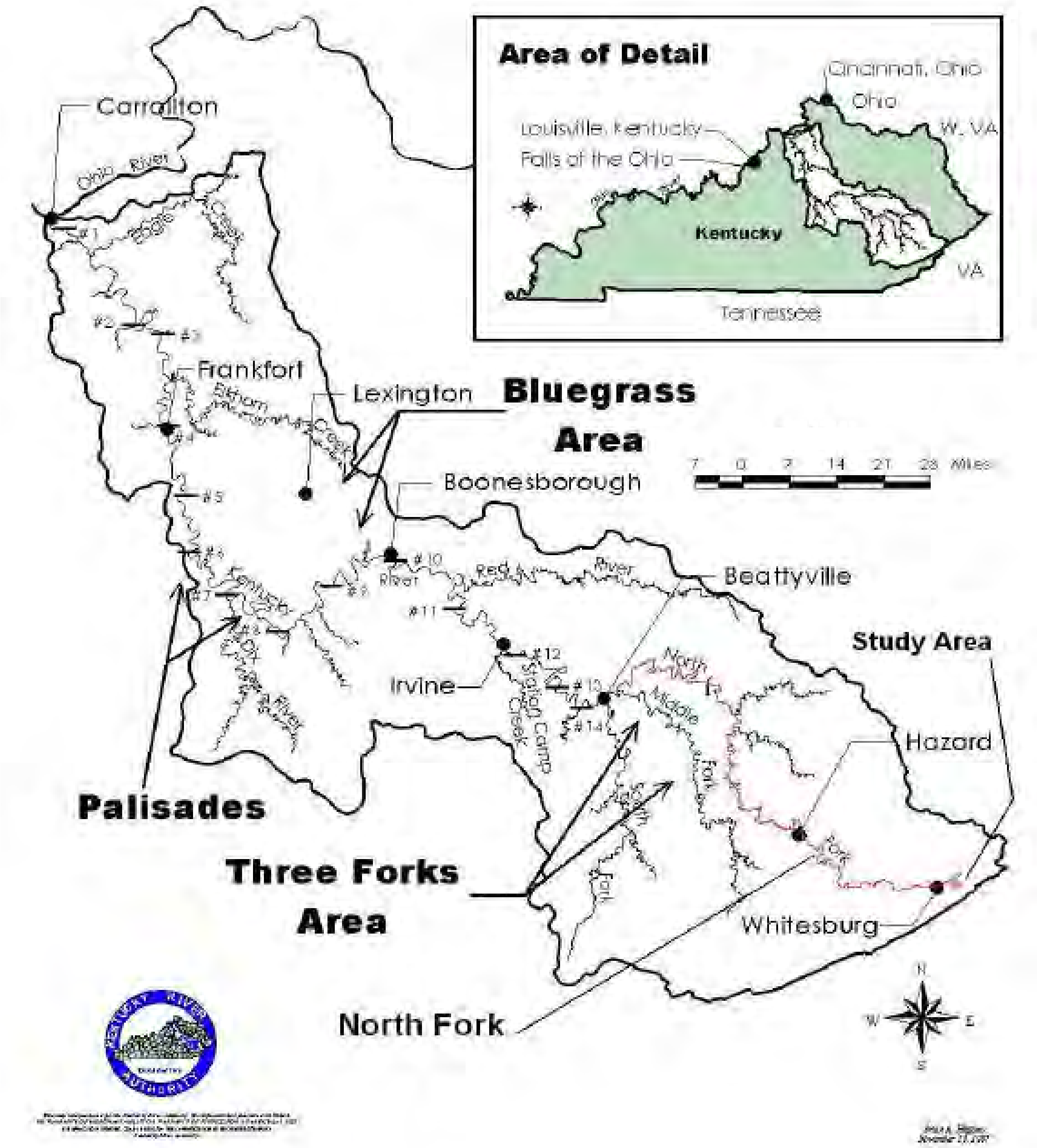


Figure 1. "Kentucky River Basin Map",
Modified from Brian A. Higgins, 1997, Kentucky River Authority

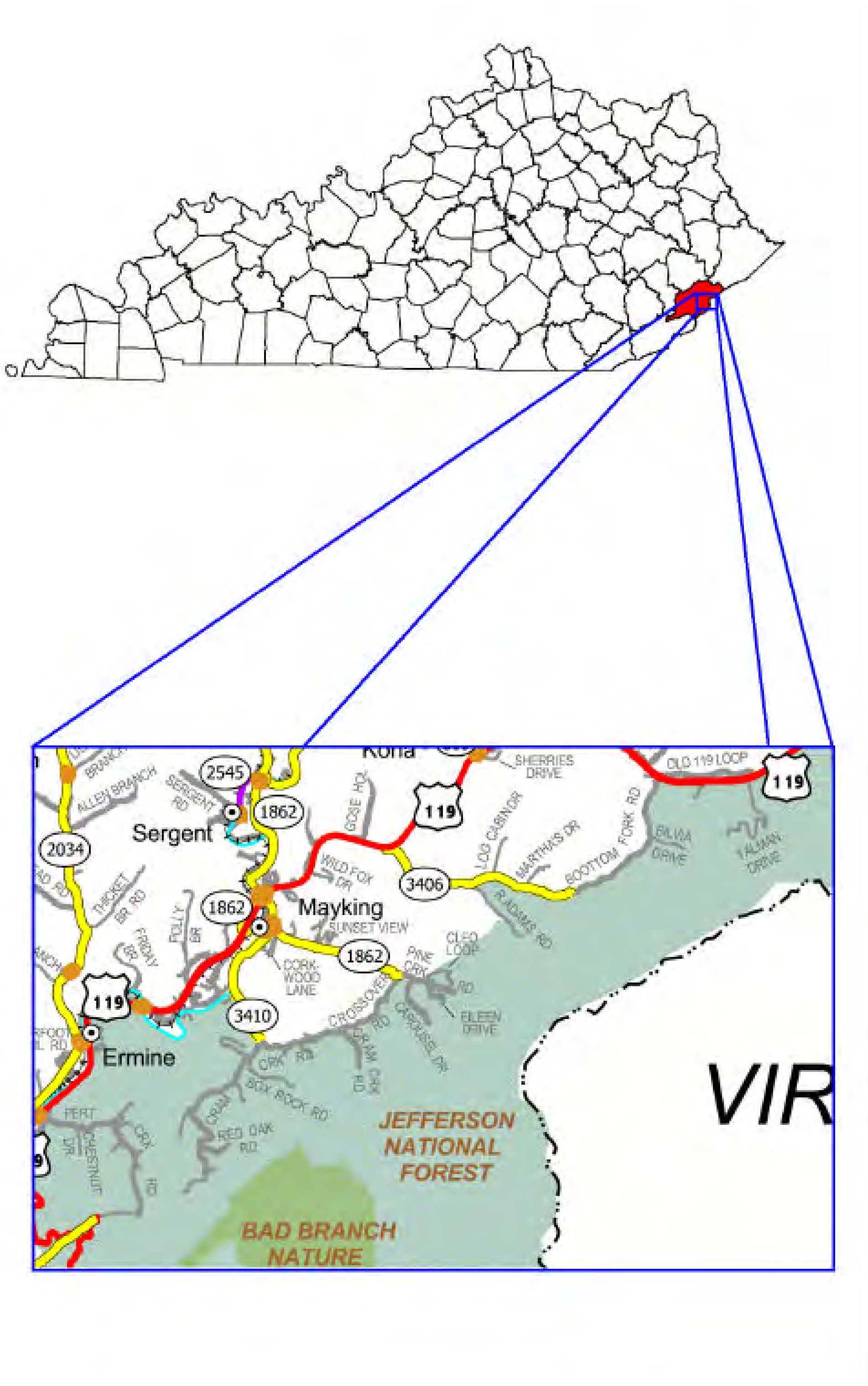


Figure 2. Location Map for the Letcher County Study Area.

Modified from: Kentucky Transportation Cabinet, 1999 and 2004, General Highway Maps, LETCHER COUNTY, Kentucky, Department of Highways, Division of Planning.

Field personnel inspected and sampled wells and springs (including water discharged through mine adits) used for domestic water supplies and evaluated each site for potential nonpoint source pollution sources. Informal interviews were conducted with well owners during these inspections and on-site conditions were used to educate participants about nonpoint source pollution, best management practices, and corrective measures.

As a minor part of this project, historical and current coal mining were also considered as potential sources of nonpoint source pollution (Puente et al., 1981). Two-thirds of Letcher County is owned by coal interests (MACED, 1999), and mining can have profound effects on groundwater quality and quantity. Parameters that may indicate impacts from mining include iron, manganese, pH, and sulfates.

Previous Investigations

Groundwater in Letcher County has been investigated by several researchers, including Mull (1965), Price et al. (1962 and 1962a), Carey et al. (1993 and 1994), and Carey and Stickney (2001). Mull (1965) inventoried 184 wells and springs (and sampled 125) used for drinking water in his “Ground-Water Resources of the Jenkins-Whitesburg Area, Kentucky”. In this study, nitrate-N, one indicator of sewage contamination occurred above the Maximum Contamination Level (MCL) of 10.0 mg/L in eight hand-dug wells. Conrad et al.(1999), looked at nitrate and nitrite in ground water statewide and Conrad et al. (1999b), looked at fluoride statewide. In two publications, Price et al. (1962, 1962a), Hopkins (1966), Kirkpatrick et al. (1963), Minns (1993), Currens (2001) and Kipp and Dinger, (1987) all present generalized geology and groundwater information for Letcher County. Carey et al. (1993, 1994) analyzed data from the statewide Kentucky Farm Bureau Ground Water Education and Testing program, including 65 sites in Letcher County. This program sampled only a limited number of constituents, including ammonia, nitrate-N, nitrite-N, chloride, sulfate, and conductivity. Ten percent of the samples statewide were also analyzed for alachlor and triazine pesticides, but none in Letcher County. This study found the Letcher County averages for ammonia, chloride, and sulfate were above the statewide averages for the same constituents. They also found the average concentrations for nitrate and nitrite in Letcher County to be below the statewide averages for these constituents.

The inherent sensitivity of groundwater to contamination has been discussed by Ray and O'dell (1993). They based their assessment on recharge, flow and dispersion, and then used this system to map groundwater sensitivity throughout the state (Ray et al. 1994). In this system, the quicker the recharge, the faster the flow and the lesser the dispersion, then the higher the sensitivity. They used a ordinal scale from 1 to 5, with low values being the least sensitive. Letcher County, including most of the study area, is underlain primarily by Pennsylvanian-age rocks, which rate a "3", or medium sensitivity. The geology of the study area is presented on 7.5-minute geologic quadrangle maps by Rice and Wolcott (1973) (Whitesburg and Flat Gap combined), and Rice (1973, 1976).

Surface water in Letcher County is discussed by Kirkpatrick et al (1963), Dyer (1983), Carey (1992), Blackburn (1998), and Carey and Morris (1996). These investigators document impacts from straight pipe discharges and coal mining, including elevated bacteria, sediment, dissolved solids, and sulfate, as well as lowered pH from acid mine drainage. Dyer (1983) concluded that increased sediment was the physical parameter primarily responsible for surface water degradation, but also concludes: "Essentially all the adverse effects of coal mining on downstream water chemistry relate either directly or indirectly to acid mine drainage produced by the oxidation of iron di-sulfides."

Materials and Methods

The Groundwater Branch, Division of Water , managed this project and provided staffing, equipment and supplies. The Water Quality Branch, Division of Water, advised on sampling techniques and conducted bacteriological analysis, and laboratory tests were conducted by the Division of Environmental Services . Additional assistance was provided by the MACED North Fork Clean Water 319 project, KRA (1997), the Letcher County Fiscal Court, and the Letcher County Water and Sewer District, all of whom will receive copies of the data.

The study area was selected because of the predominant use of private wells and springs, the occurrence of numerous straight pipes discharging un-treated sewage to surface streams, and because the area is not under consideration for the installation of public water lines. Several potential study areas in the county were rejected because of recently completed or current studies by other agencies, such as Abandoned Mine Lands, Office of Surface Mining, and the Department for Surface Mining, Reclamation and Enforcement. The study included Pine Creek, Cram Creek, Bottom Fork and adjacent minor roads, shown on the Whitesburg, Flat Gap, Jenkins West and Mayking USGS 7.5-minute topographic quadrangle maps.

Interviews, inspections, and sampling were conducted by an experienced hydrogeologist, sometimes with an assistant. Personnel canvassed the area door-to-door soliciting volunteers to participate in the study. Figure 3 illustrates the distribution of participants and type of domestic water supply used by the participants.

Interviews and inspections were conducted informally to educate participants about nonpoint source pollution and potential methods to address any problems that might have been noted. Field personnel adopted a “non-regulatory” posture during these interviews and did not issue citations for violations, but only pointed out problems and the appropriate remedial measures. For an investigation of this type, the consensus was that by using non-confrontational tactics, citizens were much more likely to participate.

Division of Water personnel inspected and sampled 80 wells and 7 springs for this study. These 87 domestic water supplies serve an estimated 350 persons. Thirty-one wells appeared to meet current water well construction standards. Forty wells did not meet current standards: 31 wells had buried wellheads, a once common well completion practice that is not allowed by current regulation; nine wells did not meet standards for other reasons, such as pit construction, casing not extending above ground level, improper seal, or the lack of a well cap. Nine wells were shallow, hand-dug wells. In addition, nine bacteria samples were collected from two streams in the study area.

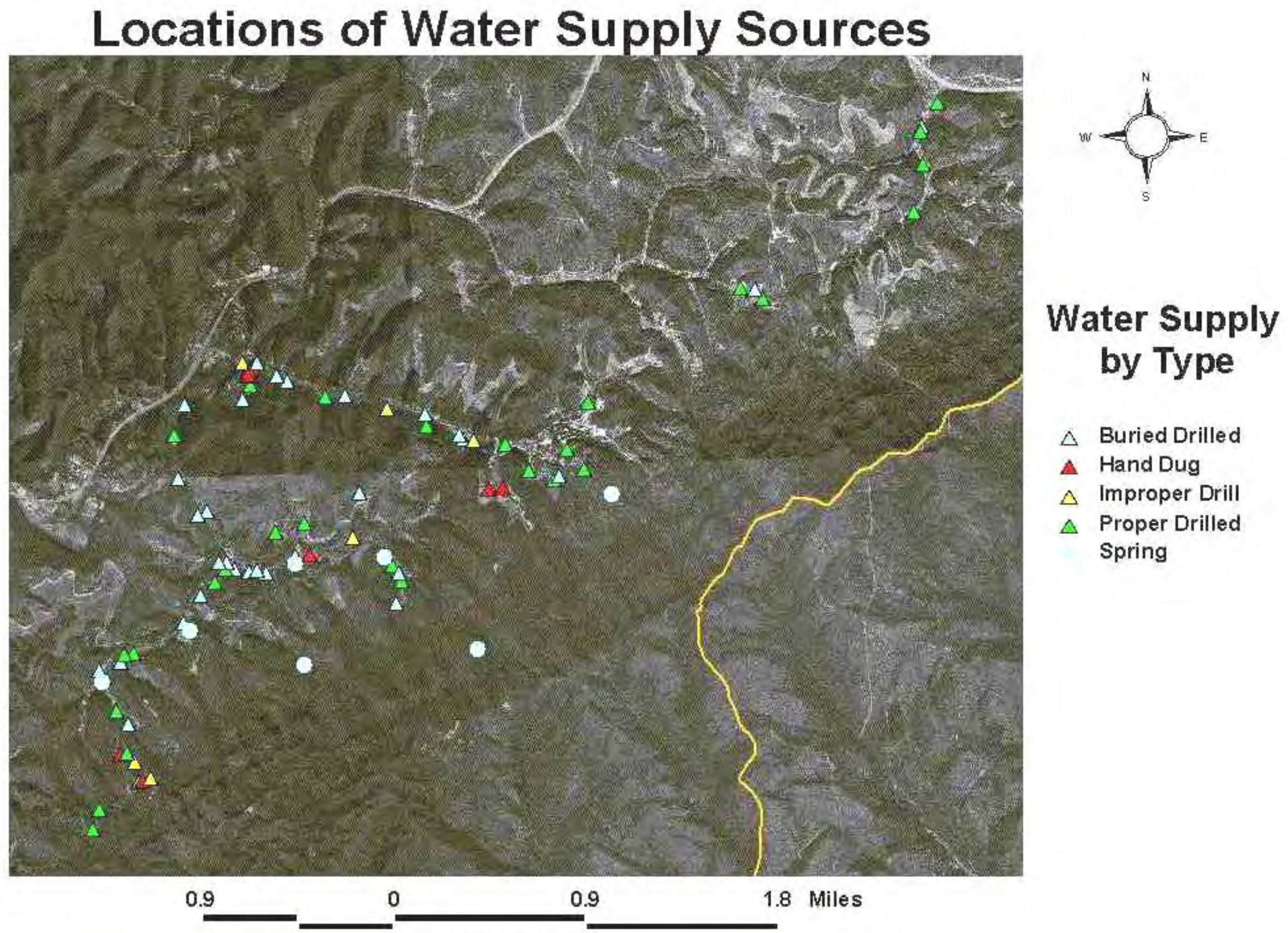


Figure 3. Locations of water supply sources used in this study

The seven springs included water discharged through mine adits, two of which provide sufficient water to supply several households. Three households piped limestone spring water more than 1000 feet to their homes. Several homes along a side spur of Pine Creek Rd. reported that they obtained their water from the adjacent surface stream. Field personnel did not collect water samples from this stream reach.

The Division of Water provided participants with material (Appendix C) on nonpoint source pollution, water wells and other topics (if applicable). These materials included: Generic Groundwater Protection Plans (GPP) for Domestic Well Owners and Residential Septic Systems; various literature regarding nonpoint source pollution and well maintenance; a completed inspection form for their well or spring; a nonpoint source inventory for their property; field screening test results; and, if applicable, information on pesticides, erosion control, on-site disposal systems, and solid waste management and disposal.

In addition to well and spring inspections, distribution systems at each site were also inspected. This helped determine proper sampling points to ensure that samples were representative of groundwater, and not distribution system artifacts. The on-site screening test (CHEMetrics, 2000) included nitrate-N, nitrite-N, ammonia-N, detergents (ionic surfactants), iron, manganese, and phosphate. Copies of the *Field Analytical Data Screening* and *Field Inspection Check Off Sheets* are in Appendix C.

On-site screening is quick and cost-effective and allowed the inspectors to integrate the results into the inspection and interview. Field results of one half or more of the drinking water Maximum Contaminant Level (MCL) were verified by laboratory analysis. Field measurements included temperature, pH, and conductivity using handheld meters calibrated according to the manufacturer's specifications and Division of Water Standard Operating Procedures (2003).

Late in the study, personnel performed pre- and post-treatment analyses for soluble iron and manganese at a few residences. The testing of treated and untreated samples in the field examined the effectiveness of these domestic treatment systems at removing iron and manganese. This pre and post treatment testing showed the water quality at the tap is often much different from the raw water quality at the well.

After the initial interview and sampling, the project manager sent postcards (Appendix C) offering each participant a bacteriological evaluation of their water, and 22 well and spring owners accepted. This sampling included total, fecal, and *E-coli* bacteria tests. Samples were also collected for caffeine (and metabolites). Caffeine samples were analyzed only for those sites detecting high levels of bacteria.

Bacteria samples were collected at 20 wells, one spring and nine stream sites from September 10-12, 2001. In order to meet the six-hour holding time for bacteria, samples were analyzed at the Division of Water's Hazard regional office, which is only 25 miles from the study area.

The hydrogeologist made field observations to determine the potential for various nonpoint source pollution at each well or spring. Since well and plumbing system artifacts can sometimes produce nonpoint source indicators, a thorough well and plumbing system inspection was made to eliminate any potential problems. Improper well and plumbing system maintenance can result in water quality problems at the tap even thought the groundwater quality is just fine.

Each participant received copies of the *Field Analytical Data Screening* and *Field Inspection Check Off Sheets*. The hydrogeologist discussed the field analytical results with each owner, including potential causes, concerns, and suggested corrective actions for any problems discovered during the inspection.

Sample Methods

Field tests manufactured by CHEMetrics and EMD Inc. were used in this study. These tests employ colorimetric comparison to determine concentration levels, and are summarized in Table 1. Samples collected for laboratory confirmation were analyzed according to departmental and USGS protocols, USGS (1983, 1984), Claassen (1982). Conductivity, pH and temperature were collected with field meters calibrated and operated according to the manufacturer's recommendations.

Bacteria were analyzed using Colilert® and Quanti-Tray/2000® systems. Some samples collected during bacteria sampling were also analyzed for caffeine and its metabolites, 1,7 - dimethylxanthine, 7 - methylxanthine, and 1- methylxanthine. Because of limited laboratory capacity, only 16 samples (six wells, one spring and nine surface water) from sites with the most significant bacterial contamination were analyzed for caffeine and its metabolites.

Parameter	Test Method	Test Range	Minimum Detection Limit MDL	Web Link to more details
Nitrate – N	Colorimetric method from CHEMetrics (VACUettes® Cadmium Reduction/Azo Dye Formation Method)	0 – 25 mg/L (low) 25 – 125 mg/L (high)	2.5 mg/L	http://www.chemetrics.com/Products/Nitrate.htm
Nitrite – N	Colorimetric method from CHEMetrics (VACUettes® Azo Dye Formation Method)	0 – 10 mg/L (low) 10 – 50 mg/L (high)	1.25 mg/L	http://www.chemetrics.com/Products/Nitrite.htm
Ammonia – N	Colorimetric method from CHEMetrics (CHEMet® Nesslerization Method)	0 – 1 mg/L (low) 1 – 10 mg/L (high)	0.05 mg/L	http://www.chemetrics.com/Products/Ammonia.htm
Phosphate – PO4 (Ortho – reactive)	Colorimetric method from CHEMetrics (CHEMet® Molybdenum Blue/Stannous Chloride Method)	0 – 1 mg/L (low) 1 – 10 mg/L (high)	1.25 mg/L	http://www.chemetrics.com/Products/Phosphat.htm
Detergents-Anionic Surfactants	Colorimetric method from CHEMetrics (Methylene Blue Active Substances (Mbas) Method)	0 – 3 mg/L	0.125 mg/L	http://www.chemetrics.com/Products/Deterg.htm
Soluble Iron	Colorimetric method from CHEMetrics (CHEMet® 1, 10 Phenanthroline Method)	0 – 1 mg/L (low) 1 – 10 mg/L (high)	0.05 mg/L	http://www.chemetrics.com/Products/IronTS.htm
Soluble Manganese	Colorimetric method from CHEMetrics (CHEMet® Periodate Method)	0 – 2 mg/L	0.15 mg/L	http://www.chemetrics.com/Products/Mangan.htm
Nitrate – NO_3^-	Colorimetric Test Strip method from EMD, Inc.	0-500 mg/L	10 mg/L	http://www.emdchemicals.com/analytics/literature/displaylit.asp?location=ar&litfile=311021_Nitrate_Test.htm
Nitrite – NO_2^-	Colorimetric Test Strip method from EMD, Inc.	0-80 mg/L	2 mg/L	http://www.emdchemicals.com/analytics/literature/displaylit.asp?location=ar&litfile=311023_Nitrite_Test_2.htm

Table 1. Field analytical methods, test ranges, Minimum Detection Limits and links.

Quality Assurance/Quality Control (QA/QC)

QA/QC plans (Appendix B) were approved by the Division of Water and the Nonpoint Source Section prior to any fieldwork, and all activities conducted were consistent with these plans.

Field test results equal to or above one-half the primary drinking water standard were confirmed via laboratory analysis by the Division of Environmental Services. Additional laboratory samples were collected from at least one well for each sampling event. Confirmatory sample testing at the laboratory was sometimes modified, dependent upon the availability of the lab, but usually included: Chloride, fluoride; nitrate-N; nitrite-N; sulfate, ortho-P; alkalinity; conductivity; pH; total suspended solids (TSS); total dissolved solids (TDS); ammonia-N; total kjeldahl nitrogen (TKN or NH_3 plus organic bound–N); total organic carbon (TOC); total phosphorus; and total metals by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometer methodology. A standard DOW Groundwater Branch chain-of-custody form (Appendix C) accompanied each sample.

Results and Discussion

Tabulated results for all field and laboratory tests can be found in Appendix D. Kentucky lacks groundwater quality standards and water quality for private systems is not regulated. Therefore, most of the raw water quality parameters collected for this study are compared to the limits established by the USEPA for public water systems supplying drinking water to the public. For parameters with no established USEPA limits, other standards, as noted in Table 2, were applied.

Table 2. Parameters and Standards

Parameter	***Standard***	***Source/Discussion***
Nitrate-N	10.0 mg/L	MCL
Nitrite-N	1.0 mg/L	MCL
Ammonia-N	0.110 mg/L	DEP
Iron	0.3 mg/L	SMCL
Manganese	0.05 mg/L	SMCL
Conductivity	800 µmho	No MCL, SMCL or HA; this corresponds to about the SMCL of 500 mg/L TDS
PH	6.5 to 8.5 S. U.	SMCL
Ortho-P	0.04 mg/L	No MCL, SMCL or HA; Texas surface water standard
Detergents-Anionic Surfactants	None	No natural sources
Caffeine/metabolites	None	No natural sources
Bacteria	Zero*	*Explained in text below

The USEPA (2004) defines three types of drinking water standards: Maximum Contaminant Levels, Secondary Drinking Water Regulations and Health Advisories. These, and other related terms, are defined below.

Maximum Contaminant Level (MCL) is "the highest level of a contaminant that is allowed in drinking water." MCLs are legally enforceable limits applied to "finished" public drinking water based on various risk levels, ability to treat and other cost considerations. MCL standards are health-based and are derived from calculations based on adult lifetime exposure, with drinking water as the only pathway of concern. These standards are also based upon other considerations, including the efficacy and cost of treatment. In addition, some parameters have a **Maximum Contaminant Level Goal (MCLG)** which is “A non-enforceable health goal which is set a level at which no known or anticipated adverse effect on the health of persons occurs and which allows a margin of safety.”

Secondary Drinking Water Regulations (SDWR) are defined as ". . . non-enforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor, or color) of drinking water." In common usage, this is often referred to as **S**econdary **M**aximum **C**ontaminant **L**evel (**SMCL**) and this usage has been adopted for this report.

Health Advisory (HA) is ". . . an estimate of acceptable drinking water levels for a chemical substance based on health effects information; a Health Advisory is not a legally enforceable Federal standard, but serves as technical guidance to assist Federal, state and local officials." Again, reflecting common usage, this term has been modified slightly and is referred to in this document as the **H**ealth **A**dvisory **L**evel (**HAL**).

Treatment Technique (TT) is "A required process intended to reduce the level of a contaminant in drinking water." Public water systems are required to control the corrosiveness of their water, and if more than 10% of tap water samples exceed the **Action Level (AL)**, then water systems must take additional action.

Nitrate/Nitrite

The nitrogen cycle is one of the most important nutrient cycles found in nature. In addition to its natural occurrence, nitrate and nitrite also occur from several anthropogenic sources, including sewage, fertilizers, explosives and the combustion of fossil fuels, which releases these compounds into the atmosphere where they become a component of "acid rain".

Nitrate is very soluble and can percolate downward to the groundwater, where it can become a health concern at elevated levels. According to the USEPA (1999a), exposure to nitrate in young children can interfere with the oxygen carrying capacity of the blood in a condition referred to as “Blue Baby Syndrome” or methemogoblinemia. Therefore, the USEPA established an MCL of 10 mg/L for nitrate-N and 1 mg/L for nitrite-N to prevent this condition. At present, there is inadequate evidence to determine whether lifetime exposure to high levels of nitrates or nitrites have the potential to cause cancer. However, chronic exposure to high levels of nitrate/nitrite is known to cause diuresis, increased starchy deposits and hemorrhaging of the spleen in some people (USEPA, 1999a.)

Three separate domestic water supplies contained nitrate above the MDL, but no domestic water supplies contained nitrate concentrations near the MCL of 10 mg/L. No trends or obvious sources of the nitrate were found during the review of the data. It is unclear whether the low nitrate concentrations are natural or the result of NPS pollution.

Nitrite was detected above its MCL of 1.0 mg/L in one hand-dug well. Attempts to re-sample this well for laboratory verification were unsuccessful.

Well water with high iron levels has a coloration that can mimic the color of low level detections of nitrate and nitrite, this resulted in nitrate/nitrite levels being recorded when it was not present. This problem with the colorimetric test produced a poor correlation with the lab verification samples. The nitrate/nitrite test strips did not produce false positives in iron rich water.   The test strips seem to be an inexpensive and adequately accurate field-screening tool for determining the presence of potential nonpoint source pollution. The speed and ease of use of the test strips allows field personnel to conduct targeted biased sampling, track contamination to a source, and make decisions in the field without waiting for the lab analyses. The strips are inexpensive and therefore can help minimize costly laboratory analysis. As result of this study, DEP emergency response personnel used the nitrate/nitrite test strips to monitor and track the source of a fertilizer spill.

Ammonia

Ammonia (NH_3) occurs naturally in the environment, primarily from the decay of plants and animal waste. The principal sources of ammonia in groundwater are ammonia-based fertilizers and human and animal waste. No drinking water standards exist for ammonia; however, the proposed DEP risk-based limit for groundwater is 0.110 mg/L.

Ammonia was detected in 16 of 83 sites (19.3%) sampled, and values ranged from 0.5 mg/L to 6.0 mg/L. The highest value was found in a well meeting current construction standards. Ammonia was not detected in any of the springs included in the study.

Because agricultural application and confined-feeding operations are not potential sources of ammonia within the study area, the interpretation is that failing septic systems or straight pipe disposal of human waste is responsible for the locally elevated levels of ammonia seen in this study.

Phosphate

Phosphate (PO_4^{-3}) is naturally occurring in soils and in some rocks of Kentucky, but is not prevalent in the soils and rocks of the project area. Elevated levels of phosphate can be indicative of contamination from sewage or the over-application of fertilizer.

Phosphate occurs in three different forms in the environment: organophosphates are found in some pesticides and in living organisms, both plants and animals; polyphosphates are common in detergents; and orthophosphate is a common constituent of sewage (The Fertilizer Institute, 2002). In water, these three different forms of phosphate break down over time to form orthophosphate, and the Chemetrics field test kit for phosphate measures this form. No drinking water standards exist for phosphate or orthophosphate, but USEPA (1999b, 2000) studies indicate that eutrophication in surface streams can be controlled by limiting maximum total phosphorus concentrations to 0.1 mg/L.

Surface water requires some phosphate to stimulate the growth of plankton and aquatic plants that provide food for fish. However, excess phosphate contributes to eutrophication or over-fertilization, a situation in which algae and other aquatic plants grow rapidly, choking waterways and reducing oxygen levels which in turn kills aquatic life (Univ. of Georgia, 2002).

Orthophosphate was found in only 5.7% of the samples, and detections ranged from 2.5 mg/L to 5.0 mg/L PO_4^{3-}, using a MDL of 2.5 mg/L, which is well above the levels at which surface waters could be impaired. Because of this relatively high detection level compared to the low levels that can influence groundwater quality, no conclusions regarding the possible impact of phosphate on groundwater in the project area can be made.

Detergents-Anionic Surfactants

Detergents-Anionic surfactants are a good indicator of domestic wastewater contamination since they are components of household detergents and soaps. Surfactants are also found in some pesticides and in products used in well drilling (particularly in oil and gas wells) to facilitate removal of cuttings.

Four samples (4.6%), all from drilled wells deeper than sixty feet, detected anionic surfactants above the MDL of 0.125 mg/L. The exact sources for these detections are unknown, but they may come from oil and gas drilling or infiltration from polluted the surface streams. No correlations could be made to other parameters included in this study. Nonpoint source pollution impacts from detergents appear to be minimal at this time.

Logistics and holding times prevented lab verification, and therefore the effectiveness of these field tests was not determined.

Soluble Metals

The Pennsylvanian-age rocks of eastern Kentucky contain enough iron locally to have supported historical iron mining. These rocks also contain significant quantities of manganese. Chemical and biological reactions, in particular the growth of iron bacteria, in aquifers can release iron and manganese into groundwater. Iron concentrations above 1.0 mg/L and manganese 0.1 mg/L can impart a foul taste to water and cause staining of laundry and porcelain fixtures. Routine well disinfection through chlorination can inhibit the development of iron-related bacteria and minimize the gradual increase of iron and/or manganese in the water. Iron and manganese have SMCLs of 0.3 mg/L and 0.05 mg/L, respectively.

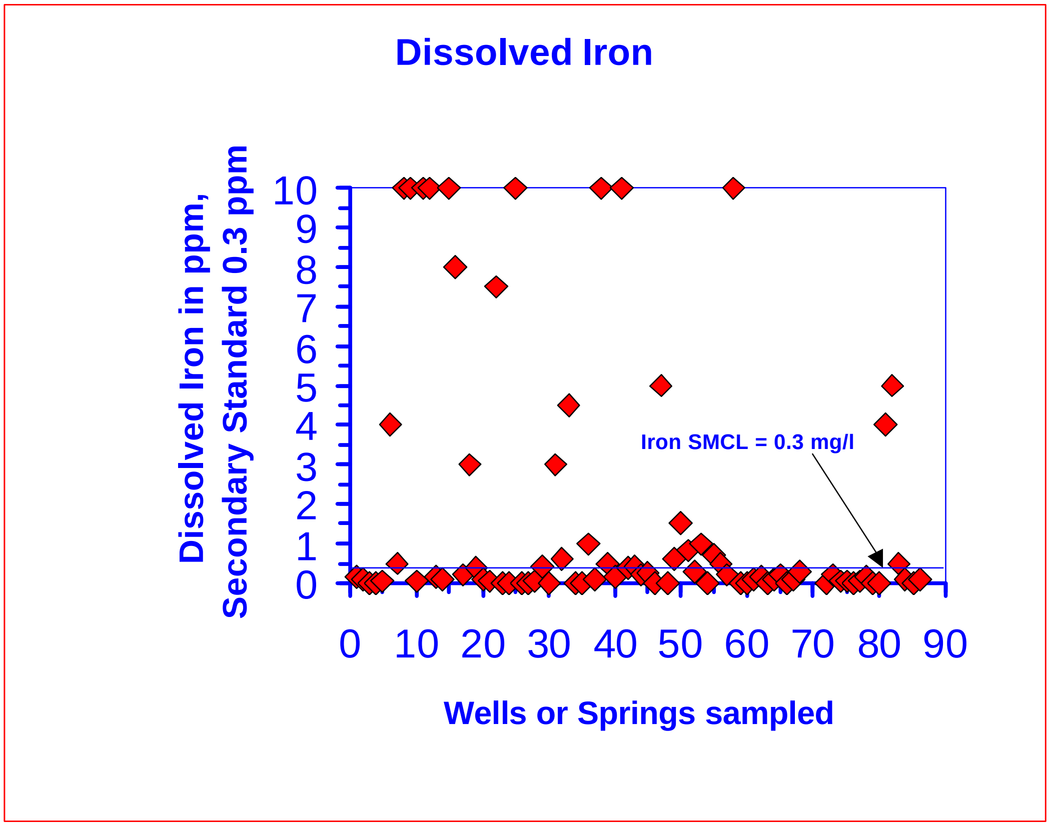
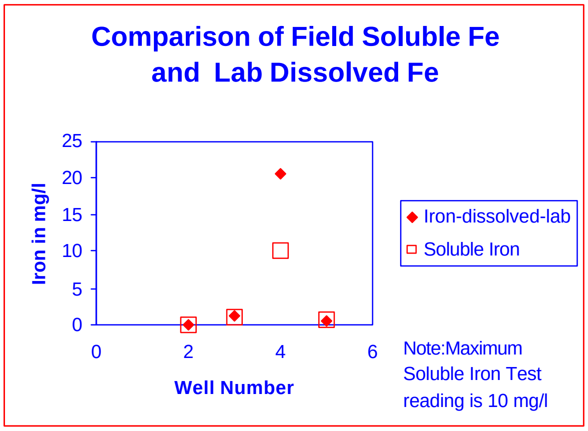


Figure 4. Iron Results from the Complete Study.

Note: field test only measured to 10 ppm (mg/L), so results of 10 ppm indicate 10 ppm or above.

Iron (Figure 4) was detected at or above its SMCL in 33 of 81 samples (40.7%). Wells with buried wellheads were most likely to have high levels of iron, with 17 of 28 meeting or exceeding the SMCL of 0.03 mg/L. Iron was not detected above SMCL in any spring. Field personnel noted iron and manganese removal is the primary purpose of all the domestic treatment systems observed.

Iron concentrations were plotted against depth (Figure 6) to see if there were any significant correlation. Most high iron concentrations occur in wells between 50 and 150 feet in depth, which is consistent with observations reported by drillers in eastern Kentucky who commonly observe that the first bedrock aquifer usually has the highest iron. Shallow soil water wells and wells cased down to a deeper aquifer are generally much lower in iron.



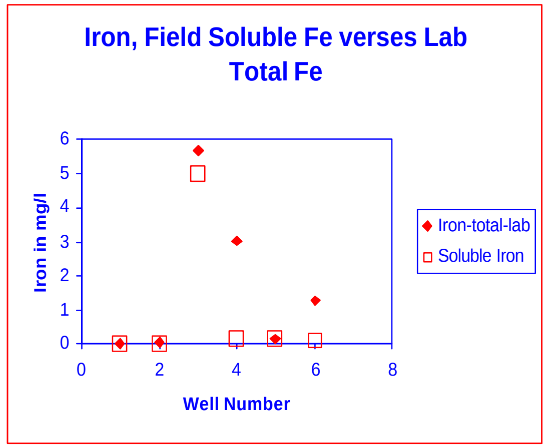


Figure 5. Iron Field Results vs. Laboratory Results

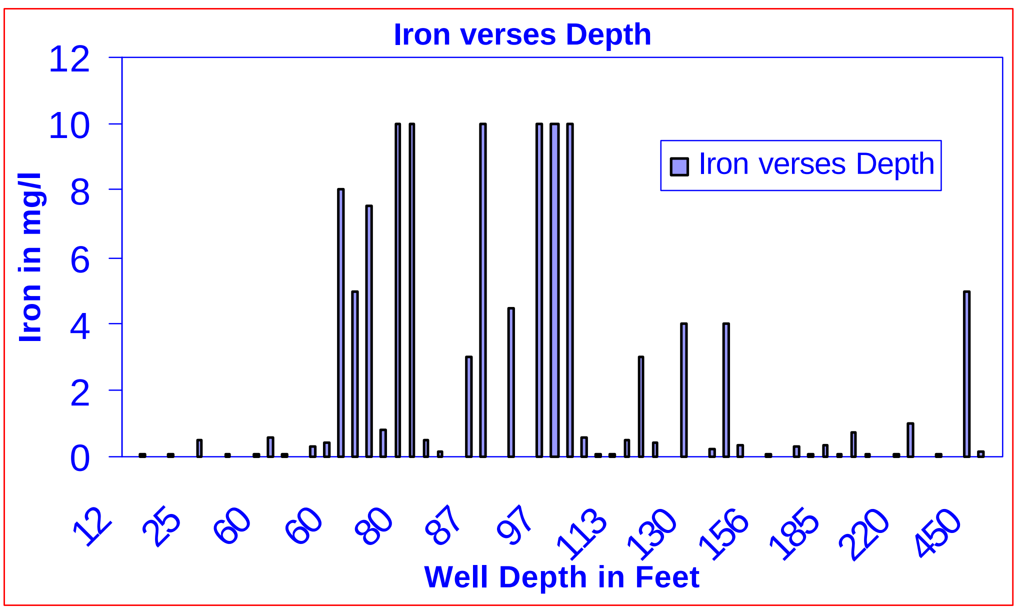


Figure 6. Iron Levels verses Well Depths

The MDL of 0.15 mg/L for the manganese field test, which is three times more than the SMCL of 0.05 mg/L, limits the usefulness of this test for drinking water. The reddish comparison color for this test is easily confused with oxidized iron in the water, which tends to mask low-level readings. Because of these factors, this test is more suitable for industrial discharge testing than evaluation of drinking water supplies. Seven wells and one spring had manganese concentrations at or above the MDL for this method. One well had manganese at 12.2 mg/L (244 times higher than the SMCL) before treatment. Field staff evaluated the effectiveness of domestic treatment systems for manganese and iron removal at a few homes by testing before and after treatment (Figure 7).

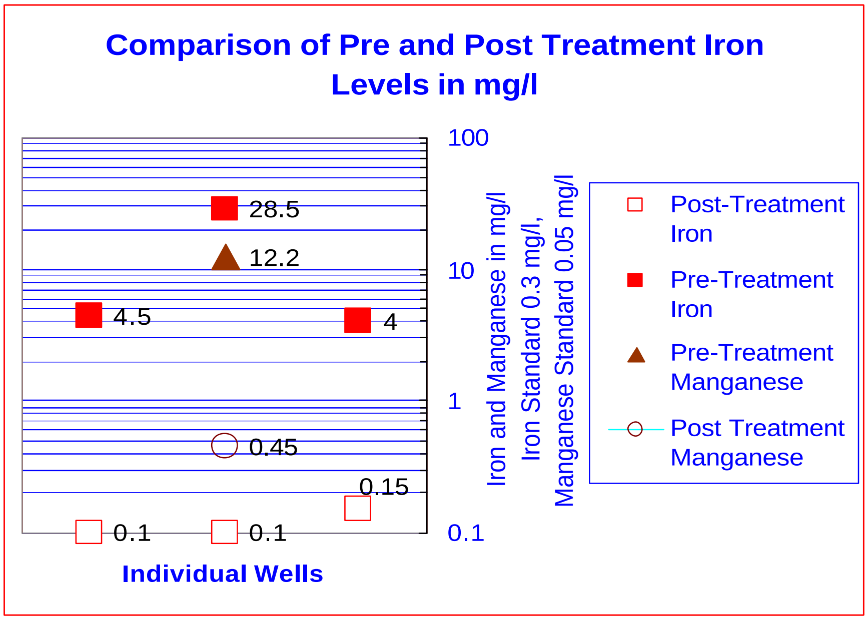


Figure 7. Pre and Post Treatment for Iron and Manganese

Conductivity

Conductivity measures water's ability to transmit an electrical current. The standard units for conductivity are microsiemens per centimeter, or mS/cm. Conductivity measures a property of water, rather than a quantity and is an indirect measurement of the amount of dissolved material in water. In general, a conductivity reading of 800 mS/cm is approximately equal to the SMCL for Total Dissolved Solids (TDS) of 500 mg/L.

Water with very low or very high conductivity can be corrosive and aggressive. Low conductivity water is a very good solvent and can dissolve metals from the plumbing. High conductivity water is often times high in salts that can be corrosive to metals. In either case, corrosion can leach lead and other heavy metals into water used for consumption. Formations with highly soluble aquifer matrices and long residence times (as found in deeper formations) generally have higher conductivity waters.

Conductivity ranged from 57.4 (mS/cm) to 2400 mS/cm with an average of 468 mS/cm. The lowest conductivities were generally at higher elevations on Pine Mountain in shallow wells. The highest conductivity was found in deeper drilled wells near the North Fork of the Kentucky River. Salty groundwater is known to occur at shallow depths in valley wells in eastern Kentucky and most likely represent naturally occurring brines. Both well owners with conductivity readings around 2000 mS/cm reported their water tasted "salty".

pH

pH is the negative log of the concentration of the hydronium ion and is essentially a measure of the relative acidity or alkalinity of water. The units of pH are dimension less, “Standard Units” or “SU”, and the scale measures from 0 to 14. In this system, 7 represents neutral pH and values less than 7 are more acidic; values greater than 7 are more alkaline. The relative acidity/alkalinity of water is important in regard to water quality because this affects the corrosiveness of the water and its ability to dissolve contaminants such as heavy metals, in particular lead and copper, and also because pH affects the taste of the water.

The pH range of normal aquatic systems is between 6.5 and 8.0. Low pH levels can indicate nonpoint source impacts from coal mining or other mineral extraction processes. High pH values for groundwater may indicate nonpoint source impacts to groundwater from brine intrusion from current or former oil and gas exploration and development activities. pH has an SMCL range of 6.5 to 8.5 S.U.

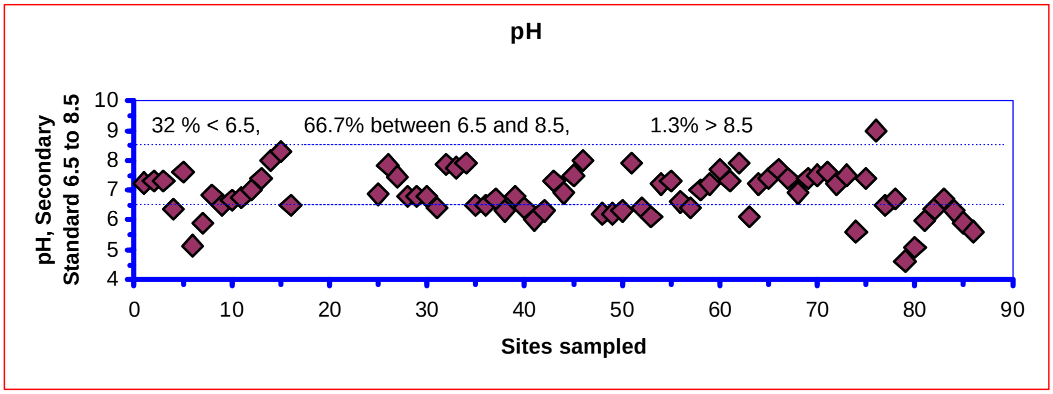


Figure 8. pH data.

In this study, 66.3% of the samples were within the SMCL range of 6.5 to 8.5. Approximately one-third of the wells were below 6.5; only one well exceeded the standard range.

Bacteria

Three types of bacterial analyses were conducted for this study: total coliform, fecal coliform and *Escherichi coli*, abbreviated *E. coli.*

"Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. They aid in the digestion of food. A specific subgroup of this collection is the fecal coliform bacteria, the most common member being *Escherichia coli*. These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals" (RAMP, 1986).

Bacteria are ubiquitous in soils and in the environment in general, Cullimore, (1993 and 1996). Public water supplies use total coliform bacteria analysis as an inexpensive and simple test to determine if the amount of disinfectant used is sufficient. Total coliform bacteria are a surrogate parameter and the assumption is that if total coliform bacteria are not present, then more harmful bacteria, pathogens and viruses are also not present. County health departments commonly use this test to evaluate domestic water well quality. Because they are ubiquitous, total coliform bacteria alone are not a fail-safe indicator of nonpoint source contamination. However, the presence of fecal or E. coli bacteria are reliable indicators of contamination from human or animal waste, which is a health risk through either ingestion or contact. Because E. coli tend to die quickly and do not multiply in groundwater, their detection indicates a direct connection to a contaminated source or possibly a sampling problem.

Publicly supplied drinking water has an MCLG of zero for total coliforms and the standard states further that "No more than 5.0% samples total coliform-positive in a month. Every sample that has total coliforms must be analyzed for fecal coliforms; no fecal coliforms are allowed." Because many participants in this study use their wells or springs only for bathing, contaminated water is also a concern because contact through the eyes, ears, nose, throat and cuts provides pathways for bacteria to enter the body. Kentucky's primary surface water standards for full body contact recreation, or swimming, provide appropriate values to compare contact through bathing. This standard is not more than 200 colonies/100 ml for fecal coliform and not more than 130 colonies/100 ml for *E. coli*.

Because of the short holding time for bacteria of six hours, samples had to be collected during the day when home-owners were not at home. Unfortunately, this lack of access to more suitable sampling sites resulted in the collection of many samples from outside, freeze proof hydrants, which by their design tend to harbor bacteria. Further, these faucets are often neglected during routine well and system disinfection. However, wells sampled from freeze proof hydrants were purged for at least five minutes to flush any residual bacteria from these fixtures and lines.

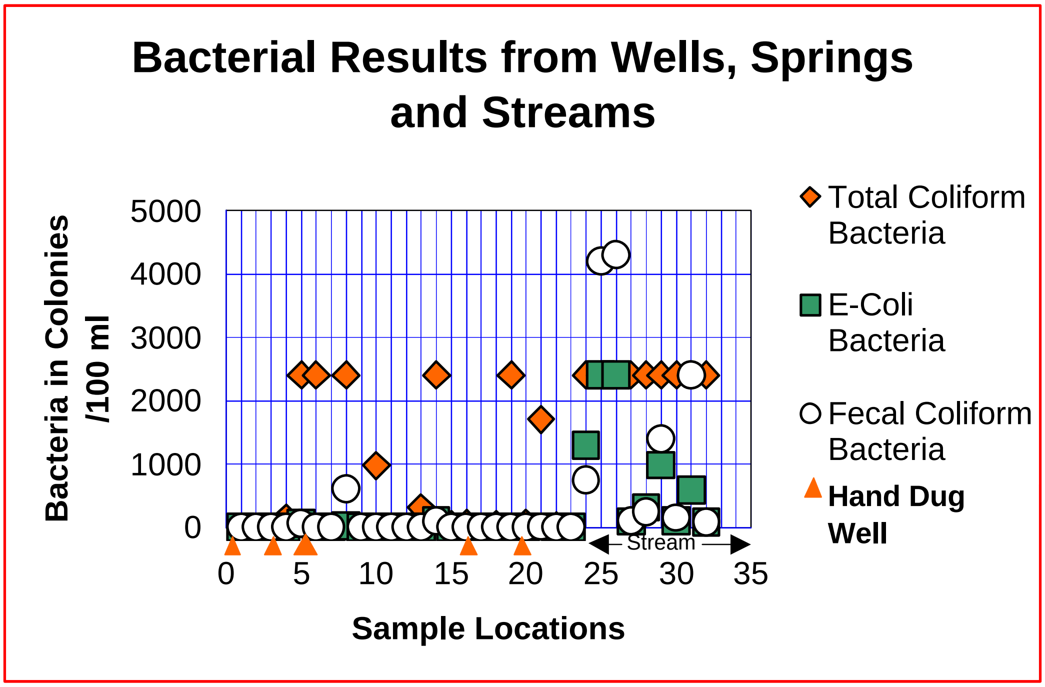


Figure 9. Bacterial Results from Wells, Springs and Streams

Bacterial results are shown graphically in Figure 10 above, and in tabular form in Appendix D, Tables 2 & 3. Total coliform bacteria ranged from zero colonies/100 ml to >2400 colonies/100 ml. Sixteen of the 21 wells tested had total coliform bacteria present. As noted above, the detection of total coliform bacteria without fecal coliform or *E-coli* bacteria does not necessarily indicate NPS contamination.

Fecal coliform bacteria ranged from zero colonies/100 ml to 610 colonies/100 ml, and were found in three hand-dug wells and one drilled well. All sites detecting fecal coliform also detected E. coli.

Stream Bacteria Sampling

Field personnel collected stream bacteria samples along Pine Creek and Cram Creek (Figure 8) for comparison to the well data as shown in Figure 9. The data are also shown in Table 6 in Appendix D.

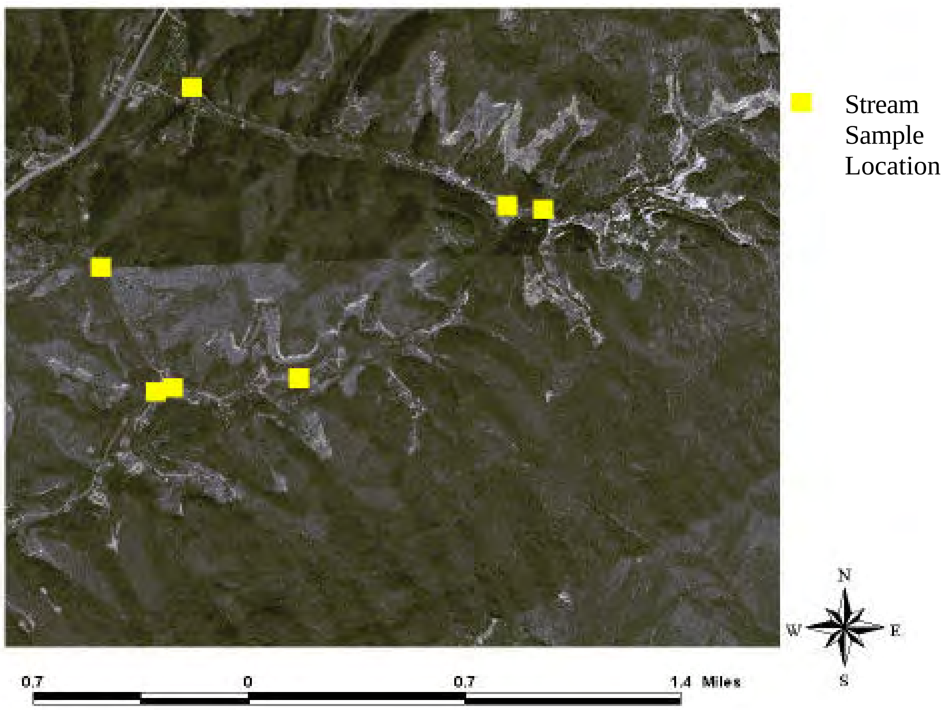


Figure 10. Locations of Stream Sample Collection Sites

Ground and surface water bacteria results show no correlation. The streams appear to be gaining streams, which may prevent stream water contaminated by straight pipe discharges from infiltrating into the nearby shallow groundwater in most places. One possible exception, a 12-foot deep hand-dug well, that reportedly produces enough water to fill an in-ground pool over night, which indicates a likely direct connection between the stream and the well. This well contained elevated total coliform bacteria, fecal coliform bacteria and *E-coli* bacteria along with nitrite, caffeine and caffeine breakdown products.

Caffeine and Metabolites

Because it is not naturally occurring in most areas, caffeine and its metabolites are good indicators of contamination from human waste (USGS, 1995; Ralof, 1998; Pearson, 2004).

Caffeine and/or metabolites were detected in six of 16 samples, as shown in Figure 11, which plots bacteria and caffeine results on a log scale, showing the high variability of bacteria, but the relatively low variability of caffeine. Two wells (of five sampled) detected caffeine or metabolites: one 12-foot deep hand-dug well and one 120-foot deep drilled well that appeared to be properly constructed. The hand-dug well was also positive for total, fecal and E. coli bacteria, but the drilled well was positive for only total coliform bacteria.

Nine surface water samples were analyzed for caffeine and metabolites, five on Cram Creek and four on Pine Creek. Four (44.4%) were positive for caffeine and/or metabolites, one

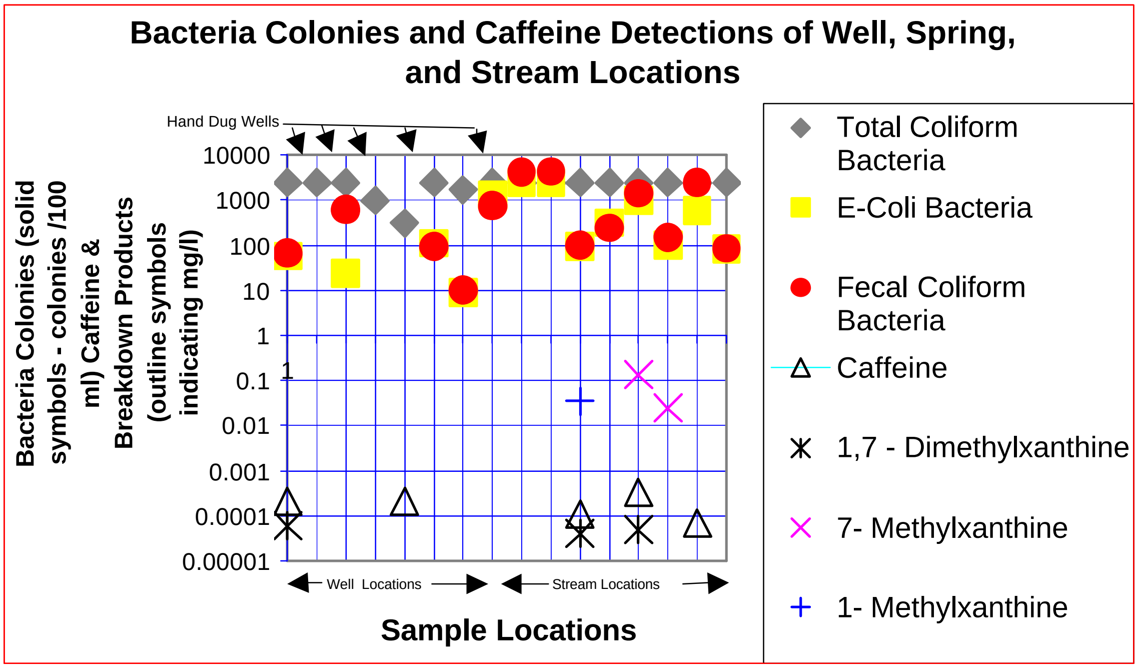


Figure 11. Relationship of bacteria and caffeine results for wells and streams.

on Cram Creek and three on Pine Creek. With limited data, no positive correlation between the occurrence of bacteria and caffeine could be established.

Because caffeine is only derived from anthropogenic sources, through waste discharged through straight pipes or from septic systems, its occurrence indicates that groundwater in the study area has been impacted and is threatened by these discharges.

Figure 12. Improper storage of household chemicals around a hand-dug well.

Conclusions and Recommendations

No pervasive nonpoint source pollution of groundwater was found in this study. However, shallow groundwater locally tests positive for total, fecal and E. coli bacteria, probably because of straight pipe discharges or failing septic systems. Total, fecal, and *E-coli* bacteria were significantly higher in hand-dug wells than in drilled wells. Many of the well problems encountered in this study result from improper construction and maintenance of wells and distribution systems, improper set-backs from possible contaminant sources and poor management or "house-keeping" around the well (Figure 13). Participants were counseled in all relevant topics, and provided with printed information, and this assistance to eighty-seven groundwater users was a valuable part of this project. Residents were very appreciative of this informal, one-on-one, "non-compliance" approach and one participant replaced her shallow, poorly constructed and easily contaminated well with a deeper drilled well meeting current construction standards as a result of this study. Little impact from other nonpoint sources was noted, including from nitrate, nitrite, phosphate, iron, manganese or altered pH from septic systems or coal mining. Streams in the area are gaining, rather than losing, and therefore wells up gradient of these streams are generally not threatened by surface water pollution. Agricultural activity and residential use of lawn and garden chemicals is very limited in the area and represent minimal nonpoint source pollution threats to groundwater. Other threats to groundwater locally include improper disposal of domestic trash and motor oil, animal waste and coal mining.

In general, properly constructed and maintained wells in the study area produce adequate water that is easily treatable by standard water treatment devices. Substandard wells not meeting current construction standards, and especially shallow, easily contaminated hand-dug wells, should be replaced with deeper, properly installed wells. Residents should consider taking advantage of The Affordable Drinking Water Act of 2001, an amendment of the Federal farm bill, which authorizes low interest loans to low-to-moderate-income households to help owners install, refurbish or service water well systems.

The relatively good quality of the shallow groundwater emphasizes the need for quality, well planned and designed septic systems to replace the straight pipe disposal of septic tank effluent. Sites should be fully evaluated and site-specific waste disposal systems should be installed and maintained. Innovative onsite septic systems, including large cluster, mound/peat mound, and modular systems (Equaris of Minnesota, Inc., 2002), have been installed in other areas of Letcher County, and these should be considered for the project area.

The extension of sewer lines into this area or the installation of package sewage treatment plants at the mouths of hollows with significant development should also be considered.

Some residents claim that coal mining has negatively impacted their water quality and quantity. Water quantity was outside the scope of this investigation; however, for the limited number of parameters included in this study, no impacts to water quality from coal mining were found.

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Appendix A. Financial and Administrative Closeout

Workplan Outputs

Milestones:

	Milestone Completion	Expected Beginning Date	Completed Date
1.	QA/QC Plan Approved	04/98	04/98
2.	Submit material to NPS Section for review and approval prior to distribution	04/98	07/98
3.	Preliminary work - identify areas where groundwater is used as source of domestic drinking water and priority areas for water and sewer expansion	04/98	07/98
4.	Start site inspections, initial sampling and on-site education re: NPS pollution	07/98	10/98
5.	Bacteriological sampling round and follow up of on-site NPS education efforts	09/98	09/01
6.	Annual Report	09/98	09/98
7.	Resampling at sites of concern.	10/98	11/98
8.	Evaluate problem groundwater resource areas from data and observations	11/98	01/99

9. Distribute results to participants along with explanation

	and relevant NPS information	01/99	03/99
10.	Share information with MACED and Letcher County Water and Sewer District	07/98	03/99
11.	Annual Report	09/99	09/99
12.	Prepare summary report	01/99	01/04
13.	Present summary report and recommendations to the Letcher County Fiscal Court and the Letcher Count Water and Sewer District	04/99	02/04
14.	Close out grant activities	05/99	05/04
15.	Final and close-out reports submitted to Division of Water	05/99	05/99

Project Budget:

Budget Summary

Budget Categories	BMP Implementation	Project Management	Public Education	Monitoring	Technical Assistance	Other	Total
Personnel				$116,365			$116,365
Supplies							
Equipment							
Travel							
Contractual							
Operating Costs							
Other							
TOTAL				**$116,365**			**$116,365**

Detailed Budget

Budget Categories	Section 319(h)	Non-Federal Match	Total	Final Expenditures
Personnel	$69,819	$46,546	$116,365	$116,365
Supplies				
Equipment				
Travel				
Contractual				
Operating Costs				
Other				
TOTAL	**$69,819**	**$46,546**	**$116,365**	**$116,365**

The Groundwater Branch of the Division of Water was reimbursed $69,819. All dollars were spent; there were no excess project funds to reallocate. The project did generate overmatch provided by the Groundwater Branch of the Division of Water. This overmatch was not posted to the Grant.

The total project budget was $116,365. The budget was expended on personnel costs reflecting a total equivalent of approximately 2.0 person years. Groundwater Branch personnel managed the project, conducted on-site inspections, sampling, and education, transported samples, interpreted sample results, prepared maps and reports, and presented the summary information to the interested parties. Water Quality Branch and Hazard Field Office personnel conducted bacteriological analyses at the Hazard Field Office laboratory. Division of Environmental Services lab personnel conducted chemical analysis at the DES lab. A time code was used to track personnel time spent on the project.

Non-personnel costs, such as travel, sampling and analysis expendable supplies, etc. were not included in the match and actually resulted in an over match of federal funds. No equipment was purchased for this project. Grant Condition #15 (QAP Plan) has been met. All tasks for this project have been completed.

Appendix B. QA/QC for Water Monitoring

QA/QC PLAN FOR
ASSESSMENT OF NONPOINT SOURCE POLLUTION IMPACTS
ON GROUNDWATER IN THE HEADWATERS OF THE NORTH FORK
OF THE KENTUCKY RIVER BASIN

SECTION 319 NONPOINT SOURCE PROJECT WORK PLAN - FFY 1998

(formerly "Monthly Assessment of Raw Water Quality at Non-transient/Community and Unregulated Roadside Spring Public-Water-Supply Karst Springs for Nonpoint Source Pollutants")

Prepared by

Phillip W. O'dell, P.G., Groundwater Hydrologist Principal
Peter T. Goodmann, Environmental Control Manager

Kentucky Division of Water

Groundwater Branch

May 12, 1997

On-site Wastewater Disposal - Straight Pipes

2. Project Organization and Responsibility

A. Key Personnel

Project Officer:	Phillip W. O'dell - KY Division of Water Groundwater Branch 14 Reilly Road Frankfort, KY 40601 (502)-564-3410
QA Officer:	Phillip W. O'dell - KY Division of Water Groundwater Branch 14 Reilly Road Frankfort, KY 40601 (502)-564-3410
Field Sampling Supervisor:	Phillip W. O'dell - KY Division of Water Groundwater Branch 14 Reilly Road Frankfort, KY 40601 (502)-564-3410
Lab Supervisor:	William E. Davis – Div. of Environmental Services 100 Sower Drive - Suite 104 Frankfort, KY 40601 (502)-564-6120
B.	**Laboratory: -** KY Dept. for Env. Protection Division of Environmental Services 100 Sower Boulevard - Suite 104 Frankfort, KY 40601 (502)-564-6120
C.	**Assisting Organizations**: - Crystal Blackburn MACED PO Box 907 Whitesburg, KY 41858 (606)633-3014 Terry Anderson, Manager Water Quality Branch 14 Reilly Road Frankfort, KY 40601 (502)-564-3410

3. Watershed Information

A. Water Body Name

The project area is in the headwaters of the North Fork of the Kentucky River and will be looking at groundwater resources of the area. Groundwater in the area provides 90% of the baseflow for the Kentucky River. The dissected nature of the area reduces the potential for large regional aquifer systems, so the study will be looking for clusters of nonpoint source contamination of wells in areas deemed low priority areas for water and sewer line expansion by the Letcher County Water and Sewer District to define impacted groundwater resource areas.

B. Basin Name

The project is in the Kentucky River Basin.

C. Stream Order

The project is a groundwater study.

D. County(s)

The project will be conducted in Letcher County.

4. Monitoring Objectives

A. Determine groundwater resource areas which have nonpoint source pollution impacts in areas deemed low priority areas by the Letcher County Water and Sewer District.

B. Compile data of nonpoint source problems so that the proper agencies can use them to direct resources to implement BMP's to help minimize the impact.

C. Provide one-on-one nonpoint source pollution awareness with the participants of the study so that these individuals can start to understand problems associated with different activities.

D. Provide education regarding groundwater pollution prevention and remediating/treating polluted domestic water supplies.

5. Study Area Description

A. General Description of Location

The area lies in southeastern Kentucky in the Eastern Coal Field Physiographic province.

The study area lies in Letcher County and may extend into portions of Perry and Knott Counties. Whitesburg is the largest city in the study area.

B. General Description of the Physical Environment

1. Topography

The topography of the area consists of a dissected plateau characterized by narrow crooked valleys and narrow irregular steep-sided ridges. The majority of the flat, usable land is located in the valley floors.

2. Soils

The soils of Letcher County are generally unsuitable for conventual on-site septic systems according to the USDA (1962), as illustrated in the following table.

Soil Series	**Suitability for Onsite Septic Systems**
Allegheny	Suitable
Berks	**Unsuitable**
Dekalb	**Unsuitable**
Gilpin	**Unsuitable**
Holston	Suitable on slopes less than 12 percent
Jefferson	Suitable on slopes less than 12 percent; **questionable on slopes of 12 to 20 percent; unsuitable on slopes of more than 20 percent**
Muskingum	**Unsuitable**
Pope	**Unsuitable**
Rock Land	**Unsuitable**
Stendal	**Unsuitable**
Upshur	**Unsuitable**
Wellston	Suitable on slopes less than 12 percent; **questionable on slopes of more than 12 percent**

Source: Table 20 - *Interpretation of engineering properties of the soils* and *Letcher County Soil Map*, USDA, Soil Series 1962, No. 1, Reconnaissance Soil Survey, Fourteen Counties in eastern Kentucky.

3. Geology

The bedrock in the study area consists mainly of Pennsylvanian rocks of the Breathitt Formation. The Breathitt Formation consists of interbedded sandstone, siltstone and shale with interspersed coal beds. The valley floors are covered with deposits of Quaternary alluvium over bedrock.

C. Description of the Local Hydrologic Regimes

1. Watershed Acreage

Unspecified at this time.

2. Streams and Major Basins

North Fork of the Kentucky River and it's groundwater inflow.

3. Flow Patterns

Unknown at this time.

4. Sinks

This study is not located in a karst area. Therefore, the only sinks possible are due to underground mining subsidence.

5. Relevant Groundwater Systems

The primary groundwater flow mechanism in the bedrock is fracture flow. Primary porosity is present in the sandstones but is not as important as the secondary porosity of the fractures. A hillslope stress relief fracture aquifer model applies to the valley walls in the area and these feed the shallow alluvial aquifers of the valley floors. The hydrogeology of the ridges has been extensively altered by underground coal mining operations which have operated in the area since 1910's. Groundwater flow in the Quaternary Alluvial aquifers is granular flow.

The Division of Waters Consolidated Groundwater Database shows that Letcher County is second only to Pike county in the number of water wells drilled since the creation of the database in 1986. A search of the Consolidated Groundwater database on February 25, 1997 revealed that approximately 1350 water wells have been constructed since 1985. Therefore, groundwater is a very important source of drinking water in the area.

Studies in adjacent counties show that many hand-dug wells, springs and seeps are impacted by on-site septic system contamination. However, deeper, properly constructed wells show little contamination from on-site septic systems, but do have detection’s of metals possibly related to coal mining. Data generated by local health departments indicates that on-site septic system contamination may be more prevalent in Letcher County.

The dissected nature of the terrain and the presence of salt water at depth indicates continuous, extensive regional aquifers are not prevalent. Instead, many smaller aquifer basins which are controlled by the topography and geology combine to form regional aquifer systems which contribute many flows to the headwaters of the North Fork of the Kentucky River Basin. These smaller basins have not been mapped out as of yet.

D. Description of Land-use Activities

Letcher County has areas of extremely dense housing along the stream valleys. Straight pipe discharges to the surface or streams are very common. This can be attributed to the lack of suitable land and soil conditions for conventual septic tank and lateral line installation, and to the depressed economy of the area. Trash is commonly dumped on the surface and into the creeks. Agricultural land is limited to small plots and grazing. Underground mining has be conducted extensively in the area since the 1910's with surface mining and auguring occurring more recently.

E. Site Map

Individual site locations will be determined in the field and will depend on the willingness of individual well owners to participate. The areas which will be the focus of the study are areas of low priority for water and sewer line expansion and will be determined with the cooperation of the Letcher County Water and Sewer District and MACED.

6. Monitoring Program/Technical Design

A. Monitoring Approaches and Strategies

The monitoring approach to be used is to sample as many wells as possible, making sure that the sample is as representative of the aquifer as possible. A minimum of 40 wells is planned to be evaluated. This will require the samplers to be experienced in well construction, water distribution systems, and their potential to influence the sample results. Samplers will document the water distribution system and activities around the well which could have an impact on the analysis, and sampling protocols. Screening tests will be used to limit the amount of nutrient testing in the lab and to allow more wells to be tested in the study. These screening test consist of self filling vacuum ampoules for colorimetric analysis. A vacuum in the vial draws in the correct volume of sample which reacts with the reagent and the color is compared to the color comparator in the kit. This semi-quantitative method will alert the sampling personnel to possible nonpoint source pollution and allow the personnel to make correction recommendations to the well owners at that time. Any significant detection’s by the on-site screening will be verified by the laboratory. Ten percent of the on-site screening tests will be verified by the laboratory so that the reliability of the screening can be determined. The determination of the reliability and accuracy of these inexpensive and quick methods will be useful for future nonpoint source studies as federal and state funds become less available in the future. A few of the new “test strip methods” for iron, alkalinity, nitrate and nitrite will also be compared to the lab and vacuum ampoule results. The knowledge of an approximate concentration of a nonpoint source constituent while the investigators are at the site will allow inspection of potential causes. Arrangements will be made with all the landowners to make a second sample collection visit for the microbiological samples. Do to the short holding times, the Division of Water Microbiological lab at the Hazard field office will be used and arrangements with the microbiologist in the Water Quality Branch have been made so that this second sampling event will be timed to fit their schedule.

B. Monitoring Station Location Strategy

Monitoring sites will be to be represent regional groundwater quality with sufficient density to be able to identify areas with impacted groundwater quality. This study requires cooperation and assistance from private individuals which own or have wells at their residences. It is anticipated that there will be those who will not wish to participate and a suitable neighboring well may be used instead. Wells sampled will be ones which the owner/user has some knowledge of the wells characteristics such as approximate depth and a generalized history which will include approximate age, water quality changes over time, their perception as to causes of changes, recent repairs to pump and piping, changes in land use around the well and area, and overall information which can help determine if a situation exists in which a well or distribution system problem could mask the true quality of the groundwater resource.

Studies which do not take into consideration the distribution system and well conditions in their sampling often result in misleading or confusing conclusions which are inconsistent with the true groundwater resource conditions. This can result in large expenditures in fixes which are un-needed or misdirected. This study proposes to objectively obtain samples which are as representative of the groundwater resource as possible.

C. Sampling Frequency and Duration

Sampling will be conducted once for the nutrient and metals testing and a second visit for bacteriological and any retesting which may be needed to verify problematic results. The results of this study will be used for prioritization of future long term studies in the areas of concern.

D. Types of Data to be Collected

Along with the observational and spatial location data, chemical analysis will be collected. The on-site screening test will follow the manufacturers instructions and ten percent of the samples will be verified with actual laboratory analysis. Parameters proposed for on-site screening include:

Parameter	Testing Method	Range and MDL
Ammonia Nitrogen	Vacuum ampoule and visual comparison	0-25 ppm and 25-250 ppm MDL - 1.25 ppm
Nitrate Nitrogen	Vacuum ampoule and visual comparison	0-25 ppm and 25-125 ppm MDL - 1.25 ppm
Nitrite Nitrogen	Vacuum ampoule and visual comparison	0-10 ppm and 10-125 ppm MDL - .625 ppm
Detergents (anionic surfactants)	Vacuum ampoule and visual comparison	0-3 ppm MDL - .125 ppm
Phosphate, Ortho	Vacuum ampoule and visual comparison	0-25 ppm and 25-250 ppm MDL - 1.25 ppm
Sulfides (total soluble)	Vacuum ampoule and visual comparison	0-25 ppm and 25-250 ppm MDL - 1.25 ppm
pH	Field Meter Analysis	
Conductivity	Field Meter Analysis	
Temperature	Field Meter Analysis	

The samples collected for laboratory analysis will comply with the following procedures and protocols for sample parameters, containerization, preservation and holding times:

Table 1

Parameter	Container	Preservative	Holding Time
Bulk Parameters	1000 ml plastic	Cool to 4^{o}C	
Alkalinity			14 days
Chloride			28 days
Conductance			28 days
Fluoride			28 days
pH			2 hours
Sulfate			28 days
Nitrate Nitrogen			48 hours
Nitrite-Nitrogen			48 hours
Nutrients Ammonia-Nitrogen Total Kjeldahl-Nitrogen	1000 ml plastic	H_2SO_4 to pH <2 Cool to 4^{o}C	28 days
Orthophosphate	1000 ml plastic	Filter on site Cool to 4^{o}C	48 hours
Metals Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Lead, Magnesium, Manganese, Phosphorus, Selenium, Silicon, Silver, Strontium, Sulfur, Thallium, Tin, Sodium, Zinc	1000 ml plastic	Filter on site HNO_3 to pH <2 Cool to 4^{o}C	6 months
Bacteria	100ml Sterile plastic with sodium thiosulfate tablet	Cool to 4^{o}C, Sodium Thiosulfate tablet	
Total Coliform Bacteria			24 Hours
Fecal Coliform Bacteria			6 Hours
Fecal Streptococci Bacteria			6 Hours

7. Chain-of Custody Procedures

A. Procedures and Forms

A questionnaire form will be developed to accompany the standard KDOW well and KDOW spring inspection forms and standard KDOW Chain of Custody forms. These forms will be provided to KDOW, NPS Section for review and approval prior to there use. This will provide data will be entered into the Consolidated Groundwater Database.

B. Specific Sample Preservation Needs

Necessary preservatives (see Table 1) are added in the field; preservatives for dissolved constituents are added after field filtration. Samples are stored in coolers packed with ice for transport to the DES laboratory in Frankfort.

C. Standardized Field Tracking Forms

Sampling personnel will complete a Chain-of-Custody Record form for each sample and follow the standard KDEP Chain-of Custody protocol.

D. Laboratory Sample Custodian

The laboratory sample custodian for this project will be William E. Davis or his designee.

8. Quality Control Procedures

A. Container and Equipment Decontamination Protocols.

1. All sampling supplies that contact the sample are new, disposable equipment, or decontaminated prior to and after each use, using the following protocols.

2. Sample collection equipment, such as bailers and buckets, will consist of Teflon if available. Disposable bailers are preferable. Any reusable equipment is decontaminated with a 10% hydrochloric acid (HCL) solution, triple rinsed with deionized water, and triple rinsed with water from the sampling source prior to collecting a sample. After sampling is complete, excess sample is disposed, and the equipment is again rinsed with 10% HCL solution and triple rinsed with deionized water.

   New 0.45 micron filters are used at each sampling site for samples requiring filtration. Any tubing that contacts the sample is also new. Any reusable filter apparatus is decontaminated in the same manner as sample collection equipment. Additionally, any intermediary collection vessel is triple rinsed with filtrate prior to use.

3. Field meter probes are rinsed with deionized water prior to and after each use.

B. Field Measurements and Equipment Calibration

Conductivity, temperature, and pH are measured in the field at each site using portable temperature compensating meters, and recorded in a field log book. Meters are calibrated according to the manufacturer's specifications, using standard pH buffer solutions. Meter probes are decontaminated according to decontamination protocols for field meters and stored according to the manufacturer's recommendations.

C. Sample Collection, Preservation and Contamination Prevention

Water samples are fresh groundwater collected prior to any type of water treatment. Samples not requiring field filtration are collected directly in the sampling container. Samples requiring field filtration are collected in a Teflon bucket decontaminated in accordance with decontamination protocols for sample collection and filtration equipment, filtered, and transferred to the appropriate container.
Sample containers are new or laboratory-decontaminated in accordance with Division of Environmental Services accepted procedures. Sample containerization, preservation, and holding-time requirements are provided in Table 1. Necessary preservatives are added in the field; preservatives for dissolved constituents are added after field filtration. Samples are stored in coolers packed with ice for transport to the DES laboratory in Frankfort.

Sample containers are labeled with the site name and AKGWA number, sample collection date and time, analysis requested, preservation method, and collector's initials. Sampling personnel complete a Chain-of-Custody Record for each sample. The DES laboratory is responsible for following approved laboratory QA/QC procedures, conducting analyses within the designated holding-times, following EPA-approved analytical techniques, and reporting analytical results to the Groundwater Branch within sixty days of sample receipt.

D. Duplicates and Blanks

At least one duplicate sample will be submitted with each batch of samples, regardless of the number of samples in the batch. Blanks of deionized water will be submitted at least once during the study. Blanks will be collected, filtered, and preserved in the same manner as a sample.

E. Acceptable Levels of Variance

F. Laboratory's Standard Operating Procedure

The DES laboratory will follow their SOP for analytical analysis.

G. Procedures for Unacceptable Results

A second confirmation sampling event has been scheduled for sample locations that may require verification/resampling. The QA Officer and hydrogeologist will examine the data to determine which results, if any are unacceptable or unreasonable. These sample locations maybe resampled to correct the problem.

9. Other

A. Wells

Small diameter wells, such as six-inch diameter private wells, are pumped for at least five minutes, or a sufficient time to purge three to five well volumes from the well, prior to sampling to ensure that fresh formation water is sampled. Large diameter wells, such as municipal supply wells, will be evaluated on a case-by-case basis to determine whether they can be efficiently purged, or whether they have already been pumped sufficiently to ensure that fresh formation water is sampled without additional purging.

Samples are collected as close to the well as possible. Multiple well systems are sampled from a point in which the designated sampling well is isolated from other wells. Wells without pumps are avoided to the extent possible due to the time necessary to manually purge the well. However, in the event that a well that uses a bailer as the water delivery is encountered, it must be purged manually, preferably with the bailing equipment already installed on the well. Hand-dug wells may have too large of volume or too slow of recharge to purge the well of 3 to 5 well volumes before sampling. In this case, the system should be run at high flow for at least 5 minutes to purge the lines of any stagnate water before sampling.

B. Springs

Spring samples are collected as close as possible to the spring resurgence with samples collected from the spring house or basin being preferable. If access to the spring, spring house or spring box is not possible, the system should be purged for at least 5 minutes to clear the lines of stagnate water before sampling.

9. Unique Aspects of the Project

Letcher County is currently planning for sewer and water extensions into rural areas of the county. The data gained from this study will be valuable for their planning and prioritizing future projects with the limited funds available. Areas with the highest nonpoint source groundwater resource impacts can be given earlier attention and focus.

The project plans to work closely with MACED and local government which will provide hands on training on groundwater, wells, and nonpoint groundwater pollution. A presentation of the results will be prepared for the local Letcher County Water and Sewer District and the Letcher County Fiscal Court. The one-on-one nonpoint source educational component to be included into the sampling, interview, and inspection process will present the concept of nonpoint source pollution and the potential effects to a number of individuals in an informal, non-regulatory manner. Previous studies conducted by the Groundwater Branch have resulted in post-study public meetings which had extremely poor turnouts. The one-on-one training allows concepts to be presented to everyone which allows us to sample their well, using examples from their immediate area in the discussion.

10. References

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Price, W.E., D.S. Mull, and C. Kilburn. 1962. Reconnaissance of Ground-Water Resources in the Eastern Coal Field Region, Kentucky. United States Geological Survey Water-Supply Paper 1604. U.S. Government Printing Office, Washington D.C.

Appendix C. – Forms and Distributed Information

North Fork of the Kentucky River Water Well 319 Nonpoint Pollution Study

Field Inspection Check Off Sheet

Kentucky Division of Water, Groundwater Branch
1-502-564-3410

Well ID. Number _____________-____________ County Letcher
Well Owner____

USGS Topographic Quadrangle Name____

Well and Water Delivery System

The wellhead appears to be sealed and properly constructed. ☐ Yes, ☐ No, explain
____
____
____

The well provides a sufficient supply of water. ☐ Yes, ☐ No, explain
____
____
____

Water quality and quantity has not changed over time. ☐ Yes, ☐ No, explain
____
____
____

The well was disinfected in the past year. ☐ Yes, ☐ No, explain
____
____
____

The well water was tested in the past year. ☐ Yes, ☐ No, When was the well last tested?
____
____
____

The well is a sufficient distance from any septic system. ☐ Yes, ☐ No, explain
____
____

The delivery system parts that are visible are in good condition and appear to be constructed out
Of materials approved for drinking water systems. ☐ Yes, ☐ No, explain
____
____

There are no unused wells on or near the property. ☐ Yes, ☐ No, explain
____
____

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There are no unsafe activities, either point or non-point pollution source activities, are being conducted near the well which could impact the well and groundwater. ☐ Yes, ☐ No, explain

Potential Pollution Sources

Fuel Storage Tank- above or below ground ☐ Yes, explain ☐No

Animal Pen ☐ Yes, explain ☐No

Trash Pile or dump ☐ Yes, explain ☐No

Trash Burning Area ☐ Yes, explain ☐No

Indications of Dumping of Waste Oil ☐ Yes, explain ☐No

Mining ☐ Yes, explain ☐No

Cemetery ☐ Yes, explain ☐No

Auto Repair or Salvage Facility ☐ Yes, explain ☐No

Septic tank has not been pumped out in the last five years. ☐ Yes, explain ☐No

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General Comments, suggestion, and recommendations.

Sketch Map (if needed)

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Literature Distributed

- ☐ Kentucky Well Inspection Form. (Well Owners Copy)
- ☐ Field Analytical Data Screening Sheet (Well Owners Copy)
- ☐ Handbook for the Kentucky Water Well Owner.
- ☐ Field Inspection Check Off Sheet (Well Owners Copy)
- ☐ Generic Groundwater Protection Plan (GPP) for Water Well Owners.
- ☐ Generic Groundwater Protection Plan (GPP) for Septic System Owners.
- ☐ Routine Water Well Maintenance and Disinfection Guide
- ☐ Groundwater Protection and Residential Septic Systems
- ☐ 10 Ways you can Keep Kentucky Waters Clean!
- ☐ Watershed Management in Kentucky…Q&A for Homeowners
- ☐ Kentucky Division of Water
- ☐ Groundwater….Protecting it is Now the Law
- ☐ Inside the Kentucky NREPC
- ☐ Private Drinking Water Wells, USEPA, Office of Ground Water and Drinking Water
- ☐ USEPA Consumer Fact-sheet on: NITRATES/NITRITES
- ☐ Requirements for Installing a Residential Wastewater Treatment Facility
- ☐ Pesticide Use and Application Act, KRS 217B
- ☐ Floodplain Management in Kentucky
- ☐ Kentucky River Basin Status Report, November 1997
- ☐ Kentucky Natural Resources Cost-share Programs
- ☐ Kentucky's Master Logger Program
- ☐
- ☐ *(Required handout)*

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<u>Informational Contacts:</u>

Division of Water -

Water wells, stream quality, water withdrawals, water discharges, non-point pollution, drinking water plants, waste water plants.

Frankfort Office	1-(502)-564-3410
Hazard Field Office	1-(606)-435-6022
Water Watch Program	1-(800)-928-0045

Division of Waste Management -

Dumps, junk collection program,

Frankfort Office	1-(502)-564-6716
Hazard Office	1-(606)-435-6022
Report a Dump Hot line	1-(888)-NO DUMPS (1-888-663-8677 toll free call)

Division of Air Quality -

Air issues

Frankfort Office	1-(502)-573-3382
Hazard Field Office	1-(606)-435-6022

Letcher County Action Team -

Assistance with septic system design and installation. Some grant and loans available for straight pipe elimination.
1-(606)-633-3014

Cabinet for Health Services -

Septic system questions, alternate septic system design information, septic system regulations.

Frankfort	1-(502)-564-4856

Environmental Response -

24-hour toll free number to report spills, leaks, fish kills, illegal dumping, etc.

1-(800)-928-2380 or 1-(502)-564-2380

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North Fork of the Kentucky River Water Well 319 Nonpoint Pollution Study

Field Analytical Data Screening Sheet

Kentucky Division of Water - Groundwater Branch

Well ID. Number ________________-_______________ County __Letcher__________

Well Owner____

USGS Topographic Quadrangle Name____

Field Results

☐ Nitrate-**N** 0---2.5---5---***10***---15---20---25---37.5---50---62.5---75---87.5---100---112.5---125 PPM NO_3-N
☐ May exceed primary drinking water standards ☐ Sample taken for lab verification

☐ Nitrite-**N** 0---***1***---1.25---2.5---3.75---5---6.25---7.5---10---15---20---25---30---35---40---45---50 PPM NO_2-N
☐ May exceed primary drinking water standards ☐ Sample taken for lab verification

☐ Ammonia-**N** 0---2.5---5---7.5---10---15---20---25---50---75---100---125---150---175---200---250 PPM NH_3-N
☐ Sample taken for lab verification

☐ Detergents 0----0.25---0.50---0.75---1.0---1.5---2.0---3.0 PPM Anionic Detergents
☐ Sample taken for lab verification

☐ Phosphate-**PO_4** 0---2.2---5---7.5---10---15---20---50---75---100---125---150---175---200---250 PPM PO_4
☐ Sample taken for lab verification

☐ pH _____***(6.5-8.5)*** ☐ Eh _________ ☐ Conductivity _______________ ☐ Temperature___________

Optional Tests

☐ Iron, **Total Fe** 0---0.1---0.2---0.3---0.4---***0.5***---0.6---0.8---1.0---2---3---4---5---6---7---8---10 PPM Total Fe
☐ May exceed secondary drinking water standards ☐ Sample taken for lab verification

☐ Iron, **Dissolved** 0---0.1---0.2---0.3---0.4---***0.5***---0.6---0.8---1.0---2---3---4---5---6---7---8---10 PPM Dissolved Fe
☐ May exceed secondary drinking water standards ☐ Sample taken for lab verification

☐ Manganese, **Soluble** 0---***0.05***----0.3---0.6---0.8---1.0---1.5---1.8---2.0 PPM Mn
☐ May exceed secondary drinking water standards ☐ Sample taken for lab verification

☐ Nitrate **Test Strip**, **NO_3^-** 0----10----25----***50***----100----250----500 PPM NO_3^- (10ppm NO_3^- = 2.3 ppm N)
☐ May exceed primary drinking water standards ☐ Sample taken for lab verification

☐ Nitrite **Test Strip, NO_2^-** 0----2--***3.3***--5----10----20---40----80 PPM NO_2^- (10ppm NO_3^- = 3 ppm N)
☐ May exceed primary drinking water standards ☐ Sample taken for lab verification

☐ Other Test ____

BART Test Collected? (This test needs several days before the results can be read)

☐ Iron Reducing Bacteria Reactions BC BG BL BR CL FO GC RC Days till reaction________
☐ Sulfur Reducing Bacteria Reactions BB BT BA CG Days till reaction________
☐ Slime Forming Bacteria Reactions DS SR CP CL BL TH PB GY Days till reaction________

Disclaimer - These test only are used for screening for nonpoint pollution and therefore are not absolute results. Any result, which is equal to or above one-half the drinking water standard, will be verified in the lab under laboratory standards to determine the validity of the result. Additional random control samples will be taken to the lab to confirm the validity of the field-testing. Questions concerning these results should be directed to: Groundwater Branch, Kentucky Division of Water, 14 Reilly Road, Frankfort, KY 40601 or by calling 1-502-564-3410.

Bacteriological Sampling Postcard

I would like to participate in the one time bacteriological sampling for the ***"Assessment of Nonpoint Source Pollution Impacts on Groundwater in the Headwaters of the North Fork of the Kentucky River Basin"*** project which will occur during the week of September 10-13, 2001.

My mailing address is:

Name
Address
Mayking, KY 41837

My 911 street address is:

The best time to catch me at home is:
? Morning ? Afternoon

? A sample can be taken at an outside faucet if I am not at home. The faucet is located

Bacteria Chain Of Custody Record

NATURAL RESOURCES AND ENVIRONMENTAL PROTECITON CABINET
DIVISION OF WATER - GROUNDWATER BRANCH - North Fork 319- Funding Source A-21

Site Identification	**Collection Date/Time**	**Field Measurements**
Location: **«Name»** County: Letcher County AKGWA #: **«AGWA»**	Date: ____________ Time: ____________	pH: ___NA_ Conductivity: ___NA___ µmhos Temp: _NA__ °C Spring flow: _____________

Sampler ID: ________________________

Division of Water Hazard Laboratory Samples			
Analysis Requested	**Container Size, Type**	**Preservation Method**	**Parameters**
X	1 - 250 ml bottle Label with stick on labels	Cool to 4°C	**Total Coliform, Fecal Coliform and E-Coli Bacteria** By Colilert
X	1 - 1000 ml amber glass bottle	Cool to 4°C	**Caffeine**

Signatures:

Relinquished by: ________________________ Date: _______ Time: ______
Received by: ____

Relinquished by:___________________________________Date: ______ Time: ______
Received by:________________________________

Relinquished by:___________________________________Date: ______ Time: ______
Received by:________________________________

Relinquished by:___________________________________Date: _______Time: ______
Received by:________________________________

Sample #:__________ Report #:___________

DISCARD SAMPLES UPON COMPLETION

Kentucky Division of Water
PROTECTING YOUR WELL AND WATER SUPPLY

A Groundwater Protection Plan For Domestic Well Owners

Why is protecting my well important?

Groundwater is an important but vulnerable source of fresh water for drinking, household use, industry, and farming. It is also the only source of water for private wells and many public utilities. Kentucky's groundwater supply can be polluted by activities above ground. Implementing groundwater protection best management practices (*e.g*. proper well siting, construction, and maintenance) is essential to safeguard your groundwater supply and to protect groundwater for generations to come.

How do I protect my groundwater?

You can protect your groundwater supply by carefully managing activities at the surface, especially in those areas where groundwater may be more easily contaminated, such as near sinkholes, around your septic system, and near your domestic water well. Best management practices are outlined in this generic groundwater protection plan for activities near and related to your domestic water well. Implementing this groundwater protection plan will go a long way toward preventing groundwater pollution and ensuring the safety of your water source, now and in the future.

What is a groundwater protection plan?

The Natural Resources and Environmental Protection Cabinet administrative regulation, 401 KAR 5:037 requires anyone participating in certain activities to develop and implement a groundwater protection plan. Construction, operation, closure, and capping of water wells are some of the activities that require a groundwater protection plan. The cabinet has developed groundwater protection plans for these activities. This publication is the generic groundwater protection plan for domestic well owners.

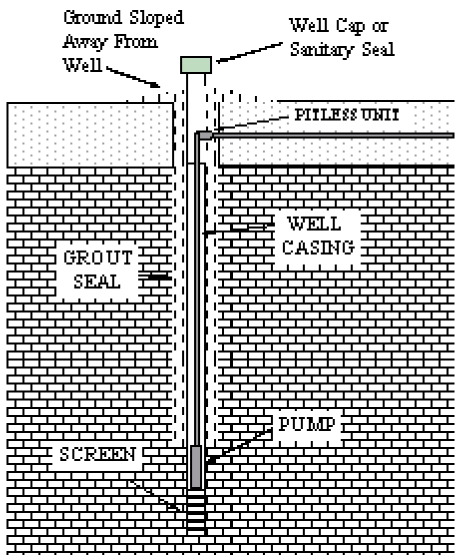
Am I required to have a groundwater protection plan?

Yes. If you own a domestic-use water well, regulation 401 KAR 5:037 requires you to develop or adopt a groundwater protection plan, to certify that you will implement a groundwater protection plan, and to keep a copy of the certified groundwater protection plan on the site where the domestic water well is located.

How does this groundwater protection plan protect my groundwater supply?

This groundwater protection plan outlines operation and maintenance practices to protect your well from contamination. It includes an area for simple record keeping of operation and maintenance practices. The plan also outlines activities and practices to be avoided in the operation and maintenance of your well, including procedures for proper well abandonment. It also includes some potentially polluting activities to be avoided near your well.

Typical properly constructed well:



Protecting Your Groundwater Supply

The goal of a groundwater protection plan is to protect your groundwater supply from potential pollution. You can protect the groundwater supply to your domestic well by following best management practices. Follow the best management practices outlined below to implement this generic groundwater protection plan.

1. Inspect exposed parts of the well periodically for problems such as: - cracked or corroded well casing - broken or missing well cap - damage to protective casing - settling and cracking of surface seals.
2. Slope the area around the well so that surface runoff drains away from the well.
3. Provide a well cap or sanitary seal to prevent unauthorized use of or entry into the well.
4. Disinfect drinking water wells at least once a year using bleach or hypochlorite granules (see Table I).
5. Provide for sediment removal or well cleaning as necessary.
6. Have the well tested once a year for fecal coliform or other constituents that may be of concern.
7. Contact your local health department for assistance with well testing.
8. Keep accurate records of any well maintenance, such as disinfection or sediment removal, that might require use of chemicals in the well.
9. Use a Kentucky certified water well driller for any new well construction or modification and proper well abandonment.
10. Located your well a minimum distance from the following potential sources of contamination:
    - animal pens or feedlots (50 feet) and manure storage areas (75 feet)
    - septic tanks (50 feet), lateral fields (70 feet), cess pools (150 feet), or pit privy (75 feet)
    - chemical storage areas (suggest 75 feet)
    - machinery maintenance areas (suggest 75 feet)
    - waste piles (suggest 75 feet), lagoons (suggest 150 feet), sewers (15-50 feet, depending on type)
    - underground storage tanks for chemicals, fertilizers, or petroleum products (suggest 75 feet)
    - above-ground tanks for chemicals, fertilizers or petroleum products (suggest 75 feet)
11. If an existing well is located closer than the specified distance for any of the above activities, then disinfection and appropriate well testing should be done more frequently than once a year.
12. Avoid mixing or using pesticides, fertilizers, herbicides, degreasers, fuels, or other pollutants near your well.
13. Do not use dry wells or wells that are not properly abandoned for disposal.
14. Do not locate any type of potentially polluting activity up slope from your well.
15. Do not cut off well casing below the ground surface because doing so leaves the well more vulnerable to contamination.

For Your Records.

An important part of complying with the groundwater protection regulations is keeping accurate maintenance and disinfection records for the well. The following table will help you maintain proper records for your well.

Disinfection:

Method Date

_______________________ _________________

Table 1. shows one method of well disinfection.

Well diameter in Inches	Amount of Bleach Required to Disinfect Well per 100 Feet of Water in Well
3	1 cup
4	2 cups
5	3 cups
6	4.5 cups
8	8 cups
10	12 cups
12	18 cups

Other Well Maintenance:

Type of Maintenance	Date

Certification

Each domestic water well owner is required to implement a groundwater protection plan. You may fulfill this requirement by using this document and signing the certification statement below. You must retain this document at the location served by the well. I certify that I have read and will implement this groundwater protection plan.

________________________________ _______________

(Signature of well owner) (Date)

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Generic Groundwater Protection Plan: Residential Septic Systems

Natural Resources and Environmental Protection Cabinet

Generic Groundwater Protection Plan: Residential Septic Systems

HOMEOWNER'S SEPTIC SYSTEM GUIDE AND RECORD KEEPING FOLDER

The purpose of 401 KAR 5:037 and this groundwater protection plan is to prevent groundwater pollution. Understanding how your septic system works and following good operation and maintenance practices are the keys to preventing groundwater pollution.

This folder provides you with that information. By carefully reading it and following the guidelines, you will not only protect groundwater, but also should receive many years of trouble-free service from your system.

FOR YOUR RECORDS

Keeping records will enable you to better protect and maintain your septic system. In case you sell your house, your records will show a prospective buyer that your system has been properly maintained.

What to keep?

1. Maintenance Log: Date, what was done and reason for the maintenance (Example: measure sludge and scum layers, pump the tank).

2. Inspection Log: Date, what you observed upon walking over the septic system (Example: any unpleasant odors, soggy soil, lush green grass over the lateral lines, surfacing wastewater).

3. Site Drawing: Show accurately the layout of the system on your lot. Include exact distances of each portion of the system from at least two (2) fixed reference points (corner of house, garage, large trees, property line markers).

4. Any permits or receipts.

5. Residential Address ____
____

Septic system type:

______ Septic tank - drainfield
______ Septic tank - constructed wetland - drainfield
______ Septic tank - leaching chambers
______ Septic tank - low pressure pipe
______ Septic tank - sewage lagoon - drainfield
______ Septic tank - gravelless pipe

Sketch System Layout Here

System Inspection Log

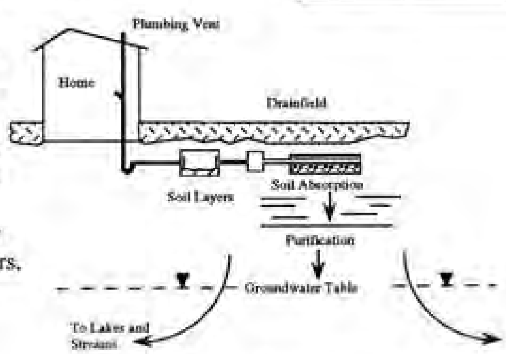
DATE	DESCRIPTION

System Maintenance Log

DATE	DESCRIPTION

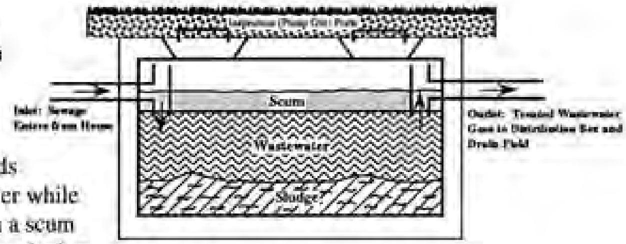
SYSTEM DESCRIPTION

A septic system uses natural processes to treat and dispose of the wastewater in your home. It typically consists of a septic tank and a drainfield (also called a leachfield, lateral field, or subsurface soil absorption beds/trenches). The system accepts both "blackwater" (toilet wastes) and "greywater" (wastes from the kitchen sink, bath tub/showers, and laundry). Water that should not be discharged to the system includes water from foundation or footing drains, roof gutters, and other "clear" water.



Basic System

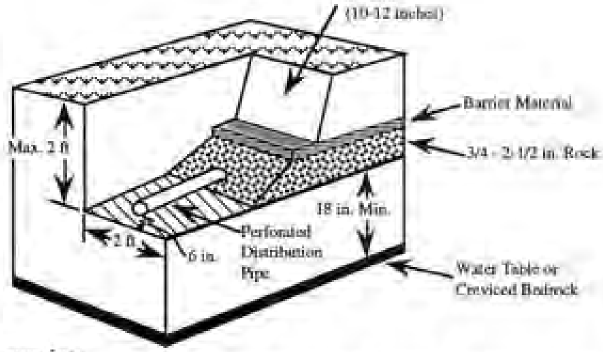
SEPTIC TANK



Septic Tank Cross-Section

The septic tank provides the first step in treatment by separating the solids from the liquids. The wastewater is retained in the tank for 24 hours or more. During this time the heavier solids settle to the bottom to form a sludge layer while the lighter solids float to the top to form a scum layer. Bacteria break down the solids, producing carbon dioxide, hydrogen sulfide, and other gases in the process. These gases are vented through the plumbing vent on your house roof. Since the bacteria reduce only about 40 percent of the sludge and scum volume, the tank must be pumped regularly (approximately every three to five years) to remove the accumulated solids. If the tank fills with sludge and scum, the solids will overflow into the drainfield and quickly clog the soil, resulting in system failure.

THE DRAINFIELD

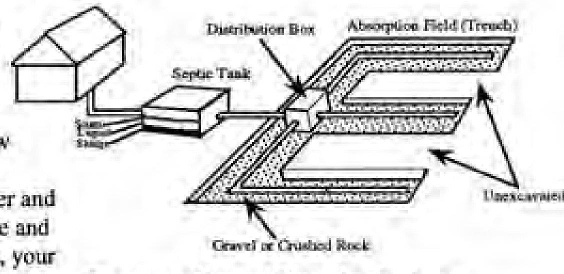


Conventional Rock Drainfield
Trench Cross-Section

The drainfield provides the final treatment of the wastewater and disposes of it through groundwater recharge. The typical drainfield is composed of trenches or beds which are shallow, level excavations installed one to one and a half feet above the groundwater table. Each trench contains a perforated distribution pipe through which wastewater drains into the gravel. The water is stored in the gravel until it can seep into unsaturated soil underlying and adjacent to the trench. As the wastewater moves slowly through the gravel and soil, many of the disease-causing bacteria and viruses are filtered out, or adsorbed and held by the soil particles until they die. Where soils do not permit a drainfield to adequately treat septic tank effluent, an additional or alternative treatment system must be used in conjunction with the drainfield. Alternative systems primarily used in Kentucky are constructed wetlands and sewage lagoons. These alternative systems have their own operation and maintenance guidelines. If you would like information about these guidelines, contact the Groundwater Branch.

TAKING CARE OF YOUR SYSTEM

Your septic system represents a significant investment worth protecting. The old adage "An ounce of prevention is worth a pound of cure" is so true when it comes to the care of your septic system. If you follow the operation and maintenance guidelines given below, your system will function better and last longer, and you will avoid the nightmare and expense of a failed system. Most important, your system will not be polluting groundwater.



Conventional Septic System

DO

- Conserve water to reduce the amount of wastewater that must be treated and disposed.
- Repair any leaking faucets and toilets.
- Discharge only biodegradable wastes into system.
- Divert down spouts and other surface water away from your drainfield.
- Keep your septic tank cover accessible for tank inspections and pumping.
- Have your septic tank pumped regularly and checked for leaks and cracks.
- Call a professional when you have problems.
- Compost your garbage or put it in the trash.

DON'T

- Use a garbage grinder.
- Flush sanitary napkins, tampons, disposable diapers, condoms and other non-biodegradable products into your system.
- Dump solvents, oil, paints, thinners, disinfectants, pesticides or poisons down the drain. These materials can disrupt the treatment process and contaminate the groundwater.
- Dig in your drainfield or build anything over it.
- Plant anything over your drainfield except grass.
- Drive over your drainfield or compact the soil in any way.

If you have a question or need additional information, contact:

Groundwater Branch
Kentucky Division of Water
Natural Resources and Environmental Protection Cabinet
14 Reilly Road
Frankfort, Kentucky 40601
(502) 564-3410

Environmental Management Branch
Division of Environmental Health and Community Safety
Cabinet for Human Resources
275 E. Main Street
Frankfort, Kentucky 40601
(502) 564-4856

Check List
for
Evaluating Your Septic System

1 Find and mark the location of the septic system. You should map this information in the space provided in your Groundwater Protection Plan: "Homeowner's Septic System Guide and Record Keeping Folder."

2 When was the septic tank last pumped?

____

3 If the tank was last pumped over three years ago, or if you have recently moved into the house and don't know when the tank was last pumped, contact a septic tank pumper. Have him service the tank and check the baffles.

4 Do toilets flush slowly and does water drain slowly from sinks and tubs, or does either "gurgle"?

Yes ☐ No ☐

5 Is there any standing water, soggy ground, or smelly liquid in or near the drainfield?

Yes ☐ No ☐

6 Does the ground slope toward the septic system?

Yes ☐ No ☐

7 Are your septic tank and drainfield less than 100 feet from a lake, stream, or pond?

Yes ☐ No ☐

8 Are water-loving trees such as willows, sycamores, birches, or water maples growing within 10 feet of the septic tank?

Yes ☐ No ☐

9 Are there any areas over the septic tank or drainfield where people have frequently driven their cars or trucks?

Yes ☐ No ☐

10 Have any additions been made to the house since the present septic system was installed?

Yes ☐ No ☐

11 Do you have dripping faucets or a toilet that runs continuously or gradually loses water from its tank?

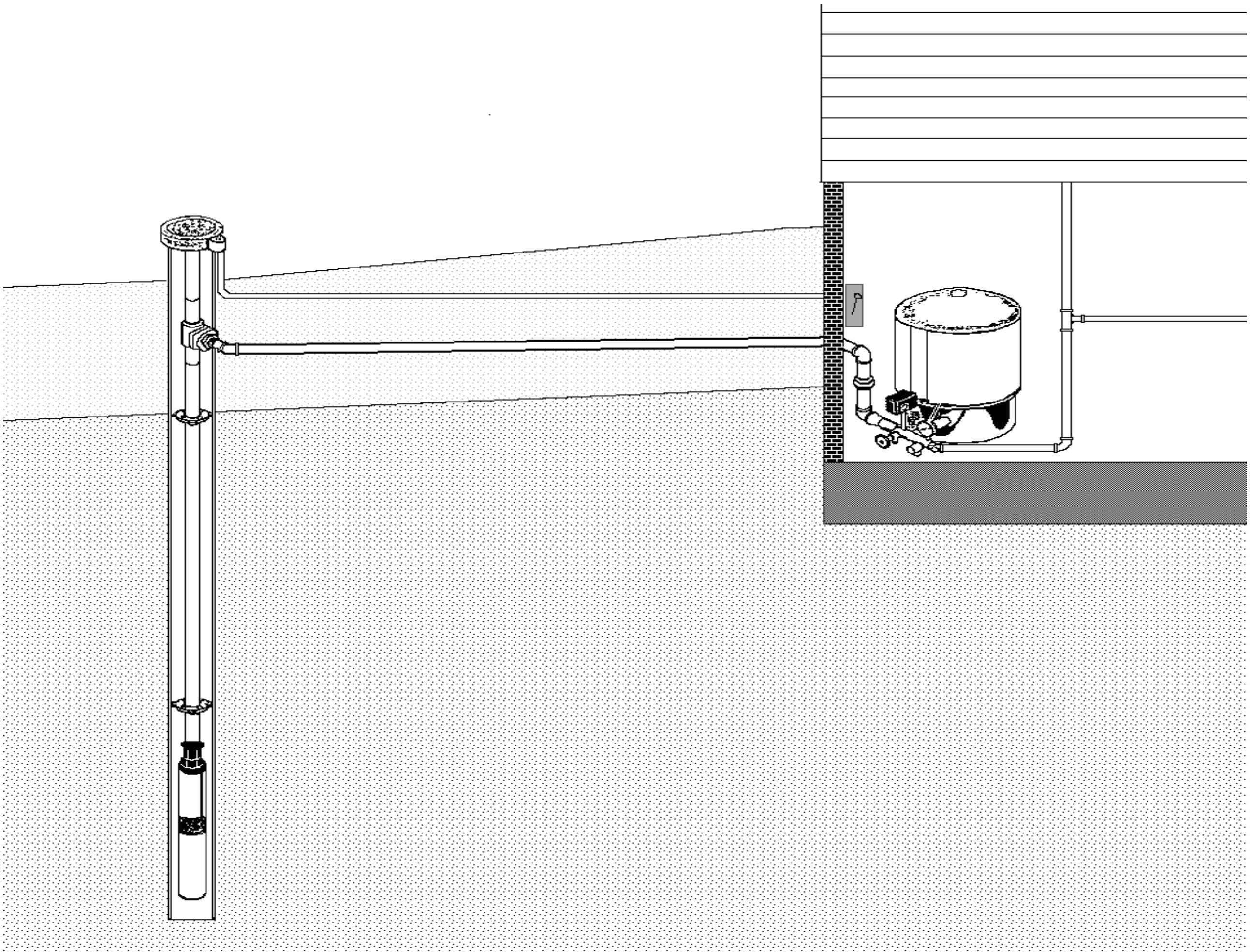
Yes ☐ No ☐

12 Do you put cigarette butts, coffee grounds, cooking fats, disposable diapers, facial tissue, wet-strength towels, or other non-biodegradeble materials into your septic tank?

Yes ☐ No ☐

If you have answered YES to one or more of questions 4 - 12, the septic system may not be functioning correctly. Call your local health department, or seek other professional help. Should repair of the system be necessary, be sure to engage the services of a professional who has a groundwater protection plan on file. If you have any questions, contact the Groundwater Branch, Division of Water, 14 Reilly Road, Frankfort, KY 40601 (telephone 502/564-3410) or the Environmental Management Branch, Division of Environmental Health and Community Safety, 275 E. Main St., Frankfort, KY 40601 (telephone 502/564-4856).

Routine Water Well Maintenance and Disinfection Guide



Natural Resources and
Environmental Protection Cabinet
Department for Environmental Protection
Division of Water

Prepared by the:
Groundwater Branch
Kentucky Division of Water
Department for Environmental Protection
14 Reilly Road
Frankfort, KY 40601
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August 1, 2001 version

The Natural Resources and Environmental Protection Cabinet provides, on request, reasonable accommodations including auxiliary aids and services necessary to afford an individual with a disability an equal opportunity to participate in all services, programs and activities. To request materials in an alternate format, contact the Division of Water, 14 Reilly Road, Frankfort, KY 40601, (502)-564-3410. Hearing- and Speech-impaired persons can contact the agency by using the Kentucky Relay Service, A toll-free telecommunication device for the deaf (TDD). For voice to TDD, call 1-800-648-6057. For TDD to voice, call 1-800-648-6056.

Routine Water Well Maintenance and Disinfection Guide

Routine well disinfection (sometimes called shock chlorination) is a technique that helps keep water from properly constructed wells, a safe and dependable source of drinking water. It also helps reduce nuisance problems such as staining and odors.

Why should I do routine well maintenance and disinfect my well?

Bacteria and viruses, which are accidentally introduced into a well or the plumbing and pipes of a home, can most of the time be eliminated, thus providing safer water. The bacteria that can be eliminated include the total coliform and fecal coliform bacteria which water supplies and health departments run laboratory tests for.

The odors and staining caused by iron, manganese, and sulfur can be reduced and sometimes eliminated through routine well disinfection, resulting in clearer, better tasting and appealing water for you and your family.

The cost of water treatment is often reduced, since iron and sulfur bacteria release iron, manganese, and hydrogen sulfide gas (rotten egg smell) as waste products. Water treatment equipment repairs and water treatment chemical usage may be lowered.

The useful life of the well can be extended, resulting in longer well life an reducing the possibility of costly well rehabilitation. The useful life of the pump, pressure tank, and piping is also increased. Iron and sulfur bacteria can make water more acidic, resulting in corrosion of metal parts in addition to the stresses placed on the pump due to restrictions created by bacterial growths.

The cost to pump water is reduced since plugging of the aquifer and piping system by bacteria slimes is minimized. The pump doesn't have to work as hard, so electrical costs are sometimes minimized.

Routine well inspections during regular well disinfections allow problems with a well to be found early before those problems become serious. Repairs made early cost less and help protect your water source.

Routine well disinfection is an inexpensive process that most well owners can do themselves for a few dollars and a couple of hours of work. The disinfectant, straight chlorine laundry bleach, can be bought at the local grocery store.

When should I disinfect my well?

Well and distribution system disinfection should be performed after any of the following are performed or noted:

After a new well is drilled or the well is otherwise modified.

After a pump repair or replacement.

After the plumbing system has been newly installed, opened, drained, repaired or modified in any way. This could include repair of broken or leaking pipes, installation of a tee to a new faucet or hydrant, draining the system to prevent freezing during a trip, after an extended time period of no use, or any other situation where air, dirt, or hands have touched the inside of the piping system. Failure to disinfect the piping after a repair is potentially exposing your family to pathogenic (disease-causing) organisms.

After the well is covered by floodwaters. Wells in flood-prone areas should have well seals (with watertight gaskets) and the vent extended above the highest known flood level to minimize the possibility of floodwater entering the well. Floodwaters can introduce bacteria and other pathogenic organisms into a well.

After you first notice signs of staining or odors from iron or sulfur bacteria. Iron and sulfur bacteria can be controlled with routine disinfection.

At least once a year as preventative maintenance, even if no problems have been observed or no repairs to the well, pump, or distribution system have been made. Wells with iron and sulfur bacteria may require frequent disinfection with higher chlorine levels to keep growths under control.

What are fecal coliform bacteria?

Fecal coliform bacteria are a family of hundreds of different strains of bacteria.

Most, but not all, are harmless to humans.

They normally live in the intestines of humans and animals.

They are used as an inexpensive test to determine if harmful pathogens (disease-causing organisms) are likely to be present. If no fecal coliform bacteria of any type are present in a sample, it is assumed that no harmful bacteria or viruses are present.

They are one of the many types of coliform bacteria which show up in a “Total Coliform Bacteria” test.

A few varieties produce toxins that can cause illness. The E. Coli 0157:H7 is a variety that has been in the news lately. It is the coliform bacteria associated with cattle and improperly cooked beef. The only known occurrences in wells have been associated with shallow wells near places where cattle are kept.

Chlorine, short wave ultraviolet light, boiling, and ozone all act to kill or inactivate these bacteria.

If your well water shows positive for Total Coliform, you should disinfect the well and distribution system and have it tested again. If the well tests positive for Total Coliform again, a chlorinator or ultraviolet light disinfection system is an option to correct the potential problem.

Fecal coliform bacteria are rare in groundwater unless there is a direct connection to the surface. Wells that become muddy or cloudy after a rain generally have a direct connection to the surface. Examples include:

> Shallow Groundwater – wells less than 20 feet deep or wells that have less than 20 feet of casing.
>
> Open Wells – wells which have no cap or seal or a leaking cap or seal
>
> Cave Streams – wells that pull water from cave streams
>
> Improperly Sealed Casing – wells which have an opening between the casing and the drill hole which allows water to drain from the surface to the groundwater
>
> Hand-dug wells and wells that have buried wellheads. These problem wells may require replacement or continual treatment to provide safe water.

A fecal coliform bacteria sample can be easily contaminated to produce a false positive result. The well may be clean, but samples taken from the faucet may be contaminated.

Source: Modified from data from the USEPA web site on fecal coliform bacteria.

Iron and Sulfur Bacteria

The iron and sulfur bacteria are not known to be harmful to health but are a nuisance causing red, orange, brown, or black slimy stains; musty, "rotten egg", or sulfur odors; and red or orange coloration of the water. They grow on small amounts of iron, manganese, and sulfur dissolved in natural groundwater and rock. They occur naturally in aquifers.

They need only a small amount of air to grow and flourish in a well bore. The agitation, aeration, and induced flow of water to the well bore by the pumping can provide an environment with the small amounts of air, iron, manganese, and sulfur which allows them to flourish. The water flow from the pump can also provide a constant flow of nutrients to the iron and sulfur bacteria around the well and in the pipes, pressure tank, and water heater to allow them to grow very well.

Iron and sulfur bacteria do not show up on a standard Total Coliform Bacteria test or Fecal Coliform test. The first indication of a developing iron and sulfur bacteria problem is the development of red, orange, brown, or black slimes in the toilet tank. Biological Activity Reaction Tests (BARTs) are available for testing for iron and sulfur bacteria in well water. These bacteria can not be eliminated, but they can be controlled through routine well and distribution system disinfection to minimize or eliminate the nuisance effects.

How can these bacterial problems be controlled?

Proper well and distribution system maintenance and routine well disinfection are the keys to controlling and preventing these problems. An inspection of the well and distribution system should occur **<u>at least</u>** once a year and should include:

1. Inspecting the cap or seal to make sure it's in place and secure. The vent should have a screen over the vent hole to prevent insects and rodents from entering the well. In most cases a vent is needed to help a well produce water more efficiently, but can sometimes be plugged in lower-use domestic wells with little noticeable affects. The best type of vents are the ones which allow a little air to enter from the bottom of a U tube, thus preventing things spilled, dumped, or dropped onto the vent from entering the well.

2. Inspecting the ground around the casing to check for slumping and settlement. Backfill slumped holes around the well casing with compacted clay soil. The land surface around the well casing should slope away from the well to prevent the ponding of surface water.

3. Make sure that things are not kept around the well that could release contaminants to the well. (A good rule of thumb is: If you're not willing to drink what could be spilled, leaked, or produced by something, it shouldn't be kept near the well.) Examples include fuel cans, fertilizer, pesticide containers, paint, dog or animal pens, gasoline and diesel-powered tools and vehicles, and solvents.

4. Inspect the piping, wiring, and pressure tank for leaks, excess corrosion, and general condition. If you have a leak or something doesn't look right, have a certified water well driller or plumber check it out.

When should my well and plumbing system be disinfected?

Any time there has been a repair or replacement of the pump or well.

Any time there has been a repair of broken or leaking pipes.

After you install of a new faucet or hydrant.

After the system has been drained to prevent freezing while you are away.

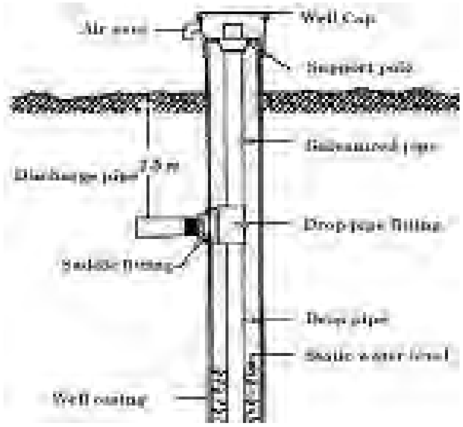
After a well has been unused for an extended period of time and is being put back into service.

Any other situation where air, dirt, or hands have touched the inside of the piping system pump or well.

How Do I Disinfect or Shock Chlorinate My Well and Plumbing System?

The disinfection process generally consists of the following: Adding chlorine to the well, circulating the chlorinated water back down the well, running water to each hot and cold faucet until you smell chlorine, letting the system sit for a minimum of 2 hours (overnight is preferable) and draining the chlorinated water out using an outside faucet.

Once you've disinfected or shock chlorinated the well and plumbing system the first time, you'll find that it's much like cleaning out the gutters or trimming the hedges, you



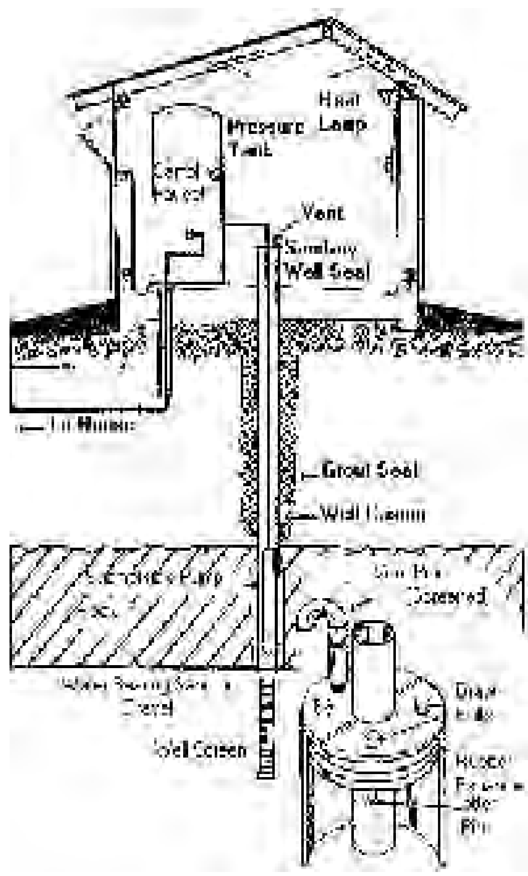
don't have to do it very often and all it takes is a little time and commitment. After all, you are the water plant operator of your own little water system, and the condition of the water coming out of the tap depends on the way you care for your system and the maintenance you provide.

Accessing Your Well

You need to have access to the top of the well casing. If you have a well with a buried wellhead (you have to dig a hole to access the top of the well casing), you should get a certified driller to upgrade your well by installing a ***pitless adapter unit***. A pitless adapter unit allows the water pipe to exit the side of the casing below the ground surface while providing a water tight seal which prevents bacteria and soil critters from getting into your well (see the diagram to the left).

Wells with pitless units have the casing extending up above the ground surface. Wells which have pitless adapter units have a cap that sits down over the well casing (sometimes they have three little set screws on the side of the cap to secure it).

If your water pipe(s) and electrical wires come out of a metal plate on top of the well, which has four bolts in it, you have what is called a ***sanitary seal*** (see figure to the right). The pump and pipe hang on a sanitary seal, so do not loosen the bolts and raise this unless you know what you are doing. Instead you can access the well through the vent pipe.



If this has you confused, ask your certified well driller to show you how to get access to your well for routine well disinfection. Modifications to the vent can allow chlorine to be added to a well by removing a plug.

If your submersible pump wires come out of the vent hole, you may need to have the certified driller install a different sanitary seal that has a separate vent hole. See the figure to the right for more details.

If your well is newer than 1986, you should have a Kentucky Water Well Record form for your well.
Since 1986, the Kentucky Certified Water Well Driller has been required by law to

provide the well owners with this record. It tells the depth of the well, diameter of the casing and static water level in the well when it was drilled among other things. Subtracting the static water level from the total depth of the well gives you the feet of standing water in the well. You can use the number of feet of standing water in your well and the diameter to determine the amount of chlorine you need to disinfect your well.

Amount of Chlorine You Need to Add

You need to calculate the amount of water in your well. Once you calculate these numbers the first time, you can use the same numbers each time you disinfect the system. To do this you need to know the diameter of the inside of the casing and the approximate number of feet of water standing in your well.

If you know these numbers, use the chart below to determine how much chlorine you need. This chart also assumes that your plumbing system has about 100 of gallons of water and this is included in this chart. If your well is different from those in this chart, you can go to Appendix 1 and calculate the exact amount for your well and plumbing system.

Amount of household Laundry Bleach Needed to Disinfect a Well and Plumbing System

Feet of Standing Water in The Well	4-inch inside casing diameter	5-inch inside casing diameter	6-inch inside casing diameter	7-inch inside casing diameter	8-inch inside casing diameter	10-inch inside casing diameter
10 feet	1 quart + 2 $^{1}/_{3}$ cups	1 quart + 2 $^{2}/_{3}$ cups	1 quart + 2 $^{7}/_{8}$ cups	1 quart + 3 ¼ cups	1 quart + 3 $^{5}/_{8}$ cups	2 quarts + ½ cups
20 feet	1 quart + 2 ¾ cups	1 quart + 3 ¼ cups	1 quart + 3 ¾ cups	2 quarts + ½ cups	2 quarts + 1 $^{1}/_{8}$ cups	2 quarts + 1 ½ cups
30 feet	1 quart + 3 ¼ cups	2 quarts	2 quarts + $^{5}/_{8}$ cups	2 quarts + 1 $^{5}/_{8}$ cups	2 quarts + 2 ¾ cups	3 quarts + 1 $^{1}/_{3}$ cups
40 feet	1 quart + 3 ½ cups	2 quarts + ½ cups	2 quarts + 1 ½ cups	2 quarts + 2 $^{7}/_{8}$ cups	3 quarts + ¼ cups	3 quarts + 3 ¾ cups
50 feet	2 quarts	2 quarts + 1 cup	2 quarts + 2 ½ cups	3 quarts	3 quarts + 1 $^{7}/_{8}$ cups	4 quarts + 2 ¼ cups
60 feet	2 quarts + $^{1}/_{3}$ cups	2 quarts + 1 $^{2}/_{3}$ cups	2 quarts + 3 ¼ cups	3 quarts + 1 ¼ cups	3 quarts + 3 $^{3}/_{8}$ cups	5 quarts + $^{2}/_{3}$ cups
70 feet	2 quarts + ¾ cups	2 quarts + 2 ¼ cups	3 quarts + $^{1}/_{8}$ cups	3 quarts + 2 ½ cups	4 quarts + 1 cup	5 quarts + 3 $^{1}/_{8}$ cups
80 feet	2 quarts + 1 $^{1}/_{8}$ cups	2 quarts + 2 $^{7}/_{8}$ cups	3 quarts + 1 cup	3 quarts + 3 $^{5}/_{8}$ cups	4 quarts + 2 ½ cups	6 quarts + 1 $^{5}/_{8}$ cups
90 feet	2 quarts + 1 ½ cups	2 quarts + 3 ½ cups	3 quarts + 2 cups	4 quarts + $^{7}/_{8}$ cups	5 quarts + $^{1}/_{8}$ cups	7 quarts
100 feet	2 quarts + 2 cups	3 quarts + $^{1}/_{8}$ cups	3 quarts + 2 $^{7}/_{8}$ cups	4 quarts + 2 cups	5 quarts + 1 $^{5}/_{8}$ cups	7 quarts + 2 ½ cups
Chlorine/10 ft. for more than 100 ft of water	*$^{3}/_{8}$ cups*	*$^{5}/_{8}$ cups*	*$^{7}/_{8}$ cups*	*1 ¼ cups*	*1 ½ cups*	*2 ½ cups*

Diagram shows approximate amounts of straight laundry bleach needed to achieve ~200-PPM chlorine in the well and plumbing system rounded to the nearest 1/8 of a cup. Chart assumes 100 gallons of water in the home pipes, pressure tank, and water heater. For wells with diameters between those shown above, use the next larger size chart (4.5-inch use 5-inch). **Be sure to use only straight laundry bleach (5 ¼ % chlorine)** (usually the cheapest), **bleaches that have scents, fabric softeners, water conditioners, or color enhancers should never be used in a water well.** Double the amounts shown if treating the system for Iron and Sulfur Bacteria to achieve ~400-PPM chlorine.

Getting Started

Let everyone in the house know that you are about to disinfect the system. Have some bottled water for drinking set aside and make sure that water-intensive needs such as watering stock, baths, showers, laundry, etc., are done before adding the chlorine to the well. An occasional toilet flush is OK, but you want the chlorinated water to sit in the system and work. **You need to bypass water treatment devices such as softeners and filters.** These devices usually have a bypass valve to redirect the water around the device. You may want to contact the manufacture or the service technician for your treatment device to find out about its tolerance to chlorine and how to operate the bypass valve. You should also minimize the amount of chlorinated water running down the drain to your septic system since septic systems rely on bacteria to break down waste and chlorine can kill these beneficial bacteria.

Adding the Chlorine to the Well

Pour the chlorine solution into the well, trying to make it run down the sides and pipe. Attach a garden hose to the closest hose attachment to the well and run the hose back to the well. Re-circulate the chlorinated water down the well, rinsing the sides, piping, and wires down for a minimum of 15 minutes.

Go to every faucet in the house, starting with the ones closest to the well and let them run until you smell chlorine and then turn them off. Do this with both the hot and the cold faucets, run the washer and dish washer on warm until you smell chlorine, flush each toilet until you smell chlorine, and don't forget the outside faucets and hydrants. The idea is to completely fill every pipe in the system with the highly chlorinated water. Let the system sit for a minimum of two hours with overnight being the best.

Clearing the System of Chlorine

After the chlorine has been in the system the needed amount of time, it needs to be flushed. Use an outdoor faucet to drain the excess chlorinated water from the system. When highly chlorinated water is exposed to air, the chlorine evaporates into the air quickly. It is best to use a hose to run this water to a driveway since high concentrations of chlorine may damage plants. High concentrations of chlorine are harmful to aquatic life so do not discharge the water to a stream or creek. A lawn sprinkler can be used to aerate and spread out the water being discharged.

After the garden hose is running clear and has no smell of chlorine, the inside faucets can be cleared. If iron and sulfur bacteria are a problem, you may find that particles of material are being discharged along with the water. These particles are dead bacteria and oxidized iron and manganese. You'll need to go to each faucet, remove the aerator and let the water run at full flow to flush this material from the lines. Be sure to run the washer and dishwasher empty through a cycle to flush this material from these lines also.

Note: If you are chlorinating your well and plumbing for an iron bacteria problem, you may have to repeat this procedure frequently to get the problem under control.

Have Your Water Tested

If you disinfected the system due to a bad Total Coliform Bacteria test or as a yearly system maintenance procedure, you should have the water tested for bacteria a week or two after the disinfection. If, after repeated disinfection and testing cycles, the Coliform tests are still coming back positive, your well may be exhibiting a possible direct connection to the surface. Wells that show connection to the surface should be repaired or properly abandoned and a new, deeper well constructed by a certified water well driller. If having the well repaired or constructing a new well is not feasible, an inline or in-well chlorinator or ultraviolet light disinfection unit should be installed to help ensure the water is safe from bacteria and viruses.

Treating the System for Iron and Sulfur Bacteria

If your well and system are being shock chlorinated for an iron and sulfur bacteria infestation, you may have to repeat the process frequently at first to get the problem under control. Extra strong chlorine solutions (400 ppm, twice the amount of chlorine from the chart) may be needed along with as long as possible contact time to allow the chlorine to work its way back into the aquifer.

Many people have found that problem wells with red, orange or black water flowing from the tap can be cleared up with persistent and frequent shock chlorination. Continuous in-well chlorinators can be installed for extremely bad iron and sulfur bacteria problems. A large back-flushable activated carbon or redox filter unit can be used to remove the excess chlorine and insoluble particles before it is distributed to the house.

In wells with extremely high iron, sulfur, and slime bacteria, a well-rehabilitation specialist may be needed to use a combination of extremely strong chemicals and procedures to bring the well back. There are times when it is cheaper to have a certified driller plug the infested well and drill a new one. If a new well is drilled by a certified water well driller, you should disinfect the well at least once a year to ensure your investment and water quality retains its value over the life of the well. Be sure and to have the certified driller properly plug and seal your old well to eliminate a pathway for surface pollution to enter groundwater.

A well does have a limited life but usually will provide 20 years or more of service before major rehabilitation/reconstruction or replacement if simple routine maintenance and routine well disinfection procedures are followed. When you have a new well drilled, extra protection, such as more than the minimum length of casing and grouting the casing into the drill hole, can cost more but are worth it. These precautions can help to protect your well water from infiltration of surface water, which could be a source of pathogens, and helps to ensure that your well will have a long, productive life while protecting your family's health and safety.

Appendix A

You can measure the casing inside diameter or get this from the well log if you have one. Look this number up in **Table 1** to determine the number of gallons of water per foot of casing. The number of feet of water standing in the well can be calculated by subtracting the static water level (distance from the top of the well to the top of the water) from the total depth of the well from the top of the casing to the bottom of the well. You may know these numbers already from the water well log or from when the well was drilled and can use them directly. You can also call the driller who drilled the well and ask if he has these records on the well. You can also make arrangements with a certified water well driller to make these measurements of your well for you.

Total Depth - Static Water Level = Feet of Water Standing in a Well

Feet of Water Standing in Well X Gallons of Water per Foot = Gallons of Water in Well

If you have a standard system and pressure tank, you can assume that the piping, pressure tank, and water heater have about 100 gallons of water in them. Add 100 gallons to the number of gallons of water in the well to get the number of gallons of water in the well and water system. If you have a larger than normal pressure tank, a water storage tank, or longer than normal pipe runs, you may need to make additions for their extra capacity. It will not harm your well if you over chlorinate it. The only problem it causes is it take longer to flush the chlorine from the well and system.

Use **Table 2** to determine the amount of chlorine product needed to bring the well and water system water to approximately 200 PPM chlorine. Systems with bad iron and sulfur bacteria infestations may require 400 PPM or more to deal with the problem, so double the amounts of chlorine. **Table 2** gives the amounts of various chlorine products needed per 100 gallons of water in the well and water system. The powdered and concentrated liquid products should be premixed with 5 or 10 gallons of water before it is poured into the well. Pellets may be too big to fit through the vent on a sanitary seal and require you to pre-dissolve them in water. Always use a plastic or glass container or bucket when mixing concentrated chlorine solutions, since strong chlorine solutions can sometimes react with metal.

Table 1. Well Volume

Well/Pipe Diameter (Inches)	**Gallons of water for each Foot of Water Depth in a well (Gallons/Ft. of Water)**	***Well/Pipe Diameter* (Inches)**	**Gallons of water for each Foot of Water Depth in a well (Gallons/Ft. of Water)**
2	0.163	12	5.87
3	0.367	20	16.23
4	0.653	24	23.5
5	1.02	36	52.9
6	1.47	48	94
8	2.61	60	147

Modified from Powell, G.M.,1990, Shock Chlorination for disinfecting Water Systems, MF-911, Kansas Cooperative Extension Service

Table 2. Chlorine Mix Ratio for Shock Chlorination*

Chlorine Source	Percent Chlorine	Form*	Amount to Add *
Laundry bleach-Chlorox, Purex, Hi-Lex, etc.	5 ¼	Liquid	3pt/100 gal.
Swimming pool-disinfectant or concentrated chlorine bleach	12-17	Liquid	1pt/100 gal.
Dairy sanitizer	30	Powder	4oz/100 gal.
High-test calcium hypochlorite, HTH Pittchlor, Perchloron, etc.	65-75	Powder	3pt/100 gal.

*Makes approximately 200 ppm (200 mg/l) concentrations. For stronger concentration increase the amount; for weaker solution decrease the amount. -Be sure that chlorine is the only active ingredient. Sometimes other materials such as algaecide may be added to bleaches or pool disinfectants. Material intended for disinfection normally contains only chlorine as the active ingredient. Other halogens such as iodine or bromine may also be included. These normally should be avoided since they do not evaporate as chlorine does, so they remain in the water. If used, greater care should be exercised when disposing of the treatment solution. Some laundry bleaches have scents, water conditioners, and softening agents added, these products are more expensive and should never be used to disinfect a well.

Modified from Powell, G.M.,1990, Shock Chlorination for disinfecting Water Systems, MF-911, Kansas Cooperative Extension Service

Notes:

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Private Drinking Water Wells

Approximately 42 million people (US Geological Survey, 1995) in the U.S. obtain water from their own private drinking water supplies. Most of these supplies are drawn from ground water through wells, but some households also use water from streams or cisterns. EPA does not oversee private wells, although some state and local governments do set rules to protect users of these wells. EPA encourages these households to take special precautions to ensure the protection and maintenance of their drinking water supplies.

- EPA has a guide for homeowners entitled **Drinking Water From Household Wells**. This booklet helps answer the most frequently asked questions. It also describes problems to look for and offers maintenance suggestions.
- EPA also offers **Private Wells: Guidance for What to Do After the Flood**.
- **Drinking Water and MTBE : A Guide for Private Well Owners** (http://www.uwex.edu/farmandhome/wqpaap/pdf/mtbe.pdf) is available from Farm*A*Syst and provides basic information and resources about this gasoline additive.

Testing private well water ~ Protecting private well water ~ More information

How can I test the quality of my private drinking water supply?

You should test private water supplies annually for nitrate and coliform bacteria to detect contamination problems early. Test them more frequently and for more potential contaminants, such as radon or pesticides, if you suspect a problem.

If you use a private laboratory to conduct the testing, nitrate and bacteria samples will typically cost between $10 and $20 to complete. Testing for other contaminants will be more expensive. For example, testing for pesticides or organic chemicals may cost from several hundred to several thousand dollars.

Many laboratories are available to test water quality. EPA does not test individual homes, and cannot recommend specific labs to test your drinking water, but states certify water testing labs. You may call your State Certification Officer to get a list of certified water testing labs in your state. Some local health departments also test private water for free. Phone numbers for your local, county, or state health department are available under the "health" or "government" listings in your phone book.

Most laboratories mail back the sample results within days or several weeks. If a contaminant is detected, the results will include the concentration of the contaminant and an indication of whether this concentration exceeds a drinking water quality standard. If a standard is exceeded in your sample, retest the water supply immediately and contact your public health department for assistance. Some problems can be handled quickly. For example, high bacteria concentrations can sometimes be controlled by disinfecting a well. Filters or other on-site treatment processes may also remove some contaminants. Other problems may require a new source of water, or a new, deeper well. If serious problems persist, you may need to rely on bottled water until a new water source can be obtained.

How can I protect my private water supply?

You can protect your water supply by carefully managing activities near the water source. For households using a domestic well, this includes keeping contaminants away from sinkholes and the well itself. Hazardous chemicals also should be kept out of septic systems.

- Periodically inspect exposed parts of the well for problems such as:

  - cracked, corroded, or damaged well casing.
  - broken or missing well cap.
  - settling and cracking of surface seals.

- Slope the area around the well to drain surface runoff away from the well.
- Install a well cap or sanitary seal to prevent unauthorized use of, or entry into, the well.
- Have the well tested once a year for coliform bacteria, nitrates, and other constituents of concern.
- Keep accurate records of any well maintenance, such as disinfection or sediment removal, that may require the use of chemicals in the well.
- Hire a certified well driller for any new well construction, modification, or abandonment and closure.
- Avoid mixing or using pesticides, fertilizers, herbicides, degreasers, fuels, and other pollutants near the well.
- Do not dispose of wastes in dry wells or in abandoned wells.
- Do not cut off the well casing below the land surface.
- Pump and inspect septic systems as often as recommended by your local health department.

- Never dispose of hazardous materials in a septic system.

More information about private wells

Several sources of technical assistance are available to help you protect your water supply.

The Water Systems Council, a nonprofit organization solely focused on individual wells and other well-based systems, recently opened a hotline for well owners partially funded by a grant from the U.S. EPA. Well owners with questions about wells and well water can call the new hotline at **1-888-395-1033** or visit their website at www.wellcarehotline.org.

The organization Farm*A*Syst/Home*A*Syst provides fact sheets and worksheets to help farmers and rural residents assess pollution risks and develop management plans geared toward their circumstances. For example, Farm*A*Syst helps farmers and ranchers identify pollution risks from nitrates, microbes, and toxic chemicals. Home*A*Syst reaches homeowners who face pollution risks from faulty septic systems, pesticide use, petroleum leaks, and hazardous waste disposal.

Local health departments and agricultural extension agents can also provide general technical assistance. They can be found under the "government" or "health" listings in your phone book. EPA's Safe Drinking Water Hotline also provides access to publications and technical assistance over the phone at (800) 426-4791. Among EPA's publications that may help you is the detailed "Manual of Individual and Non-public Water Supply Systems (EPA 570/9-91-004). Hotline staff may be able to direct you to sources of state and local assistance.

Many states, organizations, and university extension services offer information for private well owners. Some of the many resources available are:

Testing of private wells (Michigan State University)
Information for homeowners with private wells (Wisconsin Dept. of Natural Resources)
Best Management Practices for Wellhead Protection (University of Idaho College of Agriculture)
Protecting your well and water supply (Kentucky Division of Water)
American Ground Water Trust
National Ground Water Association's page for well owners

Consumer Factsheet on: NITRATES/NITRITES

List of Contaminants

As part of the Drinking Water and Health pages, this fact sheet is part of a larger publication:

National Primary Drinking Water Regulations

This is a factsheet about a chemical that may be found in some public or private drinking water supplies. It may cause health problems if found in amounts greater than the health standard set by the United States Environmental Protection Agency (EPA).

What are Nitrates/Nitrites and how are they used?

Nitrates and nitrites are nitrogen-oxygen chemical units which combines with various organic and inorganic compounds. Once taken into the body, nitrates are converted into nitrites. The greatest use of nitrates is as a fertilizer.

Why are Nitrates/Nitrites being regulated?

In 1974, Congress passed the Safe Drinking Water Act. This law requires EPA to determine safe levels of chemicals in drinking water which do or may cause health problems. These non-enforceable levels, based solely on possible health risks and exposure, are called Maximum Contaminant Level Goals.

The MCLG for nitrates has been set at 10 parts per million (ppm), and for nitrites at 1 ppm, because EPA believes this level of protection would not cause any of the potential health problems described below.

Based on this MCLG, EPA has set an enforceable standard called a Maximum Contaminant Level (MCL). MCLs are set as close to the MCLGs as possible, considering the ability of public water systems to detect and remove contaminants using suitable treatment technologies.

The MCL for nitrates has been set at 10 ppm, and for nitrites at 1 ppm, because EPA believes, given present technology and resources, this is the lowest level to which water systems can reasonably be required to remove this contaminant should it occur in drinking water.

These drinking water standards and the regulations for ensuring these standards are met, are called National Primary Drinking Water Regulations. All public water supplies must abide by these regulations.

What are the health effects?

Short-term: Excessive levels of nitrate in drinking water have caused serious illness and sometimes death. The serious illness in infants is due to the conversion of nitrate to nitrite by the body, which can interfere with the oxygen-carrying capacity of the childs blood. This can be an acute condition in which health deteriorates rapidly over a period of days. Symptoms include shortness of breath and blueness of the skin.

Long-term: Nitrates and nitrites have the potential to cause the following effects from a lifetime exposure at levels above the MCL: diuresis, increased starchy deposits and hemorrhaging of the spleen.

How much Nitrates/Nitrites are produced and released to the environment?

Most nitrogenous materials in natural waters tend to be converted to nitrate, so all sources of combined nitrogen, particularly organic nitrogen and ammonia, should be considered as potential nitrate sources. Primary sources of organic nitrates include human sewage and livestock manure, especially from feedlots.

The primary inorganic nitrates which may contaminate drinking water are potassium nitrate and ammonium nitrate both of which are widely used as fertilizers.

According to the Toxics Release Inventory, releases to water and land totaled over 112 million pounds from 1991 through 1993. The largest releases of inorganic nitrates occurred in Georgia and California.

What happens to Nitrates/Nitrites when they are released to the environment?

Since they are very soluble and do not bind to soils, nitrates have a high potential to migrate to ground water. Because they do not evaporate, nitrates/nitrites are likely to remain in water until consumed by plants or other organisms.

How will Nitrates/Nitrites be detected in and removed from my drinking water?

The regulation for nitrates/nitrites became effective in 1992. Between 1993 and 1995, EPA required your water supplier to collect water samples at least once a year and analyze tem to find out if nitrates/nitrites are present above 50 percent of their MCLs. If it is present above this level, the system must continue to monitor this contaminant every 3 months.

If contaminant levels are found to be consistently above their MCLs, your water supplier must take steps to reduce the amount of nitrates/nitrites so that they are consistently below that level. The following treatment methods have been approved by EPA for removing nitrates/nitrites: Ion exchange, Reverse Osmosis, Electrodialysis.

How will I know if Nitrates/Nitrites are in my drinking water?

If the levels of nitrates/nitrites exceed their MCLs, the system must notify the public via newspapers, radio, TV and other means. Additional actions, such as providing alternative drinking water supplies, may be required to prevent serious risks to public health.

Drinking Water Standards (ppm): MCLG MCL

Nitrate:	**10**	**10**
Nitrite:	**1**	**1**

Nitrate and Nitrite Releases to Water and Land: 1991 to 1993 (in pounds)

	Water	**Land**
TOTALS	**59,014,378**	**53,134,805**

Top Fifteen States*		
GA	12,114,253	12,028,585
CA	0	21,840,999
AL	3,463,097	6,014,674
LA	8,778,237	2,250
MO	6,985,890	206,181
MS	6,952,387	0
KS	5,140,000	877,095
VA	5,091,764 0	
NV	0	4,977,482
FL	1,056,560	1,835,736
AR	1,206,610	1,058,294
MD	1,802,219	138,819
IA	1,500,340	132,042
OK	1,436,348	14,199
UT	0	1,045,400

Major Industries*		
Nitrogenous fertilizer	41,584,611	8,607,376
Misc. Ind. inorganics	4,113,312	29,676,919
Misc. Metal ores	0	5,764,976
Misc. Ind. organics	5,091,764	0
Fertilizer mixing	480,000	4,554,916
Explosives	850,921	1,297,590
Paper mills	1,727,061	0
Pulp mills	1,321,500	3,350
Canned foods	0	1,056,794
Phosphate fertilizers	1,000,000	0

- State/Industry totals only include facilities with releases greater than 10,000 lbs.

Learn more about your drinking water!

EPA strongly encourages people to learn more about their drinking water, and to support local efforts to protect and upgrade the supply of safe drinking water. Your water bill or telephone books government listings are a good starting point.

Your local water supplier can give you a list of the chemicals they test for in your water, as well as how your water is treated.

Your state Department of Health/Environment is also a valuable source of information. For help in locating these agencies or for information on drinking water in general, call: EPAs Safe Drinking Water Hotline: (800) 426-4791.

For additional information on the uses and releases of chemicals in your state, contact the: Community Right-to-Know Hotline: (800) 535-0202.

10 Ways You Otter Care About Water

Complete and return if you would like to get involved in keeping our water resources clean!

- Name
- Address
- Telephone
- E-Mail

- What would you like to know more about?

Please return to:
Water Watch
Kentucky Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Numbers to Know

Kentucky Department for Environmental Protection
Frankfort, Kentucky

- Division of Water
  502-564-3410

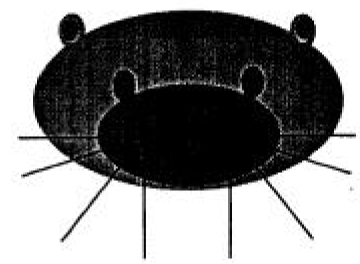
- Division of Waste Management
  502-564-6716

- Environmental Response Team
  (For emergencies involving hazardous waste)
  502-564-238

- Regional Offices - Division of Water

Bowling Green	502-746-7475
Columbia	502-384-4734
Florence	606-292-6411
Frankfort	502-564-3358
Hazard	606-435-6022
London	606-878-0157
Louisville	502-595-4218
Madisonville	502-824-7529
Morehead	606-784-6635
Paducah	502-898-8468

Water Watch Program



10 Ways You Otter Care About Water

Kentucky Department for Environmental Protection
Kentucky Division of Water

1 - Get Involved

We all need clean water. Each one of us pollutes the water - each one of us can help save it. Our contribution may seem small, but they join with those of thousands of others for a big impact.

2 - Save Water

Saving water will help our streams by reducing the volume of water going through sewage treatment plants and septic systems.

- A dripping faucet wastes 20 gallons of water a day and a leaking toilet 200 gallons.
- If your water meter dial moves when no water is running you have a leak.
- Use water sparingly while brushing your teeth, washing dishes, or shaving.
- Install a water conservation shower head and take short showers instead of baths. A bath uses 30-50 gallons of water, a short shower only 10gallons.

3 - Dispose of Household Products Carefully

Many products under your kitchen sink or in the garage can harm our streams.

- Never pour paints, preservatives, brush cleaners, and solvents down a drain. Sewers or septic tanks do not remove these materials, and they can enter the water untreated.
- Stuff paints cans and other chemical containers with newspaper before discarding. This adsorbs the liquid and reduces migration of the liquid.
- Buy the product with the least amount of toxic materials.
- Used turpentine and brush cleaners can be filtered and reused.

4 - Care for Your Lawn Ecologically

Lawns with trees and shrubs prevent erosion, soak up nutrients before they run off into the water, and improve your soil by adding organic material.

- Mulching your garden and avoiding exposed soil can improve moisture retention as well as prevent soil erosion.
- Use the proper fertilizer, and do not over fertilize. Be sure that lawn services use only the chemicals that your individual yard needs.

5 - Practice Sensible Pest Control

Pesticides can kill ALL Bugs. A better way to eliminate harmful garden bugs is to encourage helpful bugs and animals such as birds.

- Make sure wood piles which attract termites are away from your home.
- Remove old tires from water where mosquitoes like to breed.
- Follow pesticide directions carefully. Do not apply near water or bare ground, or if rain is forecasted.

6 - Dispose of Trash and Garbage Properly

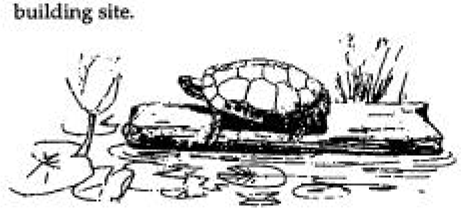
Discarding trash over a stream bank or in a sink hole can cause unsightly problems for our streams. When water flows through trash it can carry with it the chemicals we discard. Open dumps also provide breeding places for bacteria, insects and rodents which can further contaminate our streams.

- Sign up for regular trash collection and encourage your neighborhoods to do the same.
- Take large appliances and other bulky wastes to an approved landfill.

7 - Control Soil Erosion

When rain falls on bare soils in gardens, plowed fields, or building sites, dirt washes into our streams. Not only does it muddy streams, fill in channels, and destroy breeding habitat; but carries with it bacteria and chemicals found in the soil.

- Mulch or plant ground cover on exposed areas.
- Use no-till planting.
- Follow "best management practices" on your building site.



8 - Use Car Care Products Wisely

Motor-oil, anti-freeze and battery acid harm nearby water if they wash off driveways and parking areas.

- Drain uesd fluids into containers, not onto the ground.
- Recycle these products if posible.
- If you cannot recycle these products in your area put them in a strong plastic bag with newspaper or other absorbent material.
- Wash your car on grass so that the water and detergent is filtered through the grass before entering the stream.

9 - Maintain Your Septic System

If a septic system fails, its untreated waste can seep through the ground into our streams. Your system is not working properly if drains and toilets drain slowly or if effluent seeps upward from the ground.

- Use your garbage disposal sparingly to reduce grease and solids in your septic system.
- Don't use your toilet as a garbage can.
- Know the location of your system and keep heavy equipment off the drainage area.
- Plant trees and shrubs away from the drain tiles so they do not clog the drain lines.
- If a public sewersystem is available in your area be sure your home is connected.
- Check with the local Health Department for information on proper management.

10 - Contain Chemical Spills Quickly

If pesticides, oil or similar products leak or spill onto your garage floor or other hard surfaces,quick action is needed to prevent contamination of nearby waterways.

- Do not wash down the area. This will cause further contamination and may carry the material to storm drains or other water sources.
- Surround the contaminated area with dirt or sprinkle sawdust, kitty litter, or other absorbent materials over the spill.
- Put the material in a strong plastic bag and dispose of properly.

Kentucky Division of Water

WATER WATCH groups, administered through this branch. Citizen groups adopt streams, lakes, rivers, and wetlands that they monitor to help keep them clean and usable.

Division of Water Regional Offices

Bowling Green
1508 Western Avenue
Bowling Green, KY 42104
(270) 746-7475

Columbia
102 Burkesville Street
Columbia, KY 42728
(270) 384-4734

Florence
8020 Ewing Blvd., Suite 110
Florence, KY 41042
(606) 292-6411

Frankfort
643 Teton Trail, Suite B
Frankfort, KY 40601
(502) 564-3358

Hazard
233 Birch Street, Suite 1
Hazard, KY 41701
(606) 435-6022

London
85 State Police Road
London, KY 40741
(606) 676-0157

Louisville
9116 Leesgate Road
Louisville, KY 40222-5084
(502) 425-4671

Madisonville
Madisonville State Office Building
625 Hospital Drive
Madisonville, KY 42431-1683
(270) 824-7529

Morehead
200 Christy Creek Road, Suite 2
Morehead, KY 40351
(606) 784-6635

Paducah
4500 Clarks River Road
Paducah, KY 42003
(270) 898-8468

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KENTUCKY DIVISION OF WATER

14 Reilly Road
Frankfort, Kentucky 40601
(502) 564-3410
http://water.nr.state.ky.us/dow/dwhome.htm

Natural Resources and Environmental Protection Cabinet

Mission Statement

The mission of the Kentucky Division of Water is to manage, protect, and enhance the water resources of the Commonwealth for present and future generations through voluntary, regulatory, and educational programs.

Goals

The division's goals are to

- Oversee the provision of safe drinking water
- Prevent water pollution
- Manage water resources

within a

- Workplace environment that encourages and rewards professionalism

using a

- Systematic process for evaluating effectiveness and efficiency.

Responsibilities

The Division of Water is charged with the responsibility for managing and protecting the state's waters, both on the surface in lakes, streams, and rivers as well as groundwater beneath the surface of the land in the state.

The division is divided into nine branches to carry out its responsibilities.

Branches of the Division of Water and their responsibilities are:

Kentucky Pollutant Discharge Elimination System (KPDES) Branch - Issues permits to control the amount of pollutants that can be discharged to the surface waters of the commonwealth.

Facilities Construction Branch - Reviews plans for building or altering wastewater treatment plants and sewage collection systems.

Drinking Water Branch - Reviews design and operation plans for drinking water plants and monitors their operation.

Water Resources Branch - Issues permits for construction in floodplains to help prevent losses from flooding; inspects dams listed in the state's inventory; and aids communities in drawing up water supply plans and issues water withdrawal permits.

Water Quality Branch - Develops water quality standards and criteria; collects and analyzes physicochemical and biological data for rivers, streams, lakes, and wetlands throughout the state and prepares summaries and reports of this information; and develops and implements nonpoint source pollution control programs for surface and ground waters, including assessment, on-site evaluation, education, and agency coordination activities.

The *Wild Rivers Program*, administered by the Water Quality Branch, monitors water quality, enforces land-use compliance, educates users and landowners, and evaluates candidates for future designation.

Groundwater Branch - Oversees the Wellhead Protection Program, Groundwater Protection Plans, and trains and certifies water well drillers.

Field Operations Branch - Inspects water and wastewater treatment plants to monitor their operations and assure the safety of the public's drinking water and the state's streams; provides technical assistance; responds to complaints from citizens; and responds to environmental emergencies and natural disasters involving land, air, or water.

Enforcement Branch - enforces water quality and drinking water laws and regulations; trains and certifies wastewater and drinking water plant operators and offers technical assistance to plants through its *CompTrain* program.

Program Planning and Administration Branch - Citizens across the state can get involved in protecting the state's waters by joining one of the division's internationally acclaimed

Groundwater …protecting it is now the law

√ Application of chloride-based deicing materials used on roads or parking lots;
√ Emergency response activities;
√ Fire fighting activities;
√ Transportation of materials by car, truck, train, boat, or plane;
√ Application of fertilizers or pesticides on farm lands.

Generic groundwater protection plans may govern all or part of a person's activities. A generic plan prepared by another person or group, including a trade group, may be used if:

- The activities identified are substantially identical.
- The factors identified do not cause substantial differences in the potential to pollute among locations.
- The groundwater protection plan has been reviewed and approved by the cabinet.

The cabinet, in cooperation with other appropriate state agencies, shall prepare generic groundwater protection plans for use of **existing residential septic systems and construction, operation, closure, and capping of water wells.**

Examples of entities that will require plans

- churches, schools, businesses, etc., with on-site sewage systems
- small businesses with chemical storage areas
- hazardous waste generators
- city or county governments
- lawn care services
- service stations

The Division of Water will begin inspecting groundwater protection plans after the Aug. 24, 1995, deadline.

Commonly asked questions:

Q. Are there forms for submittal to the Cabinet?
A. Site-specific plans are not required to be submitted to the Cabinet. However, plans must be retained on site, and the Cabinet or citizens may request to review them.
Q. If I have a spill prevention control and countermeasure plan or stormwater plan, do I need to develop a groundwater protection plan?
A. Yes.
Q. How long must records be kept?
A. Records must be kept for six years.
Q. When do I do another plan?
A. Plans must be amended prior to implementing new activities and must be recertified every three years.

For additional information, contact:
Groundwater Branch
Kentucky Division of Water
14 Reilly Road
Frankfort, Ky. 40601
(502) 564-3410

Natural Resources and
Environmental Protection Cabinet

The Natural Resources and Environmental Protection Cabinet does not discriminate on the basis of race, color, national origin, sex, age, religion, or disability and provides, on request, reasonable accommodations including auxiliary aids and services necessary to afford an individual with a disability an equal opportunity to participate in all services, programs, and activities. To request materials in an alternative format, please contact Maleva Chamberlain, Division of Water, 14 Reilly Road, Frankfort, Kentucky 40601 or telephone (502) 564-3410.
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Groundwater . . . Protecting it is now the law

A guide to Kentucky's new groundwater regulation

What are requirements?

What activities are affected?

Goals:

√ Ensure protection for all current and future uses of groundwater
√ Prevent groundwater pollution

Requirements:

√ For the activities listed, prepare a groundwater protection plan (as required under 401 KAR 5:037)

Activities that are affected:

√ Pesticide storage and handling for commercial purposes or distribution to a retail sales outlet
√ Pesticide application for commercial purposes, public right-of-way maintenance, or institutional lawn care
√ Land treatment or land disposal of a pollutant
√ Storage, treatment, disposal, or handling of hazardous waste, solid waste, or special waste in landfills, incinerators, surface impoundments, tanks, drums, or other containers or in piles
√ Commercial or industrial storing or related handling in bulk quantities of raw materials, intermediate substances or products, finished products, substances held for recycling, or other pollutants held in tanks, drums, or other containers or in piles
√ Transmission in pipelines of raw materials, intermediate substances or products, finished products, or other pollutants
√ Installation or operation of on-site sewage disposal systems
√ Storing or related handling of road oils, dust suppressants, or deicing agents at a central location
√ Application or related handling of road oils, dust suppressants, or deicing materials
√ Mining and associated activities
√ Installation, construction, operation, or abandonment of wells, bore holes, or core holes
√ Collection or disposal of pollutants in an industrial or commercial facility through the use of floor drains that are not connected to on-site sewage disposal systems, closed-loop collection or recovery systems, or a waste treatment system permitted under the Kentucky Pollutant Discharge Elimination System
√ Impoundment or containment of pollutants in surface impoundments, lagoons, pits, or ditches
√ Commercial or industrial transfer, including loading and unloading, in bulk quantities of raw materials, intermediate substances or products, finished products, substances held for recycling, or other pollutants.

If any of the above activities are permitted under other state or federal programs, the individual conducting the activities is ***not*** *exempt from the requirement to develop a groundwater protection plan.*

Activities that are exempt:

Groundwater protection plans are not required if it can be demonstrated by substantial evidence that the activity has no reasonable potential of altering the physical, thermal, chemical, biological, or radioactive properties of groundwater in a manner, condition, or quantity that will be detrimental to the public health or welfare, to animal or aquatic life, to the use of groundwater as present or future sources of public water supply, or the use of groundwater for recreational, commercial, industrial, agricultural, or other legitimate purposes. Such a demonstration should consider at least:

√ Hydrogeologic sensitivity at or near the location of the activity;
√ Quantity of the pollutants, including the cumulative potential to pollute from small discharges, spills, or releases that individually would not have the potential to pollute;
√ Physical, chemical, and biological characteristics of the pollutants such as solubility, mobility, toxicity, concentration, and persistence;
√ Use of the pollutants at the locations of the activities;
√ Present and potential uses of the groundwater.

Specific exclusions:

The regulation does not apply to the following activities:

√ Normal use or consumption of products sized and packaged for personal use;
√ Retail marketing of products sized and packaged for personal use;
√ Activities conducted entirely inside enclosed buildings if:
- The building has a floor sufficient to prevent the release of pollutants to groundwater; and
- There are no floor drains, or all floor drains within the building are connected to an on-site sewage disposal system, closed-loop collection or recovery system or a waste treatment system permitted under the Kentucky Pollutant Discharge Elimination System;

√ Storing, related handling, or transmission in pipelines of pollutants that are gases at standard temperature and pressure;
√ Storing municipal solid waste in a container located on property where the waste is generated and where it is held prior to off-site disposal;
√ Installing and operating sewer lines or water lines approved by the cabinet;
√ Storing water in ponds, lakes, or reservoirs;
√ Impounding stormwater, silt, or sediment in surface impoundments;

In your community

Learn about watershed and natural resource issues in your community. Get involved in decision-making processes that affect your life. Water supply planning councils, zoning and utility commissions, and local chapters of various interest groups all provide opportunities to have an impact on how your watershed is managed or protected. Form a local watershed task force to address important issues in your watershed.

In your watershed

Protect wetlands that serve as natural buffers against pollution, soil erosion, and flooding. Leave vegetation buffer strips along lake and stream banks to prevent erosion and runoff into the water. Don't build a house or business in the flood plain.

Whom do I contact for more information?

For more information on how you can get involved, contact:
Kentucky Division of Water
14 Reilly Road
Frankfort, KY 40601
Phone: 502-564-3410
E-mail: colten@nrdep.nr.state.ky.us
On the web: http://www.state.ky.us/agencies/nrepc/dow/watrshd.htm

Kentucky Division of Water
14 Reilly Road
Frankfort, KY 40601

Watershed Management in Kentucky…

Q&A for Homeowners

What is a watershed?

It is the land across and under which water flows on its way to a stream, river, lake, or other waterbody. So, we all live in a watershed.

What is watershed management?

Since every thing we do in a watershed affects the soil, water, air, plants, and animals in it, watershed management means reducing those activities that result in runoff of soil and pollutants that might negatively affect the quality or our streams, lakes and groundwater and that affect droughts and flooding because of too little or too much water in the watershed..

Why watershed management?

Water is vital to the life and growth of our communities. Your watershed is not only the source of your community's drinking water, but is essential to the local economy through use in industry and agriculture. Water provides scenic beauty and areas for recreational activity. If a watershed is not managed properly, these uses of water can be threatened by pollution, drought, or flooding, which cost money and can cost lives.

What is the watershed framework?

In an effort to coordinate resource management activities among many agencies and organizations, the state has adopted a Watershed Management Framework. Its mission is to serve as a means for integrating the programs, tools, and resources of multiple stakeholder groups to better protect, maintain, and restore the ecology of watersheds and support sustainable uses of watersheds. Coordination of activities under the Framework will take place at three levels: at the state level by the Statewide Steering Committee; at the local level by local watershed task forces; and at the regional level by river basin teams, which serve as intermediaries between the state and local groups.

What does this mean to me?

Benefits

A variety of information regarding the condition or our watersheds will be available to communities. Some types of government funding will be targeted toward solving environmental problems. Watershed management provides opportunities for citizens to influence management decisions and set priorities where they live.

Drinking Water

Managing activities that pollute a watershed will result in a safer source of your drinking water. Also, the less pollution in the source, the less the cost to treat it before it is sent to you. Every time you turn on the tap to take a shower, wash the car, or water the lawn, you're using water that had to be treated at some cost to you, the user. Watershed management also means managing the amount of water used. Wasted water can strain water systems and create the need to expand existing systems or build new treatment plants, increasing the cost of water..

Wastewater

Managing the amount of water used can also result in wastewater treatment savings. So will managing potential pollutants that drain to storm sewers. All this water must be treated before it is discharged to community rivers, streams, and lakes where it travels downstream to become another community's drinking water.

Flooding

Better planning for use of property in a floodplain, including construction of homes and businesses, can reduce the risk of flooding and the tragedy and cost that result from it.

Drought

Wise use of water resources extends the use of current water supplies for more uses, more users, and more itme during periods of low rainfall.

Recreation and beauty

The better we take care of our watersheds, the safer and more enjoyable boating, fishing, and swimming will be.

What can I do?

In the lawn and garden

Use fertilizers and pesticides only as directed on the labels. If you have questions about their proper use, contact your local extension agents. Landscape your yard with plants native to the area; they will need a minimum of water and fertilizer. When lawns or plants need water, water deeply and infrequently. Also, water in the evening when evaporation loss is less, or use a drip irrigiation system.

Around the house

Dispose of left over chemicals and wastes properly so that they do not run off to streams or soak into the groundwater. For example, used automobile oil can be recycled; leftover pesticides should be used, donated to a someone who will use them, or taken to a hazardous waste disposal center.

Inside the Kentucky NREPC

To protect and preserve Kentucky's land, air and water resources

The Kentucky Natural Resources and Environmental Protection Cabinet is a state agency with the mission of protecting and preserving Kentucky's land, air and water resources. We encourage you to use this directory, so we can help you find the answers you need. Our office hours are 8 a.m. to 4:30 p.m., Monday through Friday. Or visit the cabinet's web site at **http://www.nr.state.ky.us** for more information about the cabinet and its activities.

NREPC Regional Offices

For Questions and Concerns about Local Issues

All phone numbers are 502 area code unless otherwise designated.

Dept. for Environmental Protection

Ashland -- Air Quality 606/920-2067
Bowling Green 746-7475
Columbia
  Water 384-4734
  Waste Management 384-4735
Florence 606/292-6411
Frankfort 564-3358
Hazard 606/435-6022
London 606/878-0157
Louisville
  Water 425-4671
  Waste Management 425-4543
Madisonville
  Water 824-7529
  Waste Management 824-7532
Maxey Flats 606/784-6612
Morehead -- Water, Waste 606/784-6635
Owensboro -- Air Quality 687-7304
Paducah
  Air Quality, Water 898-8468
  Waste Management 898-8495

This publication and other materials offered by the cabinet can be provided in alternative formats to any individual with a disability. To request materials in an alternative format, contact the Public Information and Education Branch, Capital Plaza Tower, Frankfort, KY 40601, or phone 502/564-5525. Hearing- and speech-impaired persons can contact the agency by using the Kentucky Relay Service, a toll-free telecommunication device for the deaf (TDD). For voice to TDD, call 800 648-6057. For TDD to voice, call 800-648-6056.

Dept. for Natural Resources

Division of Forestry
  Betsy Layne 606/478-4495
  Campbellsville 465-5071
  Elizabethtown 766-5010
  Gilbertsville
    (J.P. Rhody Nursery) 362-8331
  Hazard 606/435-6073
  Madisonville 824-7527
  Mayfield 247-3913
  Morehead 606/784-7504
  Pineville 606/337-3011
  Stamping Ground 535-7741
  West Liberty
    (Morgan Co. Nursery) ... 606/743-3511

Dept. for Surface Mining Reclamation and Enforcement

  London 606/878-0098
  Madisonville 824-7536
  Middlesboro 606/248-6166
  Pikeville 606/433-7726
  Prestonsburg 606/886-8536
Division of Abandoned Mine Lands
  London 606/878-0071
  Madisonville 824-7534
  Prestonsburg 606/886-1786

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Kentucky
Natural Resources
and
Environmental Protection Cabinet

Organizational Structure and Frankfort/Central Offices

Office of the Secretary 564-3350
  Administrative Services 564-7320
  Public Information and
    Education Branch 564-5525
  Office of Legal Services 564-5576
  Office of Information Services 564-5174
  Office of Administrative Hearings 564-7312
Dept. for Environmental Protection 564-2150
  Commissioner 564-2150
  Division of Water 564-3410
  Division for Air Quality 573-3382
  Division of Waste Management.. 564-6716
  Division of Env. Services 564-6120
Dept. for Natural Resources 564-2184
  Commissioner 564-2184
  Division of Energy 800/282-0868
  Division of Conservation 564-3080
  Division of Forestry 564-4496
Dept. for Surface Mining Reclamation and Enforcement... 564-6940
  Commissioner 564-6940
  Division of Abandoned Mine
    Lands 564-2141
  Division of Field Services 564-2340
  Division of Permits 564-2320
Environmental Quality Commission 564-2150
Kentucky State Nature Preserves Commission 573-2886
Kentucky River Authority 564-2866

October 1998

EDUCATION PAYS

Inside the Kentucky
NREPC

Kentucky
Natural Resources
and Environmental Protection
Cabinet

For Answers to Questions about Environmental and Natural Resource Issues in Kentucky

For local and regional concerns, the appropriate NREPC regional office should be contacted.

All phone numbers with 502 area code unless otherwise specified.

Abandoned Drums/Oil Tanks 564-6716
Abandoned Vehicle Recovery 564-6716
Above-ground Storage Tanks 564-5981
Acid Rain 573-3382
Agricultural District Program 564-3080
Agricultural Equip. Revolving Fund . 564-3080
Agriculture Water Quality Authority 564-3080
Air Quality Permits 573-3382
Air Releases (vapors, fumes, odors) . 573-3382
Air Quality Index .... 800/AIR INKY
Air Quality Rep. for Small Business 564-2150
Asbestos 573-3382
Best Management Practices
  Agriculture 564-3080
  Forestry 564-4496
Bioassay 564-3410
Biodiversity 573-2886
Blackwater Release 564-2340, 564-3410
Citizen Participation (water) 564-3410
Clean Air for KY Program 800/928-0047
Clean Air Act 573-3382
Clean Community Program 564-6716
Clean Water Act 564-3410
Comparative Risk 564-2150
Complaints
  Air 573-3382
  Water 564-3410
  Waste 564-6716
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Conservation (soil) Education 564-3080
Dam Failure 564-3410
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Dry Cleaners' Information 573-3382
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Urban Forestry 564-4496
Underground Storage Tanks 564-6716
Waste and Recycling Education 564-6716
Waste Tires 564-6716
Wastewater State Revolving Fund 564-3410
Wastewater Treatment 564-3410
Wastewater Discharge Permits 564-3410
Water Conservation 564-3410
Water Quality Certification 564-3410
Water Shortage 564-3410
Water Supply and Planning 564-3410
Water Toxicity Testing 564-3410
Water/Wastewater Operator Cert. 564-3410
Water Withdrawal 564-3410
Watershed Conservancy District 564-3080
Watershed Management 564-3410
Water Watch Program 800/928-0045
Water Well Drilling 564-3410
Wellhead Protection Program 564-3410
Wetlands 564-3410
Wild Rivers Program 564-3410
Wire Burning 564-6716

Division of Water
14 Reilly Road
Frankfort, Kentucky 40601

Natural Resources and
Environmental Protection Cabinet

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Where can I obtain a groundwater protection plan?

You may obtain a GPP - free - at the following locations:

Groundwater Branch
Kentucky Division of Water
14 Reilly Road
Frankfort, KY 40601 (telephone 502/564-3410)

Libraries

Kentucky Division of Water
Regional Offices:

- 1508 Western Avenue
  Bowling Green, KY 42104 (502/7467475)
- 102 Burkesville Street
  Columbia, KY 42728 (502/384-4734)
- 7964 Kentucky Drive, Suite #8
  Florence, KY 41042 (606/292-6411)
- 1047 U.S. 127 South Annex Building
  Frankfort, KY 40601 (502/564-3358)
- 233 Birch Street, Suite 1
  Hazard, KY 41701 (606/439-2391)
- 85 State Police Rd., Reg. St. Office Bldg.
  London, KY 40741 (606/878-0157)
- 312 Whittington Parkway, Suite 205
  Louisville, KY 40222-4925 (502/595-4218)
- Madisonville State Office Building
  625 Hospital Drive
  Madisonville, KY 42431 (502/824-7529)
- Mabry Building, KY 32 South
  Morehead, KY 40351 (606/784-6635)
- 4500 Clarks River Road
  Paducah, KY 42003 (502/898-8468)

Groundwater Protection and Residential Septic Systems

How Kentucky's new groundwater regulation affects homes served by septic systems

A new groundwater protection regulation became effective August 24, 1994. Its purpose is to prevent groundwater pollution, and it applies to activities that have the potential to pollute groundwater.

How do we protect groundwater?

Kentucky's groundwater regulation requires that you take a long, hard look at your activities and ask, "Am I doing something that may possibly pollute groundwater?" If the answer is "yes," you may have to complete a Groundwater Protection Plan (GPP).

Since improperly designed, operated, and maintained septic systems are major potential sources of groundwater pollution, **all owners or operators of residential septic systems must have a Groundwater Protection Plan.**

How do I develop a groundwater protection plan? How much will it cost?

A generic groundwater protection plan for residential septic systems has been developed by the Natural Resources and Environmental Protection Cabinet as required by the new regulation. It is free.

How does a Groundwater Protection Plan help me protect groundwater?

You can protect groundwater by understanding how your septic system works and by following good operation and maintenance practices. The groundwater protection plan contains information to help you do this.

I already know how my system operates and how to care for it. Do I still need a Groundwater Protection Plan?

Yes. Anyone conducting an activity with the possibility to pollute groundwater is required to have a groundwater protection plan.

Your Groundwater Protection Plan can be an important document should you decide to sell your house. The GPP contains a record-keeping section in which you can record the layout of your septic system and any maintenance that is done, such as pumping the tank. Your records will show a prospective buyer that your septic system has been properly maintained.

Why protect groundwater?

Groundwater is the source of drinking water for hundreds of thousands of Kentuckians. They obtain their water from water wells or springs, either from private wells or municipal groundwater systems.

Groundwater provides water for our streams, rivers, lakes, ponds, and wetlands. Polluted groundwater can become polluted surface water, and in turn, polluted surface water can become polluted groundwater.

Your activities may pollute your own drinking water or even that of those who live outside your community. The groundwater underlying your property may travel great distances, eventually flowing onto the land's surface at a spring or being pumped from a well as someone else's drinking water.

If you would like a generic GPP, more information, or if you have a question, please fill out this form and mail it to the Groundwater Branch, Kentucky Division of Water, 14 Reilly Road, Frankfort, KY 40601, or call the Groundwater Branch at 502/564-3410.

Name: ______________________ Telephone: ______________

Address: ______________________________________

City: ______________________ State: ________ Zip Code: ________

______ Send GPP for residential septic systems.

______ Send information on operation and maintenance.

______ Answer question(s): ______________________________

Kentucky Water Well Inspection Form

KENTUCKY WATER WELL INSPECTION FORM

(1) AKGWA NUMBER: ☐☐☐☐ - ☐☐☐☐ - ☐☐

Attach Water Well Record Label Here (if applicable)

(2) GENERAL INFORMATION:
Well Owner's Name: ______ Last ______ First ______ MI
Mailing Address:
City: ______ **State:** ______ **Zip:**
Phone: ( ) ______ ( ) No Phone

(3) WELL RECORD LABEL LOCATION: ( ) well casing ( ) other

(4) WELL LOCATION:
USGS Quadrangle Name:
County:
Elevation: ______ ft. ( ) map ( ) altimeter ( ) other
Latitude: ______ **Longitude:**
Physiographic or Hydrologic Region:
( ) Blue Grass ( ) Ohio River Alluvium ( ) E. Coal Field
( ) Miss. Plateau ( ) Jackson Purchase ( ) W. Coal Field

(5) WELL CHARACTERISTICS:
Is this a hand dug well? ( ) yes ( ) no ( ) unknown
Who constructed well? ( ) unknown
Address:
City: ______ **State:** ______ **Zip:**
Date well was completed: ______ Month ______ Day ______ Year ( ) unknown
Total depth: ______ ft. ( ) measured ( ) reported ( ) unknown
Does the casing extend above the ground? ( ) yes, ______ in. ( ) no

Casing Type(s)	Casing Inside Diameter (in)	Feet Below Surface From	To	Casing Wall Thickness
1.				
2.				
3.				
4.				

Is the well located in a pit? ( ) yes ( ) no ( ) unknown
Is the water discharge pipe below ground surface? ( ) yes ( ) no ( ) unknown
Is a pitless adapter used? ( ) yes ( ) no ( ) unknown
Well yield: ( ) gpm ( ) gph ( ) gpd
( ) measured ( ) estimated ( ) unknown
Surface annular material: ( ) clay ( ) sand ( ) cement
( ) drill cuttings ( ) gravel ( ) open annulus ( ) unknown
( ) other
Well head (casing top): ( ) well cap ( ) sanitary seal ( ) open
( ) other
Pump type: ( ) jet ( ) submersible ( ) hand pump ( ) turbine
( ) none ( ) bailer/bucket ( ) other
Level of pump intake: ______ ft. ( ) unknown
Age of pump: ______ yrs ( ) unknown
Electric connection for pump: ( ) 2 wire, 110V ( ) 3 wire, 220V ( ) unknown
Static water level: ______ ft. below surface ( ) measured ( ) reported
If unknown: ( ) can't be measured ( ) not measured
Does the owner have any log or record concerning this well?
( ) yes ( ) no If yes, specify:

(6) SKETCH MAP:

(7) WELL USE:
( ) domestic ( ) public ( ) irrigation
( ) industrial ( ) livestock ( ) monitoring
( ) unused ( ) other
PWSID #:
Water Withdrawal Permit #:

(8) WELL SERVICE:
Number of people served:
Number of service connections:
Any quantity problems? ( ) yes ( ) no
Any quality problems? ( ) yes ( ) no
Describe:

(9) COMPLIANCE TO STANDARDS:
Is this well in compliance with state water well construction standards? ( ) yes ( ) no ( ) unknown
If no, describe deficiencies:

(10) TYPE OF TREATMENT SYSTEM:
( ) none
( ) water softener
( ) ultra violet
( ) chlorination
( ) aeration
( ) charcoal filter
( ) sand filter
( ) iron inhibitor
( ) other
Is a treatment bypass available? ( ) yes ( ) no
Describe water quality problem requiring treatment:

(11) INSPECTION INFORMATION:
Date of Inspection: ______ Month ______ Day ______ Year
Check one: ( ) original inspection ( ) re-inspection
Was a water quality sample taken as part of this inspection? ( ) yes ( ) no
Reason for inspection (check all that are applicable): **Specify:**
( ) general water quality analysis requested
( ) specific complaint investigation
( ) general survey
( ) ambient groundwater monitoring
( ) other
Permit/Program Name
Other ID #:
Other ID #:
Well Inventory #:

(12) OPTIONAL USE:
Will well owner allow state monitoring? ( ) yes ( ) no ( ) unknown
Extent of monitoring allowed: ( ) collect sample ( ) measure static water level
( ) pump well ( ) remove well cap ( ) other
Monitoring feasibility:

(13) COMMENTS:

(14) INSPECTOR IDENTIFICATION:
Name: ______ Last ______ First ______ MI ______ Inspector ID #
Agency: ( ) CHR ( ) DOW ( ) DWM ( ) KGS ( ) SOAP
( ) Other
Signature of Inspector:
Date: ______ Month ______ Day ______ Year **Number of Attached pages:**

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DEP-4051
Revised 12-15-87

Kentucky Spring Inventory Form

KENTUCKY SPRING INVENTORY FORM

(1) SPRING IDENTIFICATION NUMBER: ☐☐☐☐–☐☐☐☐

Official Use Only

Do not write in this space

(2) GENERAL INFORMATION

Spring owner's name:________________________ ( ) unknown
Mailing Address:________________________ ( ) unknown
City:______________ State:________ Zip:________
Phone: (   )______________ ( ) no phone ( ) unknown

(3) SPRING LOCATION

County	Quadrangle	Latitude	Longitude	Elevation ( ) map ( ) survey ______ ft.

(4) NAME OF SPRING ( ) unnamed

(5) PHYSIOGRAPHIC OR HYDROLOGIC REGION
( ) Bluegrass ( ) Ohio River Alluvium ( ) E. Coal Field
( ) Miss. Plateau ( ) Jackson Purchase ( ) W. Coal Field

(6) ATTACHMENTS
( ) Topographic map
( ) Other:__________

(7) PHYSICAL SETTING

Primary Spring Type:
( ) gravity (*falling*) ( ) trickle
( ) bluehole (*rising*) ( ) seep

Secondary Characteristics:
(mark all that apply)
( ) karst window ( ) perched
( ) sinking spring ( ) gravel
( ) epikarst ( ) mineral
( ) estavelle ( ) fracture
( ) other:__________

Aquifer Media:
( ) limestone ( ) sandstone
( ) dolostone ( ) coal
( ) shale/siltstone ( ) alluvium
( ) unknown
( ) other:__________

Spring Discharges From:
( ) conduit ( ) mine adit
( ) bedding plane ( ) soil
( ) cave ( ) fill
( ) fracture ( ) unknown
( ) talus/loose rock

Spring Discharges To:
( ) stream ( ) pond or lake
( ) sinkhole ( ) holding tank
( ) soil ( ) wetland

Name of Receiving Water Body:
____

(8) SPRING DISCHARGE
( ) perennial ( ) seasonal ( ) intermittent
________( ) cfs ( ) gpm ( ) l/s
( ) measured ( ) estimated
( ) reported ( ) not determined

Please see worksheet and instructions on reverse of form for assistance in calculation of spring discharge.

(9) SURFACE FLOW CONDITIONS
Season:
( ) winter (November - April)
( ) summer (May - October)
Flow condition:
( ) low ( ) moderate ( ) high

(10) MODIFICATIONS (mark all that apply)
( ) spring house ( ) gravity pipe
( ) spring box ( ) pump
( ) walled pond ( ) dam
( ) storage trough or tank ( ) none
( ) other (describe in Comments)

(11) DYE TRACE INFORMATION
Has a trace been made to/from this site?
( ) Yes ( ) No ( ) Unknown
Investigator: __________
Project: __________
Date: __________
Comments: __________

(12) SPRING USE
( ) domestic ( ) irrigation ( ) public supply
( ) industrial ( ) livestock ( ) monitoring
( ) unregulated public access ( ) unused
( ) other:__________
PWSID#:__________
Water Withdrawal Permit #:__________

(13) SPRING SERVICE
Number of people served:__________
Number of service connections:__________
Quantity problems ( ) yes ( ) no ( ) unknown
Quality problems? ( ) yes ( ) no ( ) unknown
Use Comments Section to describe any problems

(14) TREATMENT SYSTEMS
( ) none
( ) water softener
( ) ultraviolet
( ) chlorination
( ) aeration
( ) charcoal filter
( ) sand filter
( ) iron inhibitor
( ) settling tank
( ) other
Treatment Bypass Available?
( ) yes ( ) no

(15) INSPECTION INFORMATION
Date of Inspection:__________
Water Sample Taken? ( ) yes ( ) no
Reason for Inspection:
( ) general survey
( ) specific complaint investigation
( ) spill or incident response
( ) contamination site investigation
( ) enforcement
( ) general water quality analysis
( ) ambient groundwater monitoring
( ) other (describe in Comments)
Program Name and Facility ID#:
____
Alternate Spring ID#

(16) OPTIONAL USE
Will Owner Allow State Access?
( ) yes ( ) no ( ) unknown
Extent of Monitoring Allowed:
( ) complete access
( ) collect sample
( ) access to spring/springhouse
( ) modify spring
( ) notification required
( ) other (describe in Comments)
Monitoring Feasibility:
____

(17) Sketch Map (show spring and associated features)

(18) COMMENTS __________

(19) INVESTIGATOR IDENTIFICATION
Name:__________ __________ ____ __________
Last First MI Inspector ID#
Agency: ( ) CHR ( ) DOW ( ) DWM ( ) KGS ( ) Other:__________
Signature of Inspector:__________ **Date:**__________

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Revised 4/10/99

Appendix D. – Data and References

Tables 3-9 show the tabulated results from the entire field screening analyses collected in the project.

NT = Not Tested, 0 = not detected at the laboratory detection limit, all chemical concentrations in ppm and all bacteria results in colonies per 100 ml. **Bold** means the result is at or above the primary or secondary drinking water standard. Conductivity is in microseimens and pH is in standard units.

Table 3. Hand-dug Well Data.

Well ID.#	Well Depth	People Served	Nitrate – N	Nitrite – N	Ammonia – N	Detergents	Phosphate – PO4	pH	Conductivity	Soluble Iron	Soluble Mn	Nitrate Test Strip – NO3-	Nitrite Test Strip– NO2-	Total Coliform Bacteria	E-coli Bacteria	Fecal Coliform Bacteria	Caffeine and/or Caffeine Breakdown products
0005-5291	12	4	1.5	**1.5**	0.5	0	0	**5.14**	351	NT	NT	0	0	2400	**57**	**66**	0.00027
0005-5393	15	3	0	0	0	0	0	6.5	180	0.05	0	0	0	1700	**9**	**10**	0
0005-5296	18	3	2.5	0	2	0.1	0	6.75	191	0	0	50	NT	2400	**24**	**610**	NT
0005-5313	19	2	0	0		0	0	**6.4**	510	0.05	0	NT	NT	NT	NT	NT	NT
0005-5292	25	1	1	0	1	0.1	0	**5.88**	397	**0.5**	NT	NT	NT	2400	0	0	0
0005-5338	25	3	0	0	0	0	0	7.2	900	0	0	NT	NT	56	0	0	NT
0005-5321	50	5	0	0	0	0	0	**6**	170	0.05	0	25	0	NT	NT	NT	NT
0005-5396	50	2	0	0	0	0	0	**5.07**	57.4	0	0	0	0	NT	NT	NT	NT
0005-5311	60	4	0	0		0	0	6.7	200	**0.6**	0	10	0	NT	NT	NT	NT
Total People		27															

Table 4. Data for wells that appear to meet current well construction standards.

Well ID.#	Well Depth	# People	Nitrate – N	Nitrite – N	Ammonia – N	Detergent	Phosphate – PO4	pH	Conductivity	Soluble Iron	Soluble Mn	Nitrate Test Strip – NO3-	Nitrite Test Strip– NO2-	Total Coliform Bacteria	E-Coli Bacteria	Fecal Coliform Bacteria	Caffeine & Breakdown products
0005-5326	60	5	0	0	0	0	0	**6.4**	670	0	0	NT	NT	NT	NT	NT	NT
0004-9856	65	1	0	0	1	0	0	7.6	680	NT	NT	NT	0	150	0	0	NT
0005-4838	65	4	0	0	0	0	0	NT	NT	**5**	0	NT	NT	NT	NT	NT	NT
0005-5394	80	6	0	0	0	0.1	0	**9**	2400	0.15	0	NT	NT	NT	NT	NT	NT
0005-0534	85	6	0	0	0	0	0	NT	NT	0	0	NT	NT	NT	NT	NT	NT
0005-5324	87	6	0	0	0	0	0	**6.3**	**410**	**3**	0	NT	NT	NT	NT	NT	NT
0005-5345	95	6	0	0	0	0	0	7.4	430	**10**	0	NT	NT	NT	NT	NT	NT
0005-5318	103	2	0	0	0	0	0	7.45	361	0.1	0	NT	NT	NT	NT	NT	NT
0003-0661	103	9	0	0	0	0	5	7.7	480	0.1	0	NT	NT	NT	NT	NT	NT
0005-5400	120	2	0	0	0	0	0	**5.6**	150	**4**	0	0	0	0	0	0	NT
0003-1954	120	3	0	0	0	0	3.5	6.5	390	**0.4**	0	NT	NT	310	0	0	0.00021
0005-5398	130	3	0	0	1	0	2	7.4	490	0	0	0	0	NT	NT	NT	NT
0005-5634	138	3	0	0	0	0	0	7.6	510	0.2	0	NT	NT	NT	NT	NT	NT
0005-5398	156	2	0	0	0	0	0	**6.38**	185.2	0.1	0	0	0	NT	NT	NT	NT
0005-3932	158	6	0	0	0	0	0	NT	NT	0	0	NT	NT	NT	NT	NT	NT
0004-7938	165	3	0	0	0	0	0	**5.9**	1120	**10**	**2**	0	0	NT	NT	NT	NT
0005-5322	185	2	0	0	0	0	0	6.9	310	**0.35**	0	NT	NT	**2400**	**110**	**94**	0
0002-8785	185	4	0	0	0	0	0	NT	NT	0.1	0	NT	NT	NT	NT	NT	NT
0001-2137	200	7	0	0	0	0	0	**4.62**	108.7	0.1	**0.15**	0	0	NT	NT	NT	NT
0004-9147	220	3	0	0	0	0	0	6.8	430	**1**	0	NT	NT	NT	NT	NT	NT
0001-1234	230	9	0	0	0	0	1	6.5	390	0	0	NT	NT	NT	NT	NT	NT
0001-1873	310	6	0	0	1	0	0	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
0005-5320	480	4	0	0	0	0	0	7.5	370	0	0	NT	NT	NT	NT	NT	NT
0005-5395	UNK	2	0	0	0	0	0	6.7	174	0	0	0	0	NT	NT	NT	NT
0005-5347	UNK	4	0	0	0	0	0	7.4	290	**0.5**	**0.15**	NT	NT	NT	NT	NT	NT
0004-6718	UNK	1	0	0	NT	0	0	6.8	480	**10**	0	0	0	NT	NT	NT	NT
0003-3313	UNK	5	0	0	1	0	0	7.24	523	**1.5**	NT	NT	NT	NT	NT	NT	NT
0005-5297	UNK	6	0	0.5	6	0	0	7	540	0.25	0	0	0	NT	NT	NT	NT
0004-1290	UNK	1	0	0	0	0	0	**6.4**	1080	0	0	NT	NT	NT	NT	NT	NT
0005-5391	UNK	3	0	0	0	0	0	NT	NT	0	0	NT	NT	NT	NT	NT	NT
0005-0539	UNK	4	0	0	0	0	0	NT	NT	0.1	0	0	0	NT	NT	NT	NT
Total # People	128																

Table 5. Data for wells with buried well heads

Well ID.#	Well Depth	Persons Served	Nitrate – N	Nitrite – N	Ammonia – N	Detergents	Phosphate – PO4	pH	Conductivity	Soluble Iron	Soluble Mn	Nitrate Test Strip – NO3-	Nitrite Test Strip– NO2-	Total Coliform Bacteria	E-Coli Bacteria	Fecal Coliform Bacteria	Caffeine & Breakdown products
0005-5330	20	5	0	0	0	0	0	7.9	**860**	0	0	NT	NT	40	0	0	NT
0003-9155	60	2	0	0	0	0	0	**6.3**	**470**	**8**	**0.15**	0	0	NT	NT	NT	NT
0005-5317	60	5	0	0	0	0	0	7.9	**689**	**0.05**	0	NT	NT	NT	NT	NT	NT
0005-5336	60	4	0	0	0	0.25	0	7.7	**380**	**0.3**	0	NT	NT	NT	NT	NT	NT
0005-5323	70	5	0	0	0	0	0	**6.4**	**530**	**7.5**	**0.6**	0	0	NT	NT	NT	NT
0005-5339	75	4	0	0	0	0	0	7.3	**490**	**0.8**	0	NT	NT	NT	NT	NT	NT
0005-5314	77	2	0	0	0	0	0	6.86	**369**	**10**	0	NT	NT	0	0	0	NT
0005-4035	80	8	0	0	1.25	0	5	6.8	**350**	**0.5**	0	NT	NT	NT	NT	NT	NT
0005-5327	87	7	0	0	0	0	0	**6.1**	**550**	**10**	0	NT	NT	50	0	0	NT
0005-5299	90	2	0	0	1	0	0	8	**430**	0	0	0	0	NT	NT	NT	NT
0005-5399	90	3	0	0	0	0	0	6.7	**575**	**4.5**	**0.3**	0	0	17	0	0	NT
0005-5316	92	3	0	0	2.5	0.5	0	7.84	820	NT	NT	NT	NT	0	0	0	NT
0005-4040	100	2	0	0	0	0	0	7.2	550	**0.6**	0	NT	NT	NT	NT	NT	NT
0005-0536	113	5	0	0	0	0	0	NT	NT	**0.5**	0	0	0	NT	NT	NT	NT
0005-5295	120	5	0	0	2.5	0	0	6.67	335	**3**	0	NT	NT	0	0	0	NT
0005-5333	120	2	0	0	0	0	0	7.2	500	0	0	NT	NT	NT	NT	NT	NT
0005-5392	145	6	0	0	0	0	0	NT	NT	**4**	0	NT	NT	NT	NT	NT	NT
0005-4034	150	1	0	0	0	0	1	**6.35**	335	**0.35**	0	0	0	NT	NT	NT	NT
0005-5315	155	4	0	0	0	0	0	7.75	366	NT	NT	NT	NT	NT	NT	NT	NT
0005-4032	169	2	0	0	2.5	0	0	7.3	310	**0.3**	0	0	0	3	0	0	NT
0005-5344	185	6	2.5	0	0	0	0	7.5	430	0.1	0	NT	NT	2400	0	0	NT
0005-4033	190	1	0	0	3	0	3	7.3	330	**0.7**	0	0	0	5	0	0	NT
0005-5300	200	2	0	0	1	0	0	8.3	470	0.05	0	0	0	NT	NT	NT	NT
0005-5340	200	6	0	0	0	1	0	6.6	380	0	0	NT	NT	NT	NT	NT	NT
0005-1392	285	3	0	0	NT	0	0	**6.3**	560	**10**	**1.8**	NT	NT	NT	NT	NT	NT
0005-5319	285	3	0	0	0	0	0	6.8	260	0.1	0	0	0	NT	NT	NT	NT
0005-5342	310	1	0	0	0	0	0	7.2	515	**5**	0	NT	NT	NT	NT	NT	NT
0005-5312	UNK	3	0	0	0	0	0	7.86	645	NT	NT	NT	NT	NT	NT	NT	NT
0005-5328	UNK	4	0	0	0	0	0	**6.2**	260	0.15	0	NT	NT	NT	NT	NT	NT
0005-5331	UNK	5	0	0	0	0	0	7.9	1890	0.2	0	NT	NT	NT	NT	NT	NT
0005-5335	UNK	5	0	0	0	0	0	7	500	0.2	0	NT	NT	NT	NT	NT	NT
Total # People		112															

Table 6. Improperly constructed or maintained wells

Well ID.#	Well Depth	Persons Served	Nitrate – N	Nitrite – N	Ammonia – N	Detergents	Phosphate – PO4	pH	Conductivity	Soluble Iron	Soluble Mn	Nitrate Test Strip – NO3-	Nitrite Test Strip– NO2-	Total Coliform Bacteria	E-Coli Bacteria	Fecal Coliform Bacteria	Caffeine & Breakdown products	Well Type
0005-5294	80	5	0	0	0	0	0	**6.48**	234	**10**	0	NT	NT	NT	NT	NT	NT	Drilled in Pit
0005-5350	128	2	0	0	0	0	0	7.4	530	0.2	0	NT	NT	NT	NT	NT	NT	Drilled in Pit
0005-5293	UNK	10	0	0	1	0	0	6.84	444	0.15	0	NT	NT	NT	NT	NT	NT	Drilled in Pit
0005-5337	UNK	3	0	0	0	0.75	0	7.3	290	**1**	0	NT	NT	NT	NT	NT	NT	Drilled in Pit
0005-5325	60	2	0	0	0	0	0	**6.2**	270	0.1	0	NT	NT	NT	NT	NT	NT	Drilled, Open Top
0005-5397	UNK	2	0	0	0	0	0	**5.98**	194	**10**	0	0	0	NT	NT	NT	NT	Drilled, Top of Casing
0005-5329	100	4	0	0	0	0	0	**6.1**	240	**10**	0	NT	NT	NT	NT	NT	NT	Drilled, Top of Casing
0005-5388	450	5	0	0	0	0	0	**4.6**	350	0.15	0	0	0	NT	NT	NT	NT	Drilled, Used as a Cistern,
0005-5349	60	4	0	0	0	0	0	6.9	200	**0.4**	0	NT	NT	NT	NT	NT	NT	Drilled in Pit, Open Top
Total # People		37																

Table 7. Data for Spring and Mine water Sources.

Well ID.#	Persons Served	Nitrate – N	Nitrite – N	Ammonia – N	Detergents	Phosphate – PO4	pH	Conductivity	Soluble Iron	Soluble Mn	Nitrate Test Strip – NO3-	Nitrite Test Strip– NO2-	Total Coliform Bacteria	E-Coli Bacteria	Fecal Coliform Bacteria	Caffeine & Breakdown products	Water Source Type
9000-2821	6	0	0	0	0	2.5	6.5	130	0	0	NT	NT	NT	NT	NT	NT	Spring
9000-2643	4	0	0	0	0	0	7.3	300	0	0	NT	NT	NT	NT	NT	NT	Spring
9000-2644	2	0	0	0	0	0	**6.3**	140	0.2	0	NT	NT	NT	NT	NT	NT	Spring
9000-2645	4	0	0	0	0	0	8	910	0.05	0	NT	NT	NT	NT	NT	NT	Spring
9000-2646	10	0	0	0	0	0	7.4	490	0	0	NT	NT	NT	NT	NT	NT	Spring
9000-2647	12	0	0	0	0	0	**5.6**	430	0.05	**0.15**	NT	NT	73	0	0	NT	Spring
9000-2648	8	0	0	0	0	0	7.5	275	0.15	0	NT	NT	NT	NT	NT	NT	Spring
Total # People	46																

Table 8. Tabulated results from all the bacterial & caffeine analyses.

Site ID.	Total Coliform Bacteria- 24 hour	Total Coliform Bacteria -48 hour	E-Coli Bacteria- 24 hour	E-Coli Bacteria- 24 hour	Total Coliform Bacteria- 24 hour	Fecal Coliform Bacteria- 48 hour	Caffeine	1,7 - Dimethylxanthine	7- Methylxanthine	1- Methylxanthine	Site Type
0005-4032	3	5	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-4033	5	7	<1	<1	<2	<2	NT	NT	NT	NT	Drilled
0004-9856	150	150	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-5291	**>2400**		**57**	**66**	**66**	**60**	0.00021	0.00006	0	0	Hand-dug
0005-5292	>2400		<1	<1	<2		0	0	0	0	Hand-dug
0005-5295	<1		<1	<2	<2		NT	NT	NT	NT	Drilled
0005-5296	**>2400**		**24**	**36**	**610**		0	0	0	0	Hand-dug
0005-5298	12	20	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-4036	980	1100	<1	<1	<2		0	0	0	0	Drilled
0005-5314	<1	<1	<1	<1	<2	<2	NT	NT	NT	NT	Drilled
0005-5316	<1	<1	<1	<1	<2		NT	NT	NT	NT	Drilled
0003-1954	310	460	<1	2	<2		0.00021	0	0	0	Drilled
0005-5322	**>2400**		**110**	**120**	**94**		0	0	0	0	Drilled
0005-5330	50	101	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-5338	56	62	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-5339	<1	<1	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-5327	50	101	<1	<1	<2		NT	NT	NT	NT	Hand-dug
0005-5344	>2400		<1	<1	<2		NT	NT	NT	NT	Drilled
9000-2647	73	133	<1	<1	<2		NT	NT	NT	NT	Spring
0005-5393	**1700**	**2400**	**9**	**9**	**10**		0	0	0	0	Hand-dug
0005-5399	17	26	<1	<1	<2		NT	NT	NT	NT	Drilled
0005-5400	<1	2	<1	<1	<2		NT	NT	NT	NT	Drilled
Cram #1	**2400**		**1300**	**1600**	**740**		0	0	0	0	Stream
Cram #2	**2400**		**2400**		**4200**		0	0	0	0	Stream
Cram #3	**2400**		**2400**		**4300**		0	0	0	0	Stream
Cram #4	2400		93	101	100		0.00011	0.00004	0	0.0346	Stream
Cram #5	**2400**		**313**	**515**	**240**		0	0	0	0	Stream
Pine #1	**2400**		**980**	**1100**	**1400**		0.00034	0.00005	0.136	0	Stream
Pine #2	2400		100	120	150		0	0	0.0242	0	Stream
Pine #3	**2400**		**580**	**650**	**2400**	**1300**	0.00007	0	0	0	Stream
Pine #4	2400	>2400	81	86	84		0	0	0	0	Stream

Table 9. Comparison of field screening and laboratory verification analyses.

Well ID. Number	Nitrate– N field	Nitrate Test Strip – NO_3^-	Nitrate – N Laboratory	Nitrite – N field	Nitrite Test Strip – NO_2^-	Nitrite – N Laboratory	Ammonia - N field	Ammonia -N Laboratory	Phosphate - PO_4 field	Phosphate Laboratory	Iron field	Iron Laboratory	Manganese field	Manganese Laboratory
0005-1392	0	NT	0	0	NT	0	NT	.402	0	.007	**10+**	**43.7**	**1.8**	**2.6**
0005-5311	0	2.3	.981	0	0	0	NT	0	0	0	**0.6**	**.514**	0	**.267**
0005-5313	0	NT	.200	0	NT	0	NT	0	0	0	.05	.166	0	.014
0004-6718	0	0	0	0	0	0	NT	.351	0	.032	**10+**	**20.5**	0	**.878**
0004-9147	0	NT	0	0	0	0	1.0	.127	0	.054	**1.0**	**1.17**	0	**.233**
0005-0534	0	NT	.037	0	NT	0	0	.463	0	.065	0	NT	0	NT
0005-5296	2.5	11.5	5.48	0	NT	0	2	0	0	.007	0	.063	0	.006