PRIVATE WATER WELL EDUCATION

FOR ADULT RESIDENTS

OF OKLAHOMA

By

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ABSTRACT

Name: SHARON M. ROBBINS

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Title of Study: PRIVATE WATER WELL EDUCATION FOR ADULT RESIDENTS OF OKLAHOMA

Major Field: ENVIRONMENTAL SCIENCE

Abstract: The scope of this study involved an investigation into the education of the adult residents of Oklahoma regarding private water wells. The groundwater supply for the private resident is directly connected to a shared water source. This source of water can become contaminated by simple lack of education and proper maintenance of the well. Without knowing the possibility of how a water source may be contaminated, there is a possible health threat to that private resident and those residents downstream who use the same water (USEPA, 2010a).

The methods used examined the comparison of groups after presentation of Programs 1 or 2. The control group received Program 1 which included Oklahoma DEQ fact sheets on private water wells currently offered. The experimental groups received Program 2 which included the booklet written and illustrated by the researcher.

Validity of the instrument used in this research was provided through use of an expert jury: members of the expert jury were employed in DEQ and work with education program related to private water wells for a pretest and posttest experiment. Data from this instrument were collected, examined, and analyzed using a one-way analysis of variance (ANOVA), Tukey HSD post hoc test, and Cronbach's alpha.

This investigation revealed that a field study was difficult to gather the numbers of participants needed to reach the statistical power required to reject the null hypothesis. The results did indicate that the participants benefitted from the Power Point presentation created by the researcher regardless of the programs added to the presentation. The experimental groups that received the Program 2 did score higher on the post testing mean score than the control group that received Program 1.

The basic goal of this researcher was to reach private well owners and those who have access to private wells. Water is vital to all life. Education was a tool used in this study to provide the information to adult participants needed to protect groundwater and to provide safe water for their own home.

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LIST OF ACRONYMS

CBW: Chemical and Biological Weapons

CDC: Centers for Disease Control

CEQ: Council on Environmental Quality

CFR: Code of Federal Regulations

CWA: Clean Water Act

DEQ: Department of Environmental Quality

EDF: Environmental Defense Fund

EIS: Epidemiological Intelligence Service

EPA: Environmental Protection Agency

DOL: Department of Labor

DOM: Department of Mines

DPS: Department of Public Safety

EDF: Environmental Defense Fund

FWPA: Federal Water Pollution Act

FWPCA: Federal Water Pollution Control Act

HHS: Department of Health and Human Services

IRB: Institutional Review Board

MAC: Mycobacterium

NEPA: National Environmental Protection Act

NRDC: National Resources Defense Council

NPDES: National Pollution Discharge Elimination System

NTCI: National Center for Technology Innovation

ODEQ: Oklahoma Department of Environmental Quality

OCC: Oklahoma Conservation Commission

OHCE: Oklahoma Home and Community Education

OPDES: Oklahoma Pollution Discharge Elimination System

OSHD: Oklahoma Department of Health

OWRB: Oklahoma Water Resources Board

OEM: Oklahoma Department of Emergency Management

PHS: Public Health Service

RCRA: Resource Conservation and Recovery Act

SDWA: Safe Drinking Water Act

TMDL: Total Maximum Daily Loads

TSCA: Toxic Substances Control Act

UCLA: University of California, Los Angeles

USGS: United States Geological Survey

CHAPTER I

INTRODUCTION

Rationale for this Study

It is a given truth that the future of all living beings is decided upon the availability of potable water. Public involvement must be attained for procurement of this vital resource. “Sustainable water management is crucial to secure social and economic stability, as well as a healthy environment – achievable only as a result of cooperation and a commitment to education” (Project Wet, 2010). In this study, those concepts were examined on a local population with a resource that is attained through the use of private water wells.

Changing current beliefs in the minds of the public about water is very difficult. Confusion comes hand in hand with change. An educator who creates a clear picture of change can dissolve the confusion that results from learning something new. Education opens the pathway to questions and answers that can broaden the knowledge base of the public audience (Oak, 2010). “The goal of any drinking water education program is to facilitate actions taken by the audience to correct water quality problems and, ultimately, to increase the percentage of participants that avoid unsafe drinking water” (Swistock, Clemens, and Sharpe, 2009).

The groundwater supply for the private resident is directly connected to a shared water source. This source of water can become contaminated by simple lack of education and proper maintenance of the well. Without knowing the possibility of how a water source may be contaminated, there is a possible health threat to that private resident and those residents downstream who use the same water (USEPA, 2010a).

Research Questions

1. Does the curriculum and delivery utilized by the DEQ actually provide learning for the target population?
2. How should the adult population be educated regarding water resources?
3. Are there differences in learning based upon demographic variables?

Limitations & Delimitations

One source of limitation in this study was the restriction of this study to a geographical location in northeast Oklahoma, and subsequently, Ottawa County. Other limitations included: voluntary participation in educational presentations, participants that had private water wells, a limited design in the educational program, and the construction of the water wells not being standardized. Reliability might be compromised by cheating or helping on tests between the participants.

One of the delimitations in this study was location of the educational presentations. The educational presentations were for adult aged participants, 18 and older, who were residents in the state of Oklahoma. Second, during the education seminars or classrooms, no offer to sample private water well was offered. That was the responsibility of the participant who owned a well or was using private water well. Third, the surveys were not mailed out but were provided in the pre-testing phase. Fourth, an evaluation of the seminar or classroom presentation was provided in the post-testing phase. Fifth, no data were analyzed until the completion of the research study collection phase. All data were sealed. The data were opened on September 9th, 2011. This prevented any change in the dynamics of the seminar or classroom presentation's educational materials, program delivery, and questions on the tests.

Assumptions

First, in this study it was assumed that the participants would have the opportunity presently or in the future to have the use of private water well. Next, it is assumed that the Oklahoma Department of Environmental Quality (DEQ) would provide the publication of the educational materials, Program 1 for the Control Group and Program 2 for the Experimental Groups, for the volunteer participants during the research program. It was also assumed that public meeting or classroom locations would be used at no cost to this researcher. The researcher also assumed that those persons in attendance at the public meetings could read and write in English at least at the 5th grade level.

Statement of Hypothesis

H_0: There is no significant difference in pre and post testing scores collected from the educational presentation that the adult participants in the Control Group who receive Program 1 prepared by the Oklahoma DEQ and the adult participants in the Experimental Groups who received Program 2 prepared by the Researcher and printed by the DEQ.

H_1: There is a significant difference in pre and post testing scores collected from the educational presentation that the adult participants in the Control Group who received Program 1 prepared by the Oklahoma DEQ and the adult participants in the Experimental Groups who received Program 2 prepared by the Researcher and printed by the DEQ.

Statement of Research Design

From January 2011 through March of 2011, locations were selected and dates for the presentations were finalized. Starting April 2011 through July 2011, the presentation of educational materials with a private water well PowerPoint was completed. All participants received the PowerPoint presentation that was given in approximately the same manner at each seminar or classroom presentation. All questions that were created for testing purposes, pre and post, were answered by the PowerPoint presentation given after the pre testing phase. Bacteriological sampling kits were provided to all adult participants. Guest speakers were not utilized. Equipment from well drillers and disinfection equipment were not available for use. A pretest was presented to examine the current knowledge of the participants in the area concerning private water well owner management. A posttest was given to see how much the participants acquired in knowledge of private water well management after the presentation of the private water well PowerPoint and the addition of either Program 1 or Program 2. A survey was utilized to collect information about the demographics of the participants. An evaluation was utilized collect information regarding the participant's opinion on these items: if the programs were beneficial and if not, and how to better accomplish that goal. Data from the research were analyzed and recorded. Due to time restraints, low participation, and other factors, there were only 80 people attended the seminar or classroom presentations in total. Of these, 59 turned in consent forms, 40 completed posttests and 36 completed pretests. The evaluation was completed by 25 participants. The survey was completed by 36 participants. Confidentiality was secured using numbers provided on the backs of the Programs 1 or 2 for use for identification of participants. During the months from September 2011 to January 2012, data were analyzed, results were completed, and conclusions were made.

Definition of Terms

To aid with understanding of the science related to water and water wells, the following terms are defined as used in this study.

- “Abandoned Well: A well whose use has been permanently discontinued or which is in a state of such disrepair that it cannot be used for its intended purpose” (USEPA, 2010b).
- “Aquifer: An underground geological formation, or group of formations, containing water. Are sources of groundwater for wells and springs” (USEPA, 2010b).
- Bacteriological tests: “Bacteriological examinations are made to determine the suitability of water for drinking and food preparation uses. When a sample is reported "safe bacteriologically," it means that coliform bacteria (a group of indicator bacteria) were not found in the sample…When a sample is reported "unsafe bacteriologically," it means that coliform bacteria were found in your sample. Coliform bacteria are found in the feces of humans and other animals as well as in surface water…Presence of coliform bacteria indicates that the water is potentially dangerous and should not be consumed unless boiled” (Wisconsin, 2009).

- “Chlorination: The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds” (USEPA, 2010b).
- “Confined Aquifer: An aquifer in which ground water is confined under pressure which is significantly greater than atmospheric pressure” (USEPA, 2010b).
- “Contaminant: Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil” (USEPA, 2010b).
- “‘Domestic use’ means the use of water by a natural individual or by a family or household for household purposes, for farm and domestic animals up to the normal grazing capacity of the land and for the irrigation of land not exceeding a total of three (3) acres in area for the growing of gardens, orchards and lawns, and for such other purposes, specified by Board rules, for which de minimis amounts are used” (Title 82 Okla.St.Ann. 2010).
- “Downgradient (sic): The direction that groundwater flows; similar to "downstream" for surface water” (USEPA, 2010b).
- “Facultative Bacteria: Bacteria that can live under aerobic or anaerobic conditions” (USEPA, 2010b).
- “Fecal Coliform Bacteria: Bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens” (USEPA, 2010b).
- “Ground Water: The supply of fresh water found beneath the…” (USEPA, 2010b) “…surface of the earth regardless of the geologic structure in which it is standing or moving outside the cut bank of any definite stream” (Title 82 Okla.St.Ann. 2010) [Groundwater is located] “usually in aquifers, which supply

wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks" (USEPA, 2010b).

- "Hydraulic Conductivity: The rate at which water can move through a permeable medium. (i.e. the coefficient of permeability" (USEPA, 2010b).
- "Hydraulic Gradient: In general, the direction of groundwater flow due to changes in the depth of the water table" (USEPA, 2010b).
- "Inorganic Chemicals: Chemical substances of mineral origin, not of basically carbon structure" (USEPA, 2010b).
- "Parts Per Billion (ppb)/Parts Per Million (ppm): Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air" (USEPA, 2010b).
- "Pathogens: Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals and plants. Percolating Water: Water that passes through rocks or soil under the force of gravity" (USEPA, 2010b).
- "Percolation: 1. The (sic) movement of water downward and radially through subsurface soil layers, usually continuing downward to ground water. Can also involve upward movement of water. 2. Slow seepage of water through a filter" (USEPA, 2010b).
- "Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems" (USEPA, 2010b).
- "Potable Water: Water that is safe for drinking and cooking" (USEPA, 2010b).

- “Prior Appropriation: A doctrine of water law that allocates the rights to use water on a first-come, first-served basis” (USEPA, 2010b).
- “Semi-Confined Aquifer: An aquifer partially confined by soil layers of low permeability through which recharge and discharge can still occur” (USEPA, 2010b).
- “Septic System: An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank and must be pumped out periodically” (USEPA, 2010b).
- “Sole-Source Aquifer: An aquifer that supplies 50-percent or more of the drinking water of an area” (USEPA, 2010b).
- Total Coliform: The basic definition in the science world for total coliforms is that they “are classically defined as all facultative anaerobic, gram-negative, non-spore-forming, oxidase-negative, rod-shaped bacteria that ferment lactose to acid and gas within 48 h at 35 ◦C or members of *Enterobacteriaceae* which are *β*-galactosidase positive (Tallon, et al., 2005, p. 144).
- “Unconfined Aquifer: An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well” (USEPA, 2010b).
- “Well: A bored, drilled, or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground” (USEPA, 2010b).

CHAPTER II

LITERATURE REVIEW

General Discussion of Water

Of the available water on the Earth, the greatest percentage of water is in a non-potable form: oceans (97.5%), glaciers and ice caps (1.8%), and water in interspaces found in the soil and around underground rock formations (0.06%). Though the United States (U. S.) potable water supply is ~1400 billion gallons per day (bgd), which is 14 times the national consumption, the United States (U. S.) has problems with the equal distribution of the supply of water throughout the country. Consumptive use, such as household use and agricultural use, is not the only way this resource is utilized. In non-consumptive use such as: fishing, boating, hydroelectric power generation is use that occurs without removing water from the stream, lake, or other body of water. In all the uses of water, irrigation is the largest single use in the U.S. (up to 90% of the total water use in the west) (USGS, 2009).

As a resource, water is the most vital to all life to survive. Water must be recycled to be used continuously. In 1957, Freedman wrote the detailed pathway of the water cycle and how it is recycled from the atmosphere to a groundwater source:

> "Moisture in the atmosphere is precipitated to form rain; rain water runs along the surface of the earth; part of the rain water runs into lakes and streams, part is

evaporated, part soaks into the ground; part of the ground water is taken up by vegetation and is transferred by plants into the atmosphere; part of the water is stored in the plant and returned to the ground or atmosphere after the plant dies; part of the ground water passes easily through the upper layers of the earth which are less dense and have certain amount of air (and therefore oxygen) in the porous structure. This is known as the 'Zone of Aeration'…the soil acts as a natural filter of bacteria; as the water continues to pass downward the ground becomes denser and more impervious and therefore the Water accumulates and saturates the ground. This saturated area is known as the 'Zone of Saturation'. Between the zone of saturation and the zone of aeration, there is a fringe where water is held by capillary action. This is called the 'Capillary Fringe' and corresponds to a narrow stratum just above the 'Water Table'" (p. 262).

Advancements to make this water safer to drink started in the late 1600s. One of the first scientists to study water purification was Sir Robert Bacan. "[He] began experimenting with a form of sand filtration to remove salt particles from seawater". The first microscope to see impurities in water was created by Anton van Leeuwenhoek. "…Leeuwenhoek became the first person to discover microorganisms in water in 1676. In the 1700s water filtration was attempted with "wool, sponge, and charcoal" in private homes…" In the year 1804, the first large municipal water treatment plant was installed in Scotland in order to provide treated water to every resident (Baker & Taras, 1981).

In 1854, the British scientist John Snow traced an outbreak of cholera to a public water pump. He was the first documented scientist to use chlorine as a disinfectant. In the late nineteenth century, the United States began to use "municipal water treatment" to supply public water. With the use of chlorine and other processes of experimentation of treatment, the U. S. and many other countries began to decrease the number of outbreaks of waterborne diseases (Baker & Taras, 1981).

History of the U. S. Basic Water Law

Who owns what water and who has rights to that water has always been and still is a fight between individuals and companies. This confrontational issue brought about the creation of laws to govern water ownership. In the U. S., a law was passed which was known as the Basic Water Law. In its contents the law states that the "water law encompasses a broad array of subjects" which are used to "resolve disputes and policy issues" that relate to water. Some of the water sources were:

- Public waters, including watercourses, lakes and under modern law (today), wetlands;
- Other surface waters: water that flows across the land from rain events, floodwaters, and snowmelt before these waters actually reach the watercourses, lakes and wetlands;
- Groundwater, defined by some as percolating underground water;
- Public regulation waters: i. e., flood control and environmental regulations (state and federal), public health regulation and regulation of fisheries;
- Related to all of the above is the interplay of public and private rights to water, which draws on aspects of eminent domain law and the federal commerce clause powers;
- Water project law is defined as a highly developed law that regard the formation, operation and finance of public and quasi-public entities which operate local

public works of flood control, navigation control, irrigation, and avoidance of environmental degradation (Wiki 2010).

There are three types of water law systems: Riparian Rights, Prior Appropriation, and Hybrid. These water laws were created geographically starting in the eastern U. S. The Riparian Rights system was established when the Eastern states of the U. S. were first settled by Europeans (and therefore influenced by English common law). The riparian doctrine that was formulated during this time period permitted anyone whose land had frontage on a body of water the use of water from it. This doctrine developed fully where lands had ample rainfall. In addition to these rights, the Riparian Rights system included: the right to access the water, the right to use or consume the water, the right to use the ground and non-public waters, and the right to use land that is added to the extent of the adjoining property of accretion (O'Conner, 1999).

The Prior Appropriation system was developed in the western part of the U.S. where the western states were lacking the abundance of water that was found in the eastern states. That system gave the water rights to the person(s) who first put the water to beneficial use (O'Conner, 1999).

The Hybrid system, which contains elements of the Riparian and Prior Appropriation systems, can be still found in Texas and states north of it, such as the Mississippi valley, and in the West Coast states. The reason for the Hybrid system was the huge variety of water sources, from little to massive, in such a large area that these states encompassed in their geographical and geological water source areas (O'Conner, 1999).

Indian Tribes and the Water Law

Native American (federally recognized) water rights were often referred to as "Winter rights". It was the term used for the Native American water rights inside the reservation lands. That name came from the case of Winters and Arizona v. California (1888). The Winter rights were:

1. Rights defined by Federal law.
2. Establishment of a reservation by treaty, statue, or executive order included an implied reservation of water rights in sources within or bordering the reservation.
3. Based on date, users with Prior Appropriation dates under state law would take precedence over the Native American rights, but those with later dates were subordinate.
4. Quantity of water reserved was defined as the amount sufficient to irrigate all irrigable land on the reservation.
5. Rights were not lost due to non-use.

In contrast to these Native American water rights, Non-Native American Purchaser's rights were:

1. A Native American landowner was entitled to the share of the reservation's water that was needed to irrigate their land.
2. When a Native American sold their allotment to a non-Native American, the purchaser acquired the allotment's reserved water rights.
3. The priority date of those rights remained the date when the reservation was created.
4. Non-Native American landowner could lose their water rights to non-use.

Oklahoma Water Law

"The owner of the land owns water standing thereon, or flowing over or under its surface but not forming a definite stream. The use of groundwater shall be governed by the Oklahoma Groundwater Law" (Title 60 § 6060). Definite stream means a watercourse in a definite, natural channel, with defined beds and banks, originating from a definite source or sources of supply. Title 82 Section 105.1 defines water in a stream as "running" if it is in a definite stream. The stream may flow intermittently or at irregular intervals if that is characteristic of the sources" water supply, in the area historically.

During the use of this water, the owner may not alter the "natural flow of stream or of the natural spring from which it commences its definite course". The owner cannot pollute this water source because that water eventually becomes public water. Public water "is subject to appropriation for the benefit and welfare of the people of the state, as provided by law". The owner may dam up the stream or "otherwise using the bed of a stream" for collection of water. The collection amount cannot exceed what the land owner owns, and the land owner must provide a "continued natural flow of the stream in an amount equal to that which entered" the owners land. This does not include the use of the water amount the land owner needs for domestic uses. Title 82 Section 105.2 defines domestic use as "the use of water by a natural individual or by a family or household for household purposes, for farm and domestic animals up to the normal grazing capacity of the land and for the irrigation of land not exceeding a total of three (3) acres in area for the growing of gardens, orchards and lawns, and for such other purposes, specified by Oklahoma Water Resources Board (OWRB) rules, for which *de minimis* amounts are used. Title 82 Section 105.1 states that a person who owns land that is riparian to a stream or “to take stream water for domestic uses from wells” on the land of the owner, has the right to take that water. Even though they are allowed water without permit, the amount of water for domestic use cannot exceed a storage amount for a two years’ supply.

Title 82 Section 105.13 states that the OWRB is allowed to permit for water uses of the state. Title 82 Section 1020.3 states that water use permits are only required for non-domestic use purpose. Title 82 Section 105.13 states that these permits can be “regular, seasonal, temporary, term or provisional temporary” as long as issuing the permit does not cause impairment or interference with “domestic uses or existing rights of prior appropriators”. The permit is to prevent waste of a natural resource that belongs to the citizens of the state of Oklahoma which is forbidden.

Oklahoma State Environmental Agencies

The agencies that exist in the State for regulation of environmental resources are the: Department of Environmental Quality; Oklahoma Water Resources Board; Oklahoma Corporation Commission; State Department of Agriculture, Food, and Forestry; Conservation Commission; Department of Mines; Department of Wildlife Conservation; Department of Public Safety, Department of Labor, and Oklahoma Department of Emergency Management. Of these, the following have rules and regulations that relate to private water wells, the domestic or non-domestic use of water, and surface water resources which can be connected to ground water resources.

The Department of Environmental Quality of Oklahoma (DEQ) was written into the Oklahoma Statues as an agency that came into effect on January 1, 1993. The DEQ oversees all regulations established through the EPA (Environmental Protection Agency) by primacy (primary responsibility) for the state of Oklahoma. If a written regulation is more stringent and enforced by the EPA, then the EPA has primacy. The DEQ's (DEQ, 2009b) mission statement is: "The mission of the Oklahoma Department of Environmental Quality is to enhance the quality of life in Oklahoma and protect the health of its citizens by protecting, preserving and restoring the water, land and air of the state, thus fostering a clean, attractive, healthy, prosperous and sustainable environment" (p.1).

And the DEQ's (DEQ, 2009b) vision statement is:

"The vision of the Department of Environmental Quality is to eliminate the effects of unintended consequences of historic development, to prevent new adverse environmental impacts and to provide significant input into national decision making, all the while enhancing both the environment and the economy of Oklahoma" (p.1).

Title 27A Section 1-3-101 states that "The Department of Environmental Quality [has] the following jurisdictional areas of environmental responsibility in relation to Oklahoma's water resources:

1. All point source discharges of pollutants and storm water to waters of the state which originate from municipal, industrial, commercial, mining, transportation and utilities, construction, trade, real estate and finance, services, public administration, manufacturing and other sources, facilities and activities, except as provided in subsections D and E of this section;
2. All nonpoint source discharges and pollution except as provided in subsections D, E and F of this section;

3. Technical lead agency for point source, nonpoint source and storm water pollution control programs funded under Section 106 of the federal Clean Water Act, for areas within the Department's jurisdiction as provided in this subsection;
4. Surface water and groundwater quality and protection and water quality certifications;
5. Waterworks and wastewater works operator certification;
6. Public and private water supplies;
7. Underground injection control pursuant to the federal Safe Drinking Water Act and 40 CFR Parts 144 through 148, except for:
    a. Class II injection wells,
    b. Class V injection wells utilized in the remediation of groundwater associated with underground or aboveground storage tanks regulated by the Corporation Commission,
    c. those wells used for the recovery, injection or disposal of mineral brines as defined in the Oklahoma Brine Development Act regulated by the Commission, and
    d. any aspect of any CO_2 sequestration facility, including any associated CO_2 injection well, over which the Commission is given jurisdiction pursuant to the Oklahoma Carbon Capture and Geologic Sequestration Act".
8. Water, waste, and wastewater treatment systems;
9. Freshwater wellhead protection;
10. Groundwater protection for activities subject to the jurisdictional areas of environmental responsibility of the Department;

11. Utilization and enforcement of Oklahoma Water Quality Standards and implementation documents;
12. Environmental regulation of any entity or activity, and the prevention, control and abatement of any pollution, not subject to the specific statutory authority of another state environmental agency;
13. Development and maintenance of a computerized information system relating to water quality; and
14. Development and promulgation of a Water Quality Standards Implementation Plan …for its jurisdictional area of environmental responsibility".

The Oklahoma Water Resource Board (OWRB) consists of nine members appointed by the governor of the state. The OWRB is responsible for administering the use of both surface and groundwater in the state. Currently, the board has over 12,000 water rights permits on file for almost six million acre-feet of water. It oversees the funds to aid water and wastewater plants to apply to their infrastructure in Oklahoma; it promulgates state water quality standards that dictate the degree of treatment requirements to discharge into the waters of the state; it directs a comprehensive water quality monitoring network that includes data that has been collected and will be from 155 lakes and streams; it licenses all water well drillers in the state and maintains a database that contains around 35,000 water well logs that well drillers submit. The Board also coordinates the floodplain management activities in the state, and it oversees the Oklahoma Dam Safety Program that includes more than 4,500 dams in the state (Oklahoma Water Resources Board, 2009).

Title 27A-1-3-101 states that the OWRB has jurisdictional areas of environmental responsibility for: water quantity including, but not limited to, water rights, surface water and underground water, flood plain management; administration of the federal State Revolving Fund Program, and water well drillers/pump installers licensing. Also they are the technical lead agency for clean lakes eligible for funding under Section 314 of the federal Clean Water Act or other applicable sections of the federal Clean Water Act or other subsequent state and federal clean lakes programs and administration of a state program for assessing, monitoring, studying and restoring Oklahoma. They are also responsible for groundwater protection and development of classifications and identification of permitted uses of groundwater, in recognized water rights, and associated groundwater recharge areas.

Title 27A-1-3-101 states that the Oklahoma Department of Agriculture, Food, and Forestry jurisdictional areas of environmental responsibility are: point and nonpoint source flows from agricultural crop production, agricultural services, livestock waste, pesticide control, forestry and nurseries, fertilizer; facilities which store grain, feed, seed, fertilizer and agricultural chemicals, and dairy waste and wastewater from milk production facilities. They also have environmental responsibility in the area of groundwater protection, utilization and enforcement of Oklahoma Water Quality Standards, development, as well as promulgation, of a Water Quality Standards Implementation Plan, and storm water discharges.

Title 27A-1-3-101 states that the Corporation Commission is directed to "promulgate and enforce rules, and issue and enforce orders governing and regulating the conservation of oil and gas, the exploration, drilling, development, production and operation of wells used in connection with the recovery, injection or disposal of mineral brines, underground injection control pursuant to the federal Safe Drinking Water Act, facilities which are subject to the jurisdiction of the Department of Environmental Quality with regard to point source discharges. They are also responsible for the utilization and enforcement of Oklahoma Water Quality Standards and implementation documents, and development and promulgation of a Water Quality Standards Implementation Plan pursuant to Section 1-1-202" for its jurisdictional areas of environmental responsibility concerning the state of Oklahoma water resources.

Title 27A-1-3-101 states that the Oklahoma Conservation Commission (OCC) jurisdictional areas of environmental responsibility are: soil conservation, erosion control and nonpoint source management except as otherwise provided by law, monitoring, evaluation and assessment of waters to determine the condition of streams and rivers being impacted by nonpoint source pollution, wetlands strategy …implementation in watersheds of clean lake…Federal upstream flood control program, groundwater protection, development, as well as promulgation, of a Water Quality Standards Implementation Plan."

Title 27A-1-3-101 states that the Department of Mines (DOM) jurisdictional areas of environmental responsibility include, but not limited to, groundwater protection, and development, as well as promulgation, of a Water Quality Standards Implementation Plan.

Title 27A-1-3-101 states that the Oklahoma Department of Emergency Management (OEM) jurisdictional areas of environmental responsibility are: coordination of all emergency resources and activities relating to threats to citizens' lives and property. OEM must maintain a computerized emergency information system allowing state and local access to information regarding hazardous materials location, quantity and potential threat.

Protection of water resources of the state of Oklahoma are subject to rules and regulations of these agencies responsibilities that are listed. With regard to groundwater, surface water that can impact groundwater, and private groundwater wells, the Oklahoma DEQ and OWRB that are the most involved with this resource protection.

History of Water Pollution and Subsequent Regulations

With the urban movement, the industrial revolution, and the advanced agricultural practices, pollution of water and other natural resources started to become an issue of concern in the early 19^{th} century. Of concern, sanitary sewers flowed into the waters of the nation, causing bacteria and viruses spread rapidly. By the early 1800s, the epidemics that spread by waterborne viruses and bacteria were seen in many cities in the U.S. Cholera and typhoid fever, in 1832, were very widespread and caused an epidemic of these diseases in New York City (EPA, 2009a).

Typhoid Mary was a nickname given to Mary Mallon at the beginning of the 20^{th} century. She was a New York resident and domestic cook who was accused of spreading typhoid to several hundred people. “Fifty cases and five deaths can be confirmed as being associated with her”. Mary was among the first healthy carriers of this disease in the U. S. She was temporarily quarantined, changed positions of work, but eventually went back to cooking. In reaction to this, the government quarantined her for 23 years until her death (CWBinfo, 1999).

In an effort to counteract this malignant problem, some cities began to filter their potable water. In Chicago, Illinois, the city worked toward a goal of potable water and accomplished it when they turned the direction of the water current against itself in the Chicago and Calumet Rivers. Other cities of the same capacity and level of problems did something on a similar course of venue. The death rate in the nation of the U. S. for typhoid reduced quickly. Where in 1900 there were 36 in every 100,000 population that had typhoid, by 1935, there were only three cases in every 100,000 people. Eventually, typhoid became nearly extinct by the end of the 20th century in the U. S. (McGlinn, 2003).

Typhoid fever still poses a threat to humans by drinking unsafe water. In March of 2008, contaminated water in Manila, Philippines, caused an outbreak of typhoid fever in Calamba City in Laguna. Coliform bacteria by bacteriological testing were found in the water source that was not disinfected to the standards necessary to destroy the bacteria. Water wells in a total of 18 villages were tested. It was eventually decided that the water being consumed was the pathway to the infection of salmonella (typhus) (Meruenas, 2008).

By 1900, the rivers ceased to carry the human waste to Lake Michigan, after Congress enacted the River and Harbor Act of 1886 and waste treatment modifications were made. Agricultural runoff from fertilizers combined with the industrial waste continued to impact water quality of many rivers, streams, and lakes. By 1958, Lake Erie was nearly dead of any aquatic life and unfit for human consumption of any kind. In the late 1960s, Cuyahoga River caught fire from the industrial pollution that was dumped into the river (EPA, 2009c).

By 1912, the industrial revolution had impacted an abundant amount of water sources that were not used for drinking water, but they also trespassed, in necessity to eliminate waste, on public water supply sources with the activity of illegal dumping (not taken to a permitted or designated dumpsite). An investigation was charged by Congress to the Public Health Service (PHS) to ascertain where the origin of the contamination and the level of the contamination to public water supplies and surface water supplies came from (EPA, 2009c).

In 1914, in reaction to the results of this investigation, the water quality standards were created, though enforced poorly by states. The states had the primary authority (primacy) to enforce the regulations on water pollution but were for the most part non active in this capacity. In the need for industry to grow, many states saw that progress and environmental quality were not on the same level of importance (EPA, 2009c). This lack of regulation eventually brought about the next phase of environmental protection and change.

The National Environmental Policy Act (NEPA) was enacted into law on the first day of 1970. NEPA established "a national policy to protect the environment, created a Council on Environmental Quality (CEQ), and required that environmental impact statements be prepared for major federal actions having a significant effect on the environment". The CEQ became the "federal environmental policy arm". CEQ's major action involved the policy area of government in environmental concerns. During the decade of the 1970s, the CEQ "developed a comprehensive environmental program that included, but was not limited to: "amendments to the Federal Water Pollution Control Act [FWPCA], the Toxic Substances Control Act [TSCA], [were] forerunners to the

Resource Conservation and Recovery Act (RCRA), and the Safe Drinking Water Act [SDWA] ... [and] laid the groundwork" for many of the current environmental legislation of today" (Alm, 1988).

NEPA was also the reason that the Natural Resources Defense Council (NRDC) and the Environmental Defense Fund (EDF) were founded. It also "developed guidelines for the environmental impact statement process". Though quick to be the center for many changes, NEPA has slowly taken a back shelf and EPA has taken the larger responsibility of caring for the environment (Alm, 1988).

The EPA became an agency on December 2, 1970. It came after a decade of downplay on conservation and environmental concern when l Rachel Carson's *Silent Spring* brought out scientists and public outcry to do something about the pollution and contamination of the President Nixon established the EPA with these goals in mind: The mission of the EPA was to:

- Establish and enforce environmental protection standards.
- Conduct environmental research.
- Provide assistance to others combating environmental pollution.
- Assist the CEQ in developing and recommending to the President new policies for environmental protection (Lewis, 1985).

The CWA's pathway to birth by Congress started in 1948 as the Federal Water Pollution Act (FWPA). It was the first major U.S. law that addressed water pollution. With public awareness on the upscale and the subsequent concern for water quality rising, amendments were made to the FWPA in 1972 (EPA, 2009a).

Johnson (EPA, 2009a) stated, in regard to the 1972 amendments to the Federal Water Pollution Control Act (FWPCA): The Earth's water resources illustrate the interaction of all parts of the environment and particularly, the recycling process that characterizes every resource of the ecosystem… Everything that man himself injects into the biosphere – chemical, biological or physical – can ultimately find its way into the earth's water. And these contaminants must be removed, by nature or by man, before the water is again potable (para.1).

It was not until after the 1977 amendments that the law became commonly known as the Clean Water Act (CWA).

The 1977 amendments:

- Established the basic structure for regulating pollutants discharges into the waters of the United States.
- Gave EPA the authority to implement pollution control programs such as setting wastewater standards for industry.
- Maintained existing requirements to set water quality standards for all contaminants in surface waters.
- Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions.
- Funded the construction of sewage treatment plants under the construction grants program.
- Recognized the need for planning to address the critical problems posed by nonpoint source pollution" (EPA, 2009b).

On June 25, 1977, the EPA announced the “national drinking water standards” that affected the entire country of the U. S. Over “40,000 community drinking water systems and 200,000 other public water systems” were required to test their water on a routine basis to provide assurance that the water was safe to drink. Part of the new law also required these facilities providing the water to report any sampling that did not meet required levels of safety and/or health standards to the public they served. The health standards included “microbiological contaminants, 10 inorganic chemicals, six organic pesticides, turbidity (or murkiness) and radiological contamination”. Since not all responsible facilities were ready to start the sampling for all these health standards, monitoring was mandatory and was to start on an immediate basis for coliform bacteria and turbidity. These two standards related to the “possible transmission of immediate illness” through drinking water. In addition, Congress intended for the States to be the regulating authority over drinking water in their state. To do this, the state had to assume “primary enforcement responsibility or ‘primacy’ over its water supply systems”. If a state could not do this, EPA would then have that responsibility (EPA, 2009b).

The Clean Water Act, which was last amended in 1987, consists of two major parts: regulatory provisions that impose progressively more stringent requirements on industries and cities to abate pollution and meet the statutory goal of zero discharge of pollutants, and provisions that authorize Federal financial assistance for municipal wastewater treatment construction (Copeland, 1995).

Safe Haven for Heroes Act of 2011 (H.R. 961) reflects efforts to make the CWA more flexible and less prescriptive and to address a number of regulatory reform issues of concern to many of those regulated by the law with industries, States, and cities, in particular. These reform efforts are most evident in titles III and VIII of the bill that included amendments to the standards and regulatory requirements and wetlands permit provisions of current law. The legislation was designed in large part to provide relief to businesses, States, local governments, and individual landowners from what many in these groups view as excessive and prescriptive clean water regulation. It does so particularly by incorporating risk assessment and elevating cost considerations in the implementation of CWA programs (Copeland, 1995).

From 1972 to 1995, the EPA accomplished what was enforceable but there was still a need for stricter regulations. This was accomplished by adding many amendments to the CWA and enforcements by the states. Since the enactment of the CWA, measurements of success were showing that CWA was working. These included but were not limited to: "doubling the number of waterways safe for fishing and swimming, reducing industrial discharges by billions of pounds a year; more than doubling the number of Americans served by adequate sewage treatment; reducing annual wetland losses by roughly 75 percent [and **]** reducing soil erosion from cropland by more than a third" (EPA, 2009c).

The EPA has established many new standards for water, for wastewater effluent, air and solid waste. The agency is ever-changing in parallel with the environmental challenges that change from day to day (EPA, 2009).

History of Waste Disposal into Water-based Environments

Fecal contamination can migrate into the public water supply via lakes, streams, and groundwater. Watersheds are often subject to fecal contamination by a variety of sources and efforts to improve water quality are often limited. This is because of lack of information on which contaminant sources are most significant. By consuming water through accidental ingestion during surface water activities, e.g., recreational activities, human beings can be exposed to waterborne disease organisms. ”Evidence of human contamination indicates human fecal pollution and an increased risk of exposure to enteroviruses” (Rotbart, 1995).

Treatment of wastewater produced by a private residence without municipal facilities in the Western U. S. began on a very simple basis: from house to lagoon or to a nearby stream. The idea was that water diluted the waste and broke it down biologically. Surface water bodies did not have the ability to take on this kind of oxygen demanding waste. Eventually the streams became “anoxic”. The smell was not the worst part of a stream that had no oxygen; the dead fish were. Farmers began to worry about the water being suitable for agricultural applications. Until the 19th century, when contaminated water was connected to disease, people did not realize how bad the pollution was from sanitary and other wastes. Over time, with research, “methods were developed” to analyze the wastewater, stream capacity of the biological oxygen demand, and what procedures could be taken to keep the dissolved oxygen up and the degradation of the water body down (Anderson & Woolsey, 2005, p. 45, 49-50).

For treatment of waste water that is discharged into the waters of the states, Section 303(d) of the Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) Water Quality Planning and Management Regulations (40 Code of Federal Regulations [CFR] Part 130) require states to develop total maximum daily loads (TMDL) for water bodies not meeting designated uses where technology-based controls are in place (Parsons, 2008, p. 1-1). As authorized by Section 402 of the CWA the

Oklahoma DEQ has delegation of the National Pollution Discharge Elimination System (NPDES) Program in Oklahoma, except for certain jurisdictional areas related to agriculture and the oil and gas industry. The NPDES Program in Oklahoma is implemented via Title 252, Chapter 606 of the Oklahoma Pollution Discharge Elimination System (OPDES) Act and in accordance with the agreement between Oklahoma DEQ and U.S. EPA relating to administration and enforcement of the delegated NPDES Program (Parsons, 2008, p. 5-40).

The NPDES permits facilities to discharge treated wastewater. These facilities are "required to monitor for one of the three bacteria indicators (fecal coliform, *E coli*, or *Enterococci*) in accordance with its permit" (Parsons, 2008, p. 3-1) Fecal coliform can come from many sources that are at a fixed point, called a point source, and also non-point (run off, non-fixed point), fecal coliform sources. The origin of these coliform sources is varied. They include but not limited to "human waste, agricultural areas or wildlife" (Mandaville, 2002, p. 4).

Lake Eutrophication

Lakes at the urban-rural fringe represent an opportunity for proactive management of urban expansion to minimize lake eutrophication. In regard to lakes, they can be classified as septic lakes, sewer lakes, or simply undeveloped lakes. Septic lakes occurred along the urban-rural fringe while sewer lakes occurred near urban centers. Undeveloped lakes are not affected by human sewage usually. Septic lakes were more eutrophic than sewer lakes and undeveloped lakes. This is indicated by higher levels of phosphorus and chlorophyll-a in septic lakes. These results suggest that septic systems contribute to the high levels of eutrophication in lakes at the urban-rural fringe (Moore, Schindler, Scheuerell, Smith, & Frodge, 2006, pp. 7-8).

In Seattle, WA, 30 lakes were surveyed using a measurement with three-lake-eutrophication indicators. The indicators were chlorophyll-concentrations, phosphorus concentrations, and the algae beds that were inedible to zooplankton. In the results of the research, the septic lakes had higher indicator amounts than the sewer or undeveloped lakes giving rise to the conclusion that ground water infiltration via septic systems (later lines and/or leaking septic tanks) can cause "lake eutrophication (sic) and ecological and aquatic injury, and human risk of contamination of viruses and pathogenic bacteria". It is not the only cause of lake contamination, but a heavy contributor when added to the other non-point and point contaminants (Moore, et al., 2006, p. 1).

In the state of Oklahoma, the Office of the Secretary of the Environment has the responsibility to "coordinate monitoring lakes …and identify those lakes which it determines to be eutrophic" as defined by Oklahoma's Water Quality Standards. In this regard, the following is stated in 27A-1-2-102:

> "No person may discharge wastewaters from a point source within or outside of this state which will foreseeably enter a lake in this state which has been identified as eutrophic by the Oklahoma's Water Quality Standards without subjecting such wastewaters to the best available technology as identified in the federal Clean Water Act for nitrogen and phosphorous. The Office of the Secretary of the Environment shall coordinate the monitoring of all lakes it identifies as eutrophic and notify by certified mail any person who discharges wastewater which enters such lakes in violation of this section of the provisions

of this section and shall order such person to immediately cease and desist from any further violation of this section" (27A §1-2-102).

In returning to the contamination of the states' surface water, the concern is with waterborne mycobacteria which are members of pathogenic family Mycobacterium (MAC). The species included in MAC can cause 70 diseases that have been defined. Of these 70 about 30 cause disease in humans and/or animals. Epidemiological evidence indicates that humans are infected by MAC from contact with the environment and not via person-to-person transmission (Cangelosi, Clark-Curtiss, Behr, Bull, & Stinear, 2004, pp. 41-22).

In Oklahoma, the Department of Environmental Quality (DEQ) sent out a press release to educate and warn the public of entering surface water and the possibilities of being exposed to surface water.

"…Certain bacteria, viruses, and protozoa can be present in bodies of water. Some of these microorganisms occur naturally while others are carried into surface waters from a variety of sources. Some of these microorganisms are harmful and can cause mild problems such as ear infection, swimmers itch, intestinal diseases, or relatively rare but serious conditions such as eye infections and some forms of meningitis. When swimming in untreated water …throughout the year, here are some steps to reduce exposure to waterborne microorganisms: hold your nose or wear nose plugs when jumping into the water, wash open skin cuts and scrapes with clean water and soap immediately after swimming, avoid swallowing water when swimming, wear ear plugs to prevent ear infections, wear swim goggles or masks to prevent eye infections, avoid swimming near storm

> drains…stay away from any area that has floating debris, stagnant water, oil sheens or dead fish. Swimmers should be aware of blue green algae and cryptosporidium as well. When waters are heated and stagnant, the risk for exposure will increase. DEQ advises swimmers to use common sense precautions when swimming in untreated waters" (McElhaney, 2008).

Subjects not seeking medical visits lower the statistics of the actual numbers who have had gastroenteritis or other diseases from exposure or consumption of contaminated water. These waterborne pathogenic parasites and protozoan are part of a large pathogenic community that can cause an outbreak of illnesses if they contaminate any water source that humans can be exposed to, especially surface water, i.e., lakes (Rose, Epstein, Lipp, Sherman, Bernard, & Patz, 2001, p. 20).

Federal and Oklahoma State Health Agencies

The Communicable Disease Center (CDC) was founded by Dr. Joseph W. Mountin on July 1, 1946, in Atlanta, Georgia. The predecessor to the CDC was the Malaria Control in War Areas during World War II. The new institution expanded to eventually include all communicable diseases. They also expanded to all the states and provided practical help where needed or called to. In 1949, Dr. Alexander Langmuir launched the first "disease surveillance program" to research malaria's existence in the U. S. It had been eradicated. The success of this program was the beginning of the building of mission service to all the states (CDC History Case Study, 1971, p. 1).

In 1950, the Korean War was the reason for the creation of the CDC's Epidemiological Intelligence Service (EIS). Dr. Langmuir saw an opportunity to train epidemiologists to watch for biological agents of warfare. In 1951, the first class of these scientists was trained and those individuals in the class pledged their service for the next two years on an emergency basis. “These disease detectives quickly gained fame for shoe-leather epidemiology” (from one place to the other on foot). They used this to find the reason(s) for different disease outbreaks (CDC History Case Study, 1971, p. 2).

In 1955, the CDC gained its credibility and found its footing of longevity in existence when poliomyelitis appeared after inoculation of the “Salk vaccine” was administered. It came to be known that a contaminated vaccine originated from a lab in California. They traced the children who were inoculated and found that a resistance had built up in six and seven year-olds to polio when compared to older children who were not inoculated early. In 1956, the “surveillance” traced an influenza epidemic. These data gathered during 1957s led to the development of the national guidelines for the influenza vaccine. With many successes over the years from the eradication of measles to their research in AIDs, the CDC became successful in public health initiatives to prevent infection and provide protection of the public and international communities. In 1970, CDC became known as the Center for Disease Control. It was reorganized in 1981 and Center became Centers. In 1992, the words “and Prevention” were added making it the Centers for Disease Control and Prevention (CDC History Case Study, 1971, pp. 2-3).

The CDC worked with states to provide among many other resources health surveillance. This is to monitor and prevent disease outbreaks. The CDC is among the 13 agencies, or components, of the Department of Health and Human Services (HHS) (CDC, 2009).

From the Oklahoma State Department of Health’s website, 2010, their organization’s Mission Statement is:

“To Protect And Promote Health Of The Citizens of Oklahoma, To Prevent Disease And Injury, And To Assure The Conditions By Which Our Citizens Can Be Healthy.”

The Oklahoma State Department of Health (OSHD), through its system of local health services delivery, is ultimately responsible for protecting and improving the public's health status through strategies that focus on preventing disease. Four major service branches: Community Health Services, Family Health Services, Disease & Prevention Services and Protective Health Services, provide technical support and guidance to 68 county health departments as well as guidance and consultation to the two independent city-county health departments in Oklahoma City and Tulsa”.

Title 63-1-206 states that “A county department of health, a district department of health, a cooperative department of health, and a city-county department of health shall, in their respective jurisdictions. In regard to the environment and waterborne illnesses, the state and county health departments maintain programs for disease prevention and control, health education, guidance, maternal and child health, including school health services, health in the working environment, nutrition and other matters affecting the public health.

Literature Related to Research & Methodology

The following literature subjects are titled separately. They are presented with the intention of the researcher to provide background related to the research preparation, methods, and the reasoning behind this study.

Education of Children and Adults

"Over 90 years ago, Binet and Simon delineated two different methods of assessing intelligence". They were the "psychological method (which concentrates mostly on intellectual processes, such as memory and abstract reasoning) and the pedagogical method (which concentrates on assessing what an individual knows)". These were designed to "predict elementary school performance independently from the social and economic background of the individual student". The results that were analyzed brought forth the settling on the psychological method. Binet and Simon "spawned an intelligence assessment paradigm which has been substantially unchanged from their original tests". Adult assessment methods progressed along these same lines but the "difficulty of items was increased for older examinees. Adult intelligence tests were created as little more than upward extensions of the original Binet-Simon scales" (Ackerman, 1996).

Though these tests were "quite effective in predicting" success in schools on the primary and secondary levels, they were "less predictive of success" for those already passed the secondary education or "occupational domains". After delineation of the results, it was decided that the possibility that the pedagogical method might be a better tool to access adult intelligence. In example, an adult that was presented with a "completely novel problem" such as memorizing, random numbers, and random letter, the results were good at predicting which adults would be successful at solving problems. The problem with that result was that an adult is rarely presented with a "completely novel problem" in the real world, whether in academics or in their occupation. The problems an adult usually had opportunity to solve were formed from the skills and knowledge accumulated by the adult individual. “Thus, the content of the intellect is at least as important as the processes of intellect in determining an adult's real-world problem solving efficacy” (Ackerman, 1996).

Pedagogy and Andragogy

“Unlike children, who participate in schooling because of legal mandates and strong social and cultural forces, most adult students choose to participate in educational programs” (Comings, 2007, p. 23).

“While the concept of andragogy [learning strategies focused on adults] had been in spasmodic usage since the 1830s, it was Malcolm Knowles who popularized its usage for English language readers. For Knowles, andragogy was premised on at least four crucial assumptions about the characteristics of adult learners that are different from the assumptions about child learners on which traditional pedagogy [“*paid*- meaning 'child' and *agogos* meaning 'leading'” (Smith, 1996, 1999)] is premised. A fifth was added later.

1. Self-concept: As a person matures his self concept (sic) moves from one of being a dependent personality toward one of being a self-directed human being;

2. Experience: As a person matures he accumulates a growing reservoir of experience that becomes an increasing resource for learning;

3. Readiness to learn. As a person matures his readiness to learn becomes oriented increasingly to the developmental tasks of his social roles;

4. Orientation to learning. As a person matures his time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly his orientation toward learning shifts from one of subject-centeredness to one of problem [centeredness];

5. Motivation to learn: As a person matures the motivation to learn is internal" (Smith, 2002).

"Adults are life, task or problem-centered in their orientation to learning. They want to see how what they are learning will apply to their life, a task they need to perform, or to solving a problem… Adults have had a lifetime of experiences." "[These experiences make] adult learners more heterogeneous than younger learners and also provides an additional base of knowledge…While adult learners may respond to external motivators, internal priorities are more important. Incentives such as increased job satisfaction, self-esteem and quality of life are important in giving adults a reason to learn." (Fidishun, n.d.). With education of the adult population, these facts and resources already established are a tool for educators to use.

Ground Water Source Contamination

In the United Kingdom (U.K.) cases of gastroenteritis increased between July 25 through August 25 in the year 2000. The municipal (public) water system supplied water to about 65% of the population of the affected community. During this interval of time, four hundred and sixty-three individuals contacted the health centers. They all had gastroenteritis. The baseline of this illness was "an average of 20 monthly cases". The first cases occurred around July 25th. On August 4th, "the number of cases increased suddenly with a peak incidence on" July 7th. After the 10th of August, the case number dropped. "The overall attack rate in the municipality according to the number of contacts…was 4.2%" (Kuusi et al., 2006, p. 273).

According to Kuusi et al. (2006), the municipality affected was supplied water by two groundwater wells. This water from these wells was pumped to two reservoirs and from there it was fed to the lines that led to the distribution and to the residents on public water. This water was not disinfected by chlorination on a regular basis. Bicarbonate was on a routine schedule for regulation of the pH of the water. Monthly bacteriological tests, coliform, were performed. The results of these previous tests did not show any indication of contamination prior to the outbreak of gastroenteritis (Kuusi, Klements, Miettiene, Laaksonen, Sarkkinen, Hänninen, et al., 2006). The total coliform test is the standard indicator for gauging the risk of disease transmission from drinking water. This indicator has limitations because coliform bacteria may originate from non-fecal sources and the test does not correlate with all waterborne diseases which could include or not include the incident of gastroenteritis (Borchardt, Po-Huang Chyou, DeVries, & Belongia, 2003b, p. 746).

No construction or cleaning of the water systems had occurred prior to the outbreak. Neither well was protected from public or animal access. Though the first well, A, had a community that was on a municipal sewage system, the second well, B, did not. The closest septic system (underground) located near well B was 15 meters distant. Water reservoirs were also assessable to the population and left unprotected. With heavier rainfalls than the year before, with the wells being located about 30 meters from a large lake, and with apparent nonpoint runoff, the water system was contaminated. "[The] water from wells A and B contained organic material indicating infiltration of lake water into ground water" (Kuusi et al., 2006, p. 274-5). "On the basis of evidence from epidemiological and microbiological investigations, this campylobacter outbreak [which caused the gastroenteritis] was caused by contaminated municipal water supply" (Kuusi et al., 2006, 275).

In 1998, Tillet, de Louvois, and Wall documented, after a case-controlled study, strains of *C. Jejuni* which were found in the municipal water system that was not chlorinated or disinfected in anyway. The incident of 2000 in the U.K., the same strains were found in patients with common symptoms that led to diagnosis of the same illness, gastroenteritis. This provided evidence that the public outbreak of these patients illness was waterborne (as cited in Kuusi et al., 2006, p. 275).

In Locust Grove, OK, there was an outbreak of *Escherichia coli* (*E. coli)* in the summer of 2008. In a news release dated February 3, 2009, the affected population was given information on the bacteria that the Oklahoma DEQ and the Oklahoma Attorney General's office were investigating. This was a public announcement intent on public education regarding the exposure and transmittal of bacteria (DEQ and OSHD, 2008).

> "Disease-causing bacteria in well water could include Salmonella, Campylobacter, E. coli, and Giardia infection, among others. The Oklahoma State Department of Health is continuing its epidemiological investigation of the 2008 outbreak and has not ruled out well water as a potential source of contamination. Most of the bacteria that cause gastrointestinal illness reside in nature in animal intestines and wastes. Porous soil in the Locust Grove area makes water wells more susceptible to contamination during heavy rainfall events in agricultural areas" (McElhaney, 2009).

In July of 2008, Norovirus was located in the public water supply at Windmill Run Marina, Oklahoma. The water system was shut down by order of the Oklahoma DEQ with the belief that the 62 individuals who had symptoms consistent with Norovirus were related to the well water that supplied this public water system. It was believed that the virus that contaminated the well came from the sewage in the ground water. Norovirus was confirmed by the Oklahoma DEQ via testing (McElhaney, 2008).

In most common occurrences, groundwater is most likely to be contaminated by enteric viruses due to its proximity to underground sources of pollution. Enteric viruses are very small (25-100 nm) and that size allows for easy percolation through the soil structure of porous grains. This infiltration continues until the enteric viruses reach underground aquifers and then travel with the groundwater (Borchardt, Bertz, Spencer, & Battigelli et al., 2003a, p. 1173).

Rainfall, type of soil and structure of that soil, pH of the soil pore water, and other factors can impeded or accelerate viruses that move in the soil structure via underground water. If the temperatures remain low enough, viruses can “persist for several months” in an environment of “when temperatures are low and soils are moist”. Groundwater is the most common pathway for migration of enteric viruses. Enteric viruses, from feces, can exist as an “infectious virus” in “potable groundwater” (Borchardt et al., 2003a, p. 1173). Barwck et al, (1997-8) found, “For 1997 and 1998, “…80% (12 of 15) waterborne outbreaks linked to an infectious agent were attributed to drinking contaminated well water…” (as cited in Borchardt et al., 2003a, p. 1173)

“Septic systems process wastewater for rural and suburban households. The effluent of a system is released into a septic tank, holding tank, and the liquid that rises over the weir and into the piping to the system, is what is filtered by the ground surrounding the pipes. If the soil is very porous or the rock is fractured, the effluent will not be treated efficiently and will percolate more quickly. This causes a risk for contamination of ground water leading to contamination of private and public drinking water wells. Enteropathogens can be released unintentionally on top of the land surface when a septic system malfunctions because of age or neglect". The other source of surface or ground filtration contamination occurs when holding tanks without lateral fields are used and are not pumped regularly (Borchardt et al., 2003b, p. 742).

Private Water Wells

Private wells in the United States have been studied recently by the United States Geological Survey (USGS). The data collected from 1991-2004 reported that 43 million people, which is about 15% of the population, obtain their drinking water from private wells. Private wells are not regulated and never have been by the Safe Drinking Water Act. Of the 2100 private wells located in 48 states sampled, 4% of the wells had over the federal drinking water standard for nitrate which is 10 ppm (parts per million). This occurrence was primarily in the areas of the nation where fertilizer is used for agricultural purposes: "Midwest Corn Belt and the Central Valley of California" (USGS, 2009). "As many as 219 properties and contaminants, including pH, major ions, nutrients, trace elements, radon, pesticides, and volatile organic compounds (VOCs), were measured. Fecal indicator bacteria and additional radionuclides were analyzed for a smaller number of wells. The large number of contaminants assessed and the broad geographic coverage of the present study provides a foundation for an improved understanding of the quality of water from the major aquifers tapped by domestic supply wells in the United States" (DeSimone, Hamilton, & Gillion, 2004). The samples were taken prior to any home prepared treatment. Other organics found were man-made: "herbicides, insecticides, solvents, disinfection byproducts, and gasoline chemicals". In the results it states that "7 out of 168" organic contaminants exceeded the standards for drinking water. About 60 percent of the wells had indications of organic contaminants. These sources of the organic contaminants were agricultural, residential, and industrial. The results were that the organic chemicals were of detections that were not necessarily of "human-health concerns". What was found in the private wells was a mixture of contaminants which were organic, inorganic, and microbial. Bacteria, total coliform bacteria, and *E. coli* were detected in about a third of a set of 400 wells. All in all, about ½ of the 2100 wells sampled had a contaminant "outside recommended ranges for cosmetic and aesthetic purposes" (USGS, 2009; DeSimone, Hamilton, & Gillion, 2004).

Madison, WI, June 23, 2008, there were pesticides found in the ground water that was used for human consumption. Pesticides can degrade into "herbicides, insecticides, and fungicides". Those pesticides found included most common were triazines and Chloroacetanilides, which are two classes of herbicides. There were four sites that were selected for the study to investigate the contamination of ground water by herbicides. They were in Maryland, Nebraska, California, and Washington. In 2004, in the spring, water samples were collected from these locations: "59 shallow single or clustered monitoring wells". They were analyzed for pesticides numbering 45 and 40 pesticide degradation products. The Nebraska site, a large farming state, herbicides and by products were found (Steele, Johnson, Sandstrom, Capel, & Barbash, 2008).

Another concern for ground water contamination is *Campylobacter* "(meaning 'twisted bacteria'), a genus of bacteria that are Gram-negative, spiral, and microaerophilic. Motile, with either unipolar or bipolar flagella, the organisms have a characteristic spiral/corkscrew appearance (Wiki, 2012). *Campylobacter* may be found in water sources such as private wells that have been contaminated with feces from infected people or animals. Human or animal waste can enter the water in many different ways (i.e., sewage overflows, polluted storm water runoff, and agricultural runoff) (CDC, 2003). Campylobacteriosis is an infection by *Campylobacter*. It produces an inflammatory, sometimes bloody, diarrhea, periodontitis, or dysentery syndrome, mostly including cramps, fever and pain occurs much more often in the summer than in the winter (Wiki, 2012).

A study by Zimmerman et al. (2001) provided this information about the contamination or not of private wells. A sanitary well has a seal to keep out bugs and other contamination and is grouted along "the entire annulus" of the casing. A nonsanitary well is constructed of loose dirt, no grout, no sanitary seal, and a loose-fitting well cap (p. 8). This study provided data that indicated that "throughout the study area" total coliform was detected more often than not (Tallon, Magajna, Lofranco, & Leung, 2005, p. 144). Potential pathways for total coliform to enter a well include localized entry from a poorly protected wellhead (no sanitary sealed cap) and by pests, particularly earwigs, known to contribute coliform bacteria contamination to ground water. In this scenario, the occurrence of bacteria could be reduced by installing a sanitary sealed well cap. However, because total coliform was detected in a similar number of wells that had different pathways to contamination (cracked seal, no seal, and fractured bedrock) a combination of characteristics could all be contributing to the bacterial contamination (Zimmerman, et al., 2006, p. 17).

In 2001-2002, a non-profit organization in Yakima Valley offered free water testing to low-income private well owners. "This research presented that few of the wells were fit for human consumption. That is not a surprise considering the parameters that were used to select private wells for their research" (Sell and Knutson 2002) The non-profit decided at the end of the research, education was the only answer into seeing these wells to better quality of water output. The problem was that it is very "common that educational materials are taken and never used" (Sell & Knutson, 2002).

Education has been seen to work in protection of the groundwater source for private wells. In October of 2003, the Southern Coastal Plain Groundwater Program produced a report that stated that based on research, education was a factor of decontamination of private water wells. They provided a questionnaire to indicate the general knowledge of well construction and characteristics in regard to private well owners. "Analysis of the sample questionnaires indicated a general lack of knowledge on well construction and characteristics. This was probably the least reliable information gathered, because the specifics of the construction cannot be seen after the well is in place. The lack of consistent data on well depth and construction indicated a clear need for educating well users on proper construction and protection issues". Since the well characteristics were generally unseen, well contamination could not be pinpointed to a particular "point source, aquifer, or construction characteristics". Documented data of each well would bring a more reliable outcome of possible contamination.

Pre-Post Testing Design: New Versus Old

Pretest-posttest designs are used for the purpose of comparing groups and/or measuring change resulting from experimental treatments. An experimental study seeks to determine if a program/intervention had "intended causal effect on program participants. There are three key components of an experimental study design: (1) *pre-*

post test design, (2) a *treatment group* and a *control group*, and (3) *random assignment* of study participants." A pre-post test design enables the research to see the level of performance of the participants before and after the program/intervention took place. This design is one of the methods used be sure that the program/intervention had a causal effect. "To get the true effects of the program or intervention, it is necessary to have both a treatment group and a control group" (NTCI,2012). In order to see if the experiment of education of the adult residents of Oklahoma in this research had a causal effect, the 3 requirements of a pre-post test design considered and applied.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

Introduction

The following research design and methodology provided the foundation on which this study was based. The research questions that are addressed in this study are followed by the sample, the research design, and the analysis that was used to examine the data collected.

Research Questions

This research is focused on the following research questions:

1. Does the curriculum and delivery utilized by the DEQ actually provide learning for the target population?
2. How should the adult population be educated regarding water sources?
3. Are there differences in learning based on demographic variables?

Research Hypothesis

The research questions are stated as hypotheses to permit direct assessment through the research design and to allow decisions related to the research questions.

H_0: There is no significant difference in pre and post testing scores collected from the educational presentation that the adult participants in the Control Group who received Program 1 prepared by the Oklahoma DEQ and the adult participants in the Experimental Groups who received Program 2 prepared by the Researcher and printed by the DEQ.

H_1: There is a significant difference in pre and post testing scores collected from the educational presentation that the adult participants in the Control Group who received Program 1 prepared by the Oklahoma DEQ and the adult participants in the Experimental Groups who received Program 2 prepared by the Researcher and printed by the DEQ.

Sample

The research participants for this study voluntarily attended and participated in the educational seminar or classroom presentations. The educational seminar or classroom presentation setting included survey, pretesting, post testing, and evaluation found in Appendix D. The participants signed a confidentiality statement found in Appendix E. The educational presentations were designed for adults only. Those under 18 were allowed to attend the seminar or classroom presentation, but not to participate in the research. The research protocol was submitted to the Oklahoma State University Institutional Review Board (IRB) for approval prior to beginning the educational seminar or classroom presentations. The concern for safety of the participant was the principal responsibility of this researcher and the IRB. The concern included but did not limit to the information given by the researcher. The information provided by the researcher might lead a minor (under age of 18) to investigate a private well that has many dangers. Any individual, minor or adult, who has not had proper training or awareness education should not be around such a potentially dangerous location.

The sample of the participants selected for this study had an interest in private water well management through education, who had a private well, knew someone who did, had an interest in having a private well, or were concerned with a natural resource in this study which is groundwater. The northeastern part of Oklahoma was the geographical location selected for this study to be conducted. The population that would be sampled focused on residents of Oklahoma including 9 different American Indian Tribes, Caucasian, and other ethnic groups. The census data for the research area for 2010 can be found in *Figure 2.* Included in the participants of the research were students at Northeastern Oklahoma A & M College located in Miami, OK. The students who volunteered represented a regional population, lived in rental homes or private residences in the area of study, and were in the agricultural college where they might have private water wells included in their educational program.

Design

The research plan was approved by the Oklahoma State University IRB, Appendix C. The proposed study was conducted in a seminar or classroom presentation setting. All confidentiality forms were signed prior to any program presentation and were collected before the program was presented. Confidentiality was accomplished by numbered programs being given out to all participants. Names were not to be put on any document other than signature on the confidentiality form.

The researcher provided the educational program materials for all participants via PowerPoint (visual), lesson materials (Programs 1 or 2), and supervised the pre and post testing of the participants. During the pretesting, a census based survey was provided for the participant to fill out voluntarily. They were informed that participation in the study was purely voluntary, but to please fill out all forms and take all tests. The researcher explained that the data collected was very important to the analysis done after the educational presentations were completed. At the top of each front page of the survey, testing, and evaluation forms was a place to put a number. The number that was to be placed there was found on the back and at the bottom of the last page of the program passed out to the participants. This was done to attempt to provide internal validity and realistic results.

The pretest and the posttest were given on the same day. The original plan for this research included specific dates and locations for delivery of the seminar or classroom presentation . Though not all locations originally considered for delivery of programs were accomplished, the study was conducted and concluded. The convenience of finding participants was a problem in this research. The participants that attended were already scheduled to be at the location of Groups 2, 3 and 4. Group 1 was those who stayed after their luncheon to participate in the presentation. Table 1 has the actual locations and dates where the program was delivered to the participants.

Table 1.

Location, Date, Type of Advertising, Presentation of the Seminar or classroom presentation , and Program provided at each location.

Location and Date	Group Number For Research Data Will Reflect These Assigned Numbers	Advertising	Presentation of Seminar or classroom presentation and Programs by Researcher	Program Provided
OHCE Conference 03-29-11	3	Program	Pretest, Educational Program, and Posttest	2
NEO A&M College 04-7-11	2	Classroom Invite by Mr. Neal	Pretest, Educational Program/and Posttest	2
Wyandotte Tribe 04-12-11		Flyer (Appendix G)	No Participants Attended	none
Wyandotte Tribe 04-19-11	1	Personal Invite at luncheon 04-18-11	Pretest, Educational Program, and Posttest	2
Tribal Environmental Group 06-01-11	4	Email and placed on the meeting list as a speaker	Pretest, Educational Program, and Posttest	1

The major research question of this study was to find out if there was or was not a significant difference in pre and post testing scores as measured before and after the seminar or classroom presentation of programs.

Procedure

Advertising was provided by public invitation, personal invitation to a meeting, program invitation to a conference, and flyers that are found in Appendix G.

Instrumentation

The instrument utilized to measure learning among those in the Control Group and the Experimental Group was developed specifically for this project. No standardized instrument was available for use in this assessment. As a result, the instrument in Appendix D was fact-based from the instructional program provided. Validity of the instrument was provided through use of an expert jury: members of the expert jury were employed in DEQ and work with education program related to private water wells.

The instrument was designed with a maximum possible score of 100 points, permitting an easy assessment of correct answers. Then, the score for each participant was easily evaluated as a percentage of 100 possible points. In addition, the instrument was designed with a readability level established at the fifth grade level based on the Flesch index.

Data Analysis

The pretest, posttest, and survey were held in sealed envelopes until the day of examination of data. The results could be biased by the questions of the test questions, but each group received the same questions. These questions were created using the information collected from referenced sources found on the PowerPoint in Appendix B. The Programs used as added education to the PowerPoint presentation to evaluate which did or did not benefit the volunteer participants.

A one-way analysis of variance (ANOVA) was used to compute data between the four groups using commercially available software SPSS (Statistical Product and Service Solutions) (IBM, 2011). In case of a significant effect, a Post Hoc test, Tukey HSD, was used to detect the source of the differences. Statistical significance was set at $p<0.05$.

Program Presented

Copies of all educational materials that were provided to the participants are located in Appendices A, B, D, and E. These included the following: (1) Demographic Questionnaire (Survey), (2) Pretest, (3) Syllabus for the education program, (4) Program 1: DEQ Fact Sheets, (5) Program 2: Private Water Well Education Booklet, (6) Visual Aids, (7) a group of frequently asked questions – FAQ – and answers for these questions, (8) a Post-test, and (9) an Assessment Survey (Evaluation, Table 8).

All completed tests and surveys were turned face down and collected randomly. Without knowledge of who had what number assigned to them, the researcher therefore could not give bias to any participant in the program. There was no sign-in sheet for the participants. The numbers that were put on the backs of the Programs was performed by an outside person who had no participation in the testing portion of this research. The materials collected at each seminar or classroom presentation were sealed in unmarked large envelops until the study was completed. The tests were then graded, data collected and analyzed using SPSS. All pretest and posttest scores were graded using an answer sheet that was developed at the same time as the questions were. The grades were by a percentage, 100% being the absolute score to attain.

Validity of Data

There was a potential loss of external validity. The human participants were in small samples, in a single geographical area, were all volunteers, and attended because of the convenience and availability of the presentation being brought to the participants.

There was a possible loss of internal validity. Experimenter bias could have occurred while conducting the research. The researcher wrote and illustrated the booklet used in Program 2. However, an assessment of reliability was included in the data analysis using Cronbach's alpha as a measure of reliability.

Summary

The research was developed, locations were selected, participants volunteered, and the program was activated. The materials were presented, the PowerPoint was presented, the tests were taken, surveys were filled out, and data collected for later analysis.

CHAPTER IV

RESULTS

In this chapter, the methods used and results collected are examined. The study was centered in a specific geographical area. The collected data covered three avenues of interest. The first issue to be examined was the method utilized for educational program material delivery: in the seminar or classroom presentation environment or delivered through electronic or postal mail. The second issue to be examined was the two programs presented: Program 1 was presented to a single control sample and Program 2 was presented to 3 experimental samples. The data collected were analyzed and those results follow. The third issue to be examined was the demographics of the participants. The demographics of the participants were collected in a questionnaire that was created based on the traditional measuring used by the U. S. Census Bureau in 2010. Another part was of those who attended regarding access for themselves or knowledge of others to a private well. All educational seminars or classroom presentations were completed between April of 2011 and June of 2011.

Analysis of Research

These research questions are stated as hypotheses to permit direct assessment through the research design and to allow decisions related to the research questions. In order to reproduce the order of materials presented to the population, the order of questions will reflect this.

Research Question 1: How should the adult population be educated regarding water resources?

Comings (2007) summarized the important point behind this research with the adult population. He stated, "Unlike children, who participate in schooling because of legal mandates and strong social and cultural forces, most adult students choose to participate in educational programs". The pre and post testing results of the adult population are displayed in Table 2.

To analyze the first research question and related hypotheses, pre- and post-test scores from 34 participants were evaluated using a one-way ANOVA. Note: the score on each test could be 100% or lower. The scores therefore are being treated as percentages. While more participants had completed either a pretest or a posttest, only those who completed both components were included in the analysis. The test scores for all participants can be found in Appendix F.

Table 2. Group Test Scores: Mean and Std. Dev. Based

	Group	N	Mean score	Std. Deviation	Std. Error
Pretest	1	7	61.4	31.3	11.8
	2	7	55.7	16.2	6.1
	3	11	56.4	16.9	5.1
	4	9	54.4	15.9	5.3
	Total	34	56.8	19.5	3.3
Posttest	1	7	93.6	6.8	2.6
	2	7	91.0	9.0	3.4
	3	11	81.2	4.0	2.8
	4	9	65.7	27.0	9.0
	Total	34	81.6	18.6	3.2

Results from Table 2 show that Group 4's mean was close to Groups 2 and 3 in the pretest with Group 1 only slightly higher. This Table shows that Group 4, the Control Group, had a lower mean posttest score than the Experimental Groups 1, 2, and 3. This study was in the field and participation was by convenience and voluntary. The numbers of participants were not great enough to provide the statistical power for a confident statement that Program 2 was of greater benefit to the participants than Program 1. There is not a great enough confidence level to reject the null hypothesis. In order to do so, further research is required.

There was a threat to internal validity of Group 3. That day was a rushed day at conference and the time for post testing was not adequate for all to finish the posttest. Some of the participants had to leave early to make attend another breakout session, small class on specific topics. Therefore, many of the posttests of Group 3 were not completed and could not be included in the data. Another threat was that Group 3 was given only 10 minutes of presentation compared to the 20 minutes the other 3 Groups received. It was also the first presentation that the researcher had given in starting the research and data collection. The reliability of that data collected is also suspect to a couple of participants were seen helping each other with the pretest and posttest even though they were asked in the beginning of the presentation not to.

Results from the one-way ANOVA are shown in Table 3.

Table 3.

Summary of one-way ANOVA (α=0.05)

		Sum of Squares	Mean square	F	Significance
Pretest	Between Groups	210.2	70.07	.170	.916
	Within Groups	12333.9	411.13		
	Total	12544.1			
Posttest	Between Groups	39084	1302.81	5.228	**.005***
	Within Groups	7475.4	249.18		
	Total	11383.8			

*significant at α=0.05

As is shown in Table 3. There was a significant difference between groups in the posttest scoring. This difference found in the initial one-way ANOVA required further post hoc investigation. To identify the source of this variation, the researcher conducted a Tukey HSD post hoc test. Table 4 presents the results of that statistical analysis completed.

Table 4.

Tukey HSD comparison of posttest scores

Posttest	**Group (I)**	**Group (J)**	**Mean difference (I – J)**	**Standard Error**	**Significance**
	1	2	2.57	8.44	.990
		3	12.39	7.63	.381
		4	27.90	7.96	**.007***
	2	1	-2.57	8.44	.990
		3	9.82	7.63	.578
		4	25.33	7.96	**.017***
	3	1	-12.39	7.63	.381
		2	-9.82	7363	.578
		4	15.52	7.10	.150
	4	1	-27.90	7.96	**.007***
		2	-25.33	7.96	**.017***
		3	-15.52	7.10	.150

*significant at α=0.05

Research Question 2: Does the curriculum and delivery utilized by the DEQ actually provide learning for the target population?

The educational materials found in Program 1 provided by the DEQ are Fact Sheets. The delivery is by mail or internet access via its public web page that provides fact sheets to the public. There are not official classroom locations for public education. There are local DEQ Offices in the counties that give technical assistance when asked to or see the opportunity to do so.

The initial one-way ANOVA has revealed a difference on posttest scores. The Tukey post hoc test revealed, as seen in Table 4, that difference to have occurred between groups. Group 4, who received Program 1, showed a statistically significant difference from the post test scores in Groups 1and 2 that received Program 2.

Research Question 3: Are there differences in learning based upon demographic variables?

“A one-way between subjects ANOVA was conducted to compare the effect of demographic variable of Race on the ability to learn from the programs presented to the adult participants in an educational based environment. The subjects were divided into Group 1, White and Group B, Non-white participants as seen in *Figure 1*.

Survey results: Demographics

Figure 1. From Survey on the Race of the Participants

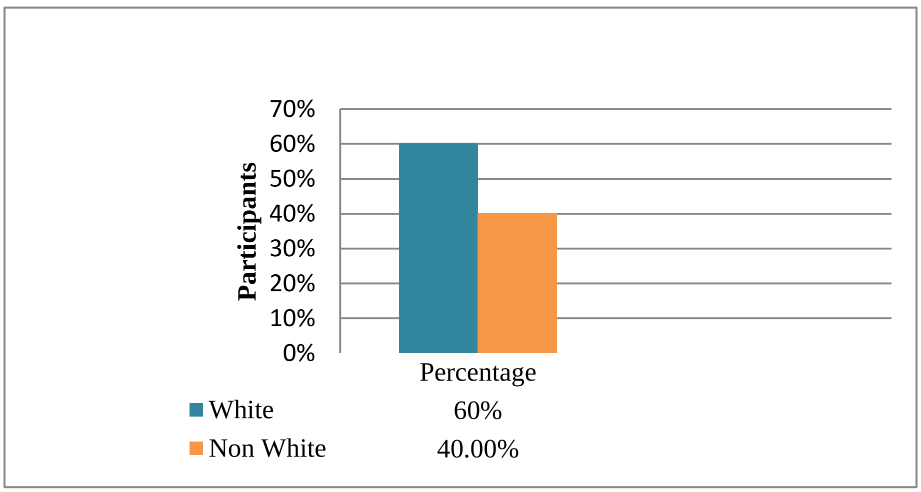


Table 5.

Demographic Variable Results

		Sum of Squares	df	Mean Square	F	Sig.
Pretest	Between Groups	200.042	1	200.042	.526	.474
	Within Groups	12176.429	32	380.513		
	Total	12376.471	33			
Posttest	Between Groups	930.313	1	930.313	2.761	.106
	Within Groups	10780.629	32	336.895		
	Total	11710.941	33			

The results found in Table 5 reveal that there are no significant differences between groups A and B.

Cronbach's Alpha

Table 6.

Case Processing Summary

		N	%
Cases	Valid	34	100
	Excluded	0	0
	Total	34	100

Table 7.

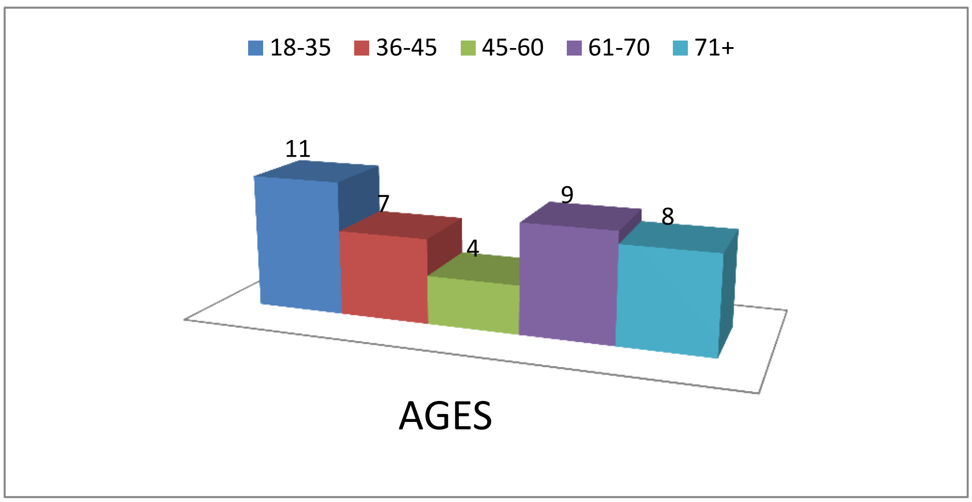
Reliability Statistics

Cronbach's Alpha	N of Items
.191	**2**

Cronbach's alpha is a measure of internal consistency (UCLA, 2012). The alpha was 0.191. Though low, the alpha did indicate consistency and reliability in a sample that showed significant change.

Survey results: Ages

Figure 2. Age span of participants from Survey



As can be seen in *Figure 2* above, there was a good representation of the adult population by age group considering the whole was 34.

Survey Results: Private Wells

There are 720 domestic wells to date logged in OWRB drill logs for Ottawa County, Oklahoma (OWRB, 2012). Per 2011 United States Census, there are 13,915 households in Ottawa County. Based on percentages, 720 domestic wells out of 13,915 households, 5.2% of households in Ottawa County have access to a private domestic water well. Therefore, it was discovered that the percentage that participated in this research study was greater than 5.2% as displayed in *Figure 3.*

Figure 3. From Survey Have a Private Well

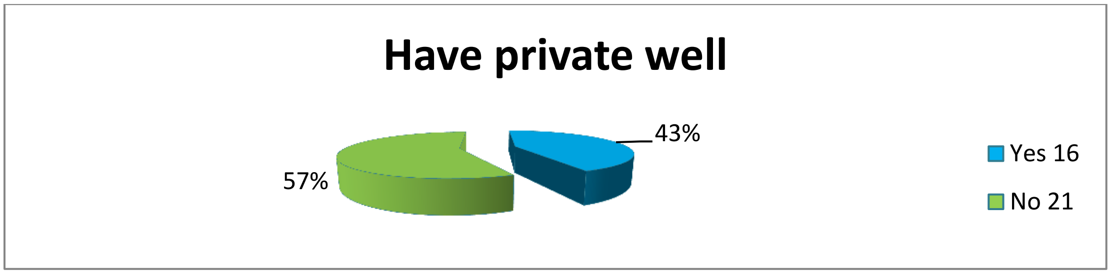


Table 8.

Evaluation Results

	Questions and Answers	Y	N
1.	Given materials to view on your own time (mailed to you)?	4	13
2.	Presentation beneficial in learning process?	17	0
3.	Group 1: Material provided answers your questions about private water wells	7	0
4.	Group 2: Material provided answers your questions about private water wells	10	0
5.	Opportunity to attend a presentation by DEQ and/or researcher would you attend?	17	0
6.	Was this educational program worth your time?	17	0
7.	If you know a person who has a private water well…see question 7 in Appendix D.	17	0
8.	Would all ages benefit from learning all they could about a private water well?	25	1

Case Study of a Private Well

Private Well Owner Technical Assistance was completed from July 2011 – September 2011. The sample of water from a private well was sent into Oklahoma DEQ Lab for a bacteriological test (bac-t) and was found to have total coliform present in the water sample. The well was shocked with 2.5 gallons of bleach. See Table 9. (~800' deep well and 6" diameter= 2.5 gallons) and allowed to sit for 24 hours. The next test was performed a week later, sent in to Oklahoma DEQ Lab, and came back with total coliform present in sample. The well was shocked again with a gallon of bleach (as was suggested by the Oklahoma DEQ Lab) and allowed to sit for 5 hours so the residents would not have to spend another night without running water. Another week of use and a sample was collected and shipped to Oklahoma DEQ Lab. This sample was tested and the number of coliform present in the sample was counted which resulted as 28 MPN/100 ml sample. This was a very low number but in consideration of water quality standards which are 0 MPN/100ml sample, and the health of the residents, another date was set to shock the well. This time a half gallon of bleach was used (suggested by the Oklahoma DEQ Lab), allowed to set for 7 hours, as long as the residents thought they could go without water. The residents used the well for one week, boiling or using drinking water sold at the store. The next test was collected and sent in. During the first visit, it was note that the well head was not maintained (sealed) properly to prevent contamination by the outside environment. The hole that was for venting in the well head, pitted well, was open. A vent was constructed and placed in the hole with pipe tape and a screen on the end. The wiring was also compromised in the same way. Caulking was used to seal off that area of the well head. The well seal was adequate but the cement structure at the bottom of the well head was cracked. These cracks were filled in with caulking on the second disinfection visit. The last test came back with zero presence of any coliform bacteria. A suggested method of how to disinfect a well by well depth and well diameter is located in Table 10. The summary of procedure and results follow in Table 9.

Table 9.

Case Study of Private Well Owner and Maintenance

Unnamed Private Well Visit Dates	Sampling Dates	Well head repair dates	Disinfection of well by bleach amounts	Results of bacteriological tests
07-25-11				Site visit. Positive bac-t. Called for tech assistance by homeowner
07-27-11			2.5 gallons from 1:30 pm To 1:30 pm the next day	
07-28-11		Vent added and well head caulked		
08-3-11	Took sample			Presence of coliform
08-10-11		Cracks in cement caulked	1 gallon at 1:3:0pm Flushed out by 5 pm	
08-17-11	Took sample			Presence of coliform 28 MPN/100ml
08-30-11		Re-caulked the well head	08-23-11 Consulted Lab. Going to try one more time. ½ gallon added at 1100 am 08-30-11; flushed at 8 pm	
09-06-11	Took sample 09-06-11			Total Absence of Coliform.

Table 10.

Calculation for disinfection of private water wells.

Well Diameter	Well Depth	Bleach Amt.	Well Depth	Bleach Amt.	Well Depth	Bleach Amt.
3 inch	50 feet	3 oz.	100 feet	6 oz. or (3/4 cup)	150 feet	8 oz. or (1 cup)
6 inches	50 feet	8 oz. or (1 cup)	100 feet	20 oz. or (2 ½ cups)	150 feet	30 oz. or (3¾ cups)
9 inches	50 feet	25 oz. or (3 1/8 cups)	100 feet	50 oz. or (6¼ cups)	150 feet	75 oz. or (9¼ cups)
12 inches	50 feet	50 oz. or (6 ¼ cups)	100 feet	100 oz. or (12½ cups)	150 feet	150 oz. or (19 cups)

(DEQ, 2010)

CHAPTER V

CONCLUSION

In this chapter, a summary of the study has been discussed, conclusions have been made from the data analysis, the limitations that resulted in the study have been listed, and the finding has been explained. Also, recommendations of future research have been suggested.

Discussion

This dissertation investigated, first, the current written materials on private wells offered to the residents of Oklahoma through various agencies. Secondly, the goal was to discover how to present education on private wells in order to benefit the adult resident participant population. In a third area, this dissertation investigated the new information created by this researcher to see if it would benefit the research participants in comparison to those materials currently offered by the Oklahoma DEQ. Lastly, this dissertation examined the demographics of the research participants in order to answer the question that there was or not a possibility that this variable had any influence on learning.

Research Question 1: How should the adult population be educated regarding water resources?

"Unlike children, who participate in schooling because of legal mandates and strong social and cultural forces, most adult students choose to participate in educational programs" of their own choosing (Comings, 2007, p. 23).

"While the concept of andragogy [learning strategies focused on adults] had been in spasmodic usage since the 1830s, it was Malcolm Knowles who popularized its usage for English language readers. For Knowles, andragogy was premised on at least four crucial assumptions about the characteristics of adult learners that are different from the assumptions about child learners on which traditional pedagogy ["*paid*- meaning 'child' and *agogos* meaning 'leading'" (Smith, 1996, 1999)] is premised. A fifth was added later.

1. Self-concept: As a person matures his self concept (sic) moves from one of being a dependent personality toward one of being a self-directed human being

2. Experience: As a person matures he accumulates a growing reservoir of experience that becomes an increasing resource for learning.

3. Readiness to learn. As a person matures his readiness to learn becomes oriented increasingly to the developmental tasks of his social roles.

4. Orientation to learning. As a person matures his time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly his orientation toward learning shifts from one of subject-centeredness to one of problem [centeredness]

5. Motivation to learn: As a person matures the motivation to learn is internal" (Smith, 2002).

"Adults are life, task or problem-centered in their orientation to learning. They want to see how what they are learning will apply to their life, a task they need to perform, or to solving a problem… Adults have had a lifetime of experiences." "[These experiences make] adult learners more heterogeneous than younger learners and also provides an additional base of knowledge…While adult learners may respond to external motivators, internal priorities are more important. Incentives such as increased job satisfaction, self-esteem and quality of life are important in giving adults a reason to learn" (Fidishun, n.d.). Therefore, the program was centered on the adult population and the learning styles that would implement the educational process for them. The one statement that stands out above them all was what was used in the building of the program and program materials by this researcher. As Smith, 2002, stated, "Motivation to learn" is from maturation of an individual and their need to learn being an internal factor.

The evidence from this investigation shows that the presentation of verbal and visual curriculum with a new, vivid and easy-to-read booklet, made a difference in the learning of the participants. The one-way ANOVA revealed that there was no difference between the learning groups at the outset of the study (pretest), but the ANOVA did show that differences did exist at the end of the study (posttest).

Research Question 2: Does the curriculum and delivery utilized by the DEQ actually provide learning for the research population?

The Tukey HSD post hoc test, Table 4, provided proof that the Experimental Groups who received Program 2 scored significantly higher than the Control Group that received Program 1. The data could not conclusively show, due to lack of participants, that Program 2 was a better educational curriculum than Program 1, but the results do lean that direction.

Research question 3: Are there differences in learning based upon demographic variables?

In Table 3, the one-way Anova that was used to examine the demographic variable provided evidence that there is no significant difference in the posttest scores. Therefore, the answer is no: there was no difference between demographic groups examined.

Limitations of the Study

The study was limited to adult residents of Oklahoma who volunteered to participate in this research whether they had access to a private well or did not. The observations of this study were limited to those made by the researcher and artifacts created by the participants. Those participant ages and ethnicity were examined, but there was a limitation of collection of data based on the participation of the research group members to fill out the survey. The number who did was not as many as those who participated with the pretests and posttests which can be seen in the results displayed on Table 1. The same limitation was discovered in the evaluation with even lesser numbers participating than for the survey. A limitation was also seen by the researcher in the ability to repeat each presentation exactly in each Group. Another limitation was time management and geographic locations. It was the endeavor of this researcher to extend this research to two other counties. In the process of attempting this research in Ottawa County first, it was apparent that time management was a problem. There was just no more time left to do the seminar or classroom presentation and research nor a probability that volunteer participants would attend.

Significance of Findings

The results of the study indicate that educational presentations are beneficial if the participants are willing to attend. The results showed that the Experimental Groups mean score was higher than the Control Group, but the number of participants was not enough to conclusively state that one Program was better than the other. The results did show that volunteer participants benefitted from the seminar or classroom presentation regardless of the Program used.

Recommendations for Future Research

The number of participants was low due to many outside factors with the recession being one of them. With gas prices rising and travel expense increasing, it was very difficult to have people come to a place for a class/meeting unless they were already planning on being there. This study warrants future examination of a pathway to provide the education and technical assistance needed by the private water well owners/users of the state of Oklahoma. This study established that this educational program on private water wells was needed. Future efforts need to be made to see that this information gets out to those who need it.

In 2001-2, a non-profit organization in Yakima Valley offered free water testing to low-income private well owners. "This research presented that few of the wells were fit for human consumption. That is not a surprise considering the parameters that were used to select private wells for their research." Sell and Knutson (2002) decided at the end of the research, education was the only solution to assure these wells provided a better quality of water output. “It has been common that educational materials are taken and never used” (Sell & Knutson, 2002).

To emphasize the opinion that education is necessary, in October of 2003, a report stated that based on research, education was a factor. Teaching others to disinfect their wells was fine but the money to do so was not provided The researchers provided a questionnaire to investigate the general knowledge of well construction and characteristics in regard to private well owners. Their research proved that lack of knowledge was high among private well owners regarding their private wells. “Analysis of the sample questionnaires indicated a general lack of knowledge on well construction and characteristics. This was probably the least reliable information gathered, because the specifics of the construction cannot be seen after the well is in place. The lack of consistent data on well depth and construction indicated a clear need for educating well users on proper construction and protection issues. Since the well characteristics were generally unseen, well contamination could not be pinpointed to a particular “point source, aquifer, or construction characteristics”. Documented data of each well would bring a more reliable outcome of possible contamination (Southern Coastal Plain Groundwater Program, 2003).

Education about private water wells is needed. Finding a way to get it to the adult residents of Oklahoma is difficult. Until something happens to their water source, the need to know may not be perceived as important. My suggestion is to keep attempting various pathways and find the one(s) that prove to be most effective and efficient. Some pathways are door to door educational encounters, well drilling log searches, public television, and other avenues of media. This is to let the participants know that a private water well needs to be tended to appropriately and who to call and/or how to find out more information be made available and easy to find on any search engine or phone book.

As Benjamin Franklin put it, *"When the well runs dry, we know the worth of water"*, Poor Richard's Almanac, 1775.

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APPENDICES

Appendix A

WATER

Private Water Well Education Program for Adult Residents of Oklahoma

Research Education Program

Group 1

2011

OSU & DEQ

WATER

Fact Sheet | February 2009

How To Properly Maintain Your Private Water Well

Once disinfected, a properly protected and constructed water well should yield bacteriologically safe drinking water until the well is opened. Recontamination can be prevented if the following measures are taken:

1. In order to protect the well from surface water, grade around the well to divert surface water away from the well.

2. Maintain at least 100 foot separation between the well and all up-slope pollution sources such as septic systems and ponds. Maintain at least 50 foot separation on down-slope and 75 foot on same elevation pollution sources.

3. Maintain at least 50 foot separation between the well and all buildings (which may be termite treated).

4. The well should be cased to at least 10 feet below ground level.

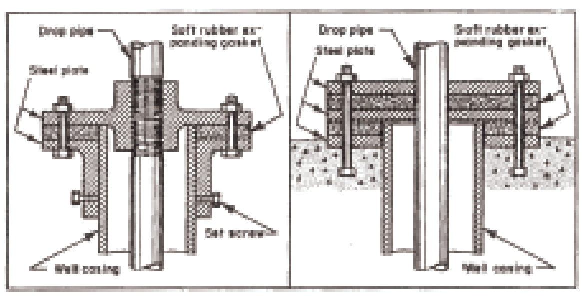
5. The casing should extend at least 8 inches above ground level.

6. The upper terminal of the well casing should be capped with a commercial, sanitary well seal. Old deteriorated seals may no longer be effective and should be replaced. Electrical cables passing through the seal should be caulked to prevent airborne contamination.

7. Any necessary vents in the well seal should be turned down and screened.

8. Any time you remove the well seal, you should chlorinate in accordance with the DEQ fact sheet on chlorinating your private water well.

For additional information contact your local Department of Environmental Quality office or call DEQ Environmental Complaints and Local Services at (405) 702-6100.



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WATER

DISINFECTION OF INDIVIDUAL WATER WELLS

A water well should be disinfected (1) when the well is newly drilled; (2) when repairs to the well or pumping equipment are completed; (3) when an unsafe sample has been reported or (4) after a disaster situation which has impacted your home or business. Ordinary liquid laundry bleach may be used to disinfect a well. Liquid laundry bleach contains 5.25 percent chlorine. Care should be taken to avoid using scented bleach as this will contaminate the well.

In order to disinfect a well:

1. Pump the well enough in advance to completely remove sediment and other debris caused by construction or repairs.
2. Add enough chlorine to make 50 to 100 parts per million solution (use table below).
3. Circulate the solution by pumping the discharge back into the well. This can be done by inserting a garden hose through the well seal at the top of the well and pumping until the chlorine is thoroughly mixed (at least fifteen minutes).
4. Open each water tap in the system until a strong chlorine odor is present, then close the tap. This will also disinfect the house service lines.
5. Let the chlorine stand for at least 24 hours, if possible, but no less than two hours.
6. Flush the system thoroughly.
7. Resample after a one week period to allow for the possibility of bacterial regrowth.

If a sample has tested positive, the disinfection has been done and another sample is collected for testing, please write 'RETAKE' in the Samplers Remarks.

The volume of laundry bleach needed to make a 50 parts per million (ppm) solution may be found from the table below if one knows the depth of the water in the well and the casing (pipe) size. This volume may be doubled to achieve a 100 ppm solution if desired. Further assistance regarding disinfection of your well may be obtained from your local environmental specialist. Questions about the testing can be answered at the State Environmental Lab (405) 702-1000.

Amount of Chlorine Bleach Needed				
	Well Diameter			
Depth of Well	3 in.	6 in.	9 in.	12 in.
50 ft.	3 oz.	8 oz.	25 oz.	50 oz.
100 ft.	6 oz.	20 oz.	50 oz.	100 oz.
150 ft.	8 oz.	30 oz.	75 oz.	150 oz.
8 oz. = 1 cup	25 oz. = 3 cups	50 oz. = 6 1/4 cups	100 oz. = 12 1/2 cups	150 oz. = 19 cups, 1 1/4 gals.

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WATER

Private Water Well Education Program for Adult Residents of Oklahoma

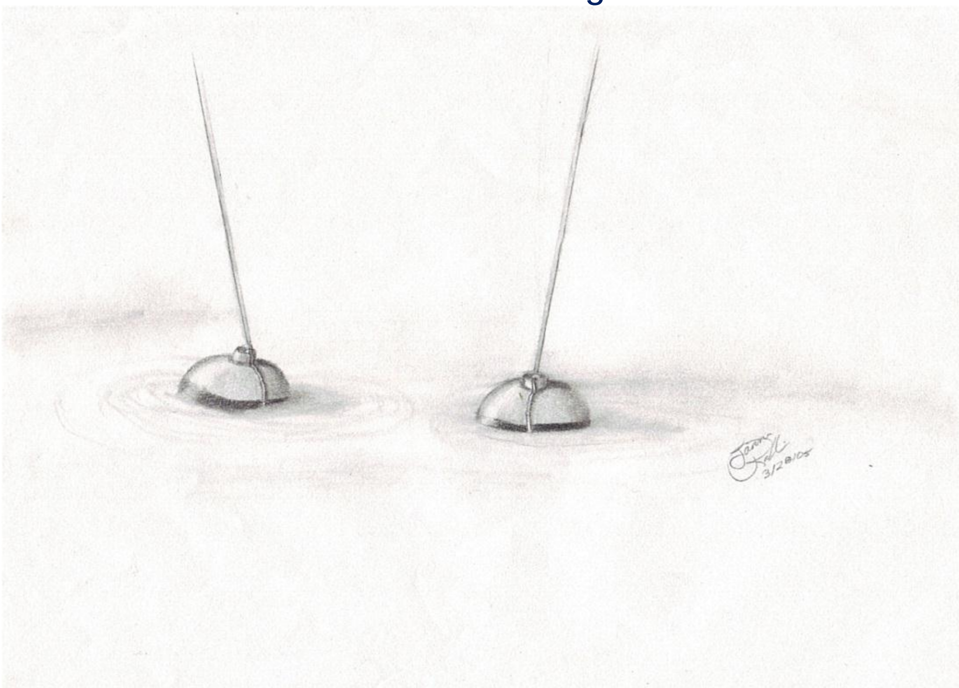
Research Education Program

Group 2

2010

OSU & DEQ

Private Water Wells: Fishing for Answers?



Introduction

Section 1: Water

- Ground Water: Aquifers

Section 2: Private Water Wells

- Kinds: Dug, Driven, Drilled

Section 3: Ways to Protect:

- Prevention of Contamination of Water Source
- Distances: Title 785 Chapter 35

Section 4: Maintenance

- List of Common Maintenance Needs of a Private Well

Section 5: OWRB (Oklahoma Water Resource Board) and Well Driller Organization

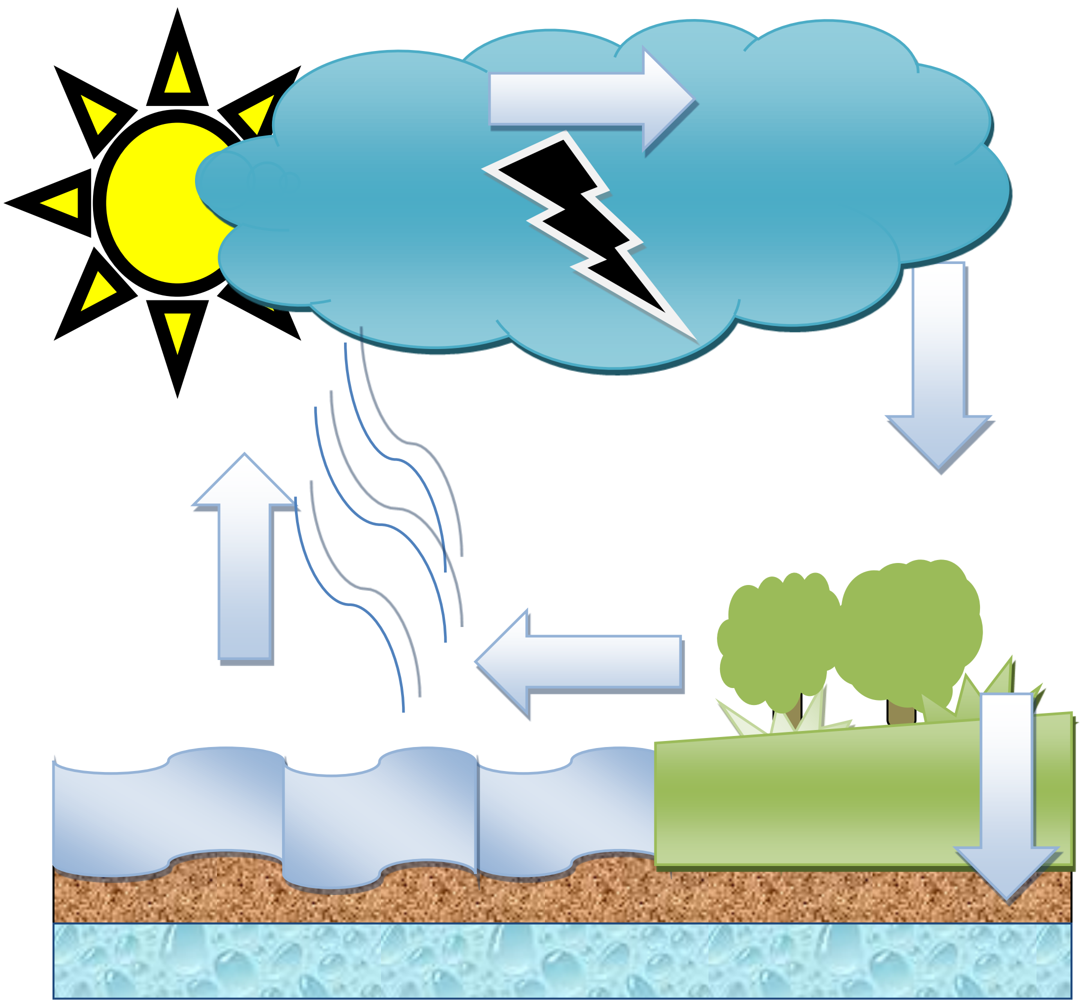
- FAQs

Introduction

Water is our natural resource and no living organism can continue life without it. Water is also known as H_2O and once it comes out of the faucet, it is safe to drink. Generally that is the rule, but just because it looks, smells and acts like safe water, does not mean it is safe water.

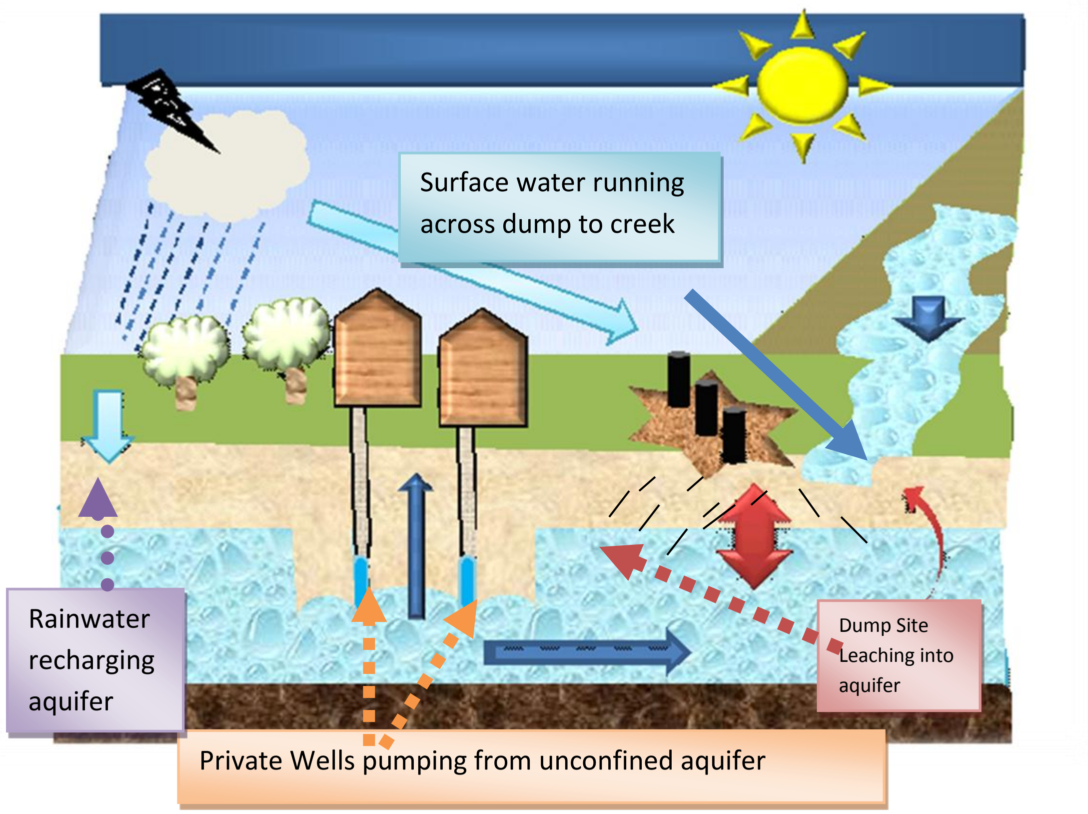
Section 1: Water and the Water Cycle

Water comes from: precipitation: rain, hail, frost, sleet, and snow; transpiration: from tree plants leaves; and evaporation: creeks, streams, lakes, and oceans. Water goes to: groundwater



where it filters down until it reaches an area where it can stay in the soil, rocks, and minerals.

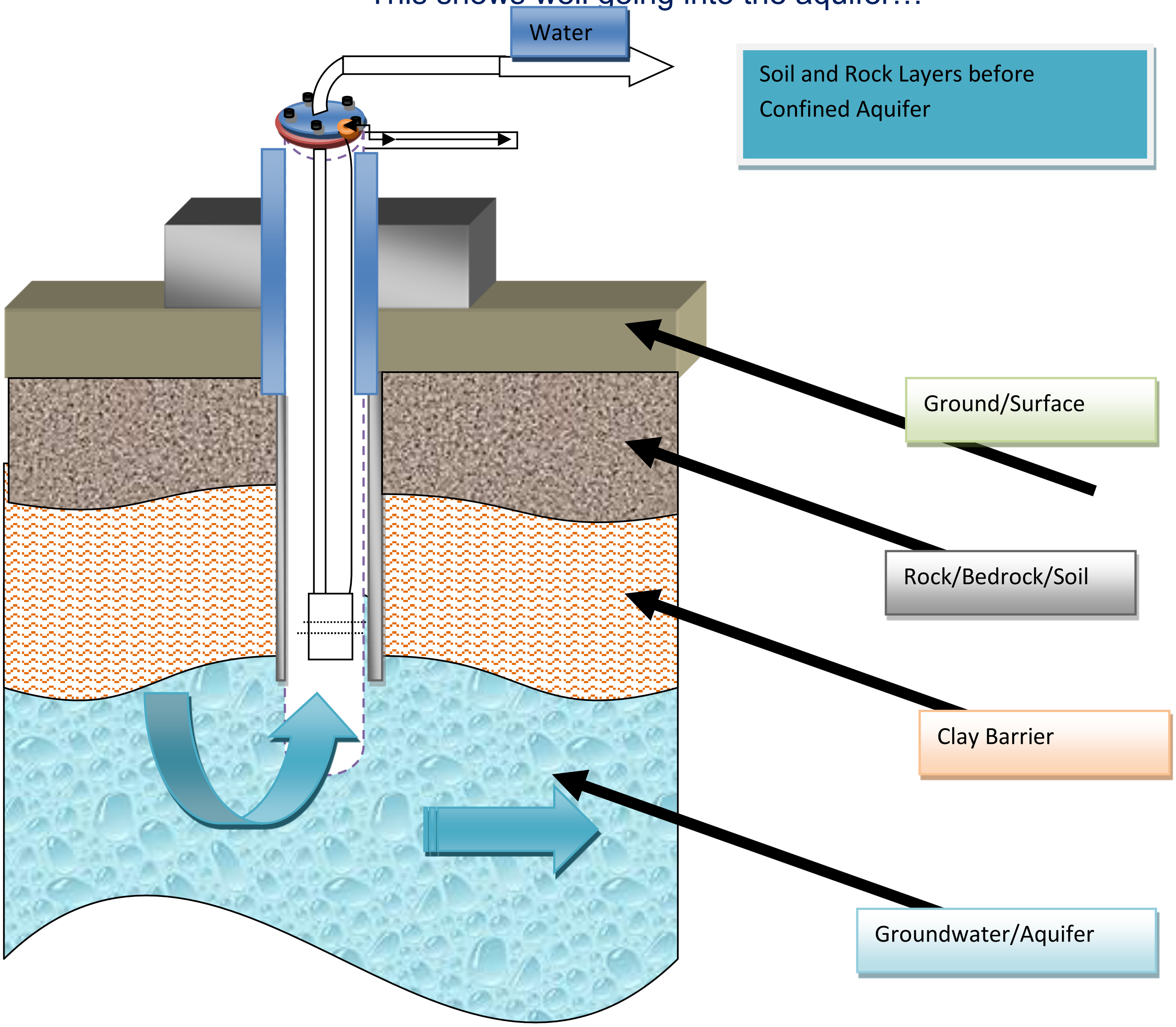
Note: As ground water moves through the ground, it dissolves some of the minerals that it comes in contact with. Those dissolved minerals give ground water its chemical character or quality (Wellowner.org, 2010). It can be soft (fewer minerals) or harder (more minerals).



Water also can travel across the surface of the ground and carry with it whatever it comes into contact with. This water then goes into our surface waters or filters into the ground water.

From these locations, the public gets their drinking water. Whether from public wells, treatment plants or private wells, it all comes from a water source they all share. Then the cycle starts again with the used water.

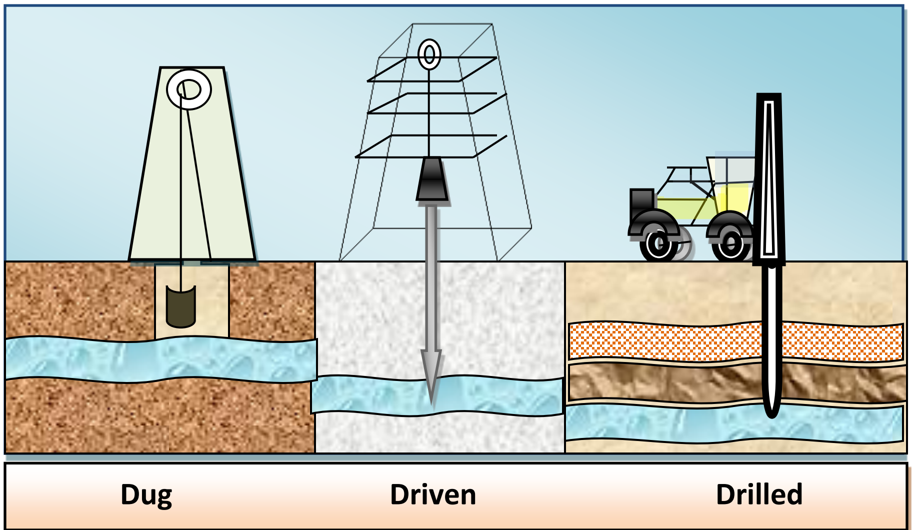
This shows well going into the aquifer…



Section 2: Private Water Wells

Private water wells, also referred to as household wells, are estimated to provide 40-45 million Americans with their drinking water. The concern of all families consuming water from an aquifer is that others are using the same water supply. This includes nearby households, businesses, water systems for the public, and some animal operations (CDC, 2010).

Over the years, three general types of private water wells have been utilized. These are Dug Wells, Driven Wells, and Drilled Wells. The United States Geological Survey, 2010, provides the differences between these three well types.



Based on: http://ga.water.usgs.gov/edu/graphics/welltypes.gif; by Sharon M. Robbins

Dug Wells

Dug wells generally are 10-30 feet deep and are dug by a shovel or backhoe. These wells being shallow have the highest risk of all the well types for contamination of the water supply.

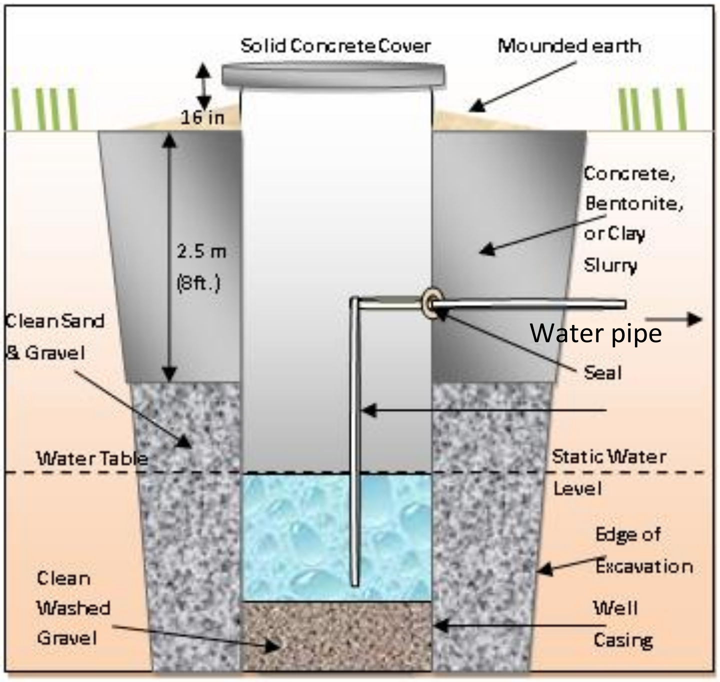
Disinfection (chlorination, UV, etc.) need to be utilized to make sure this supply is potable (drinkable by people) (CDC, 2010).

The well should be lined with a water proof material. This can be cement grout, precast concrete (tongue and groove), or a solid hard (Bentonite) clay sealant that extends out around the well on the surface at the top of the well.

The well itself should have a lid of concrete that stands a foot or so above the ground.

The ground should slope away from the well so rain water or other water on the ground does not get into the well by standing there and just going down into the ground water. Don't pile snow, leaves, or other materials around your well. Keep your well safe.

The pump that carries this water to the house should not be in a pit next to the well. It should be inside the home or in a pump house (kind of like a little dog house) outside.



Beware of the dry season, this type of well can go dry when the ground water table (top of the water source) goes down.

Driven Wells (Sand Point Wells)

Driven wells in the state of Oklahoma are called Sand Point Wells. (h) Sand point well construction requirements. Unless otherwise approved by variance, applicable. These wells can be found in areas of sand and gravel that is thickly deposited in the grounds soil. The water table is usually located 15 feet from the ground surface.

These wells are Moderate to High in the risk level for possibility of contamination. Follows the requirements for drilled wells in Oklahoma Chapter 35 rules except for theses specifications:

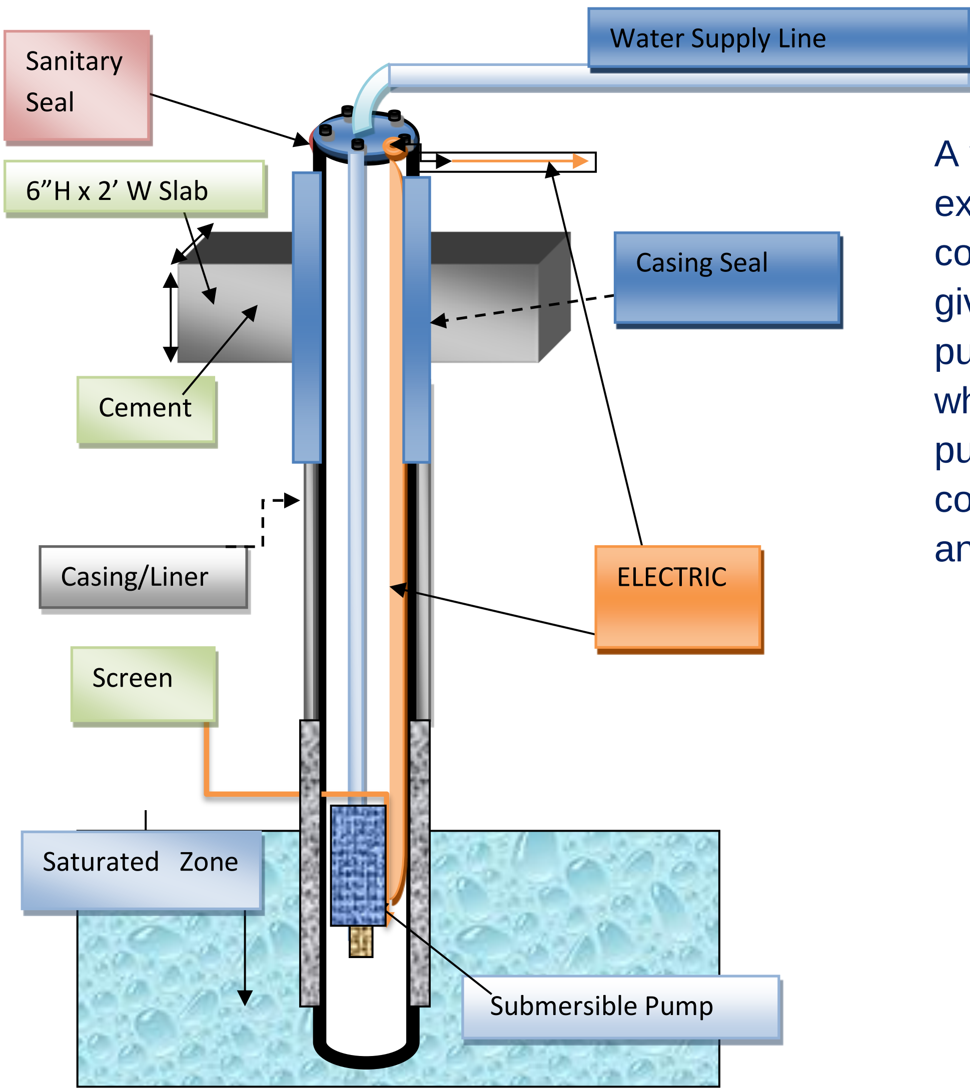
> The sand point well shall be drilled to a total depth of no more than thirty feet (30'); and a pilot hole shall be constructed first, with cement installed to a depth of three feet (3') around surface casing, then the

remaining bore hole can be installed then production casing installed (OWRB, 2010). Note: see Figure 4.

Drilled Wells

Drilled wells penetrate about 100 to 400 feet into the bedrock. To serve as a water supply, a drilled well must intersect bedrock fractures containing ground water.

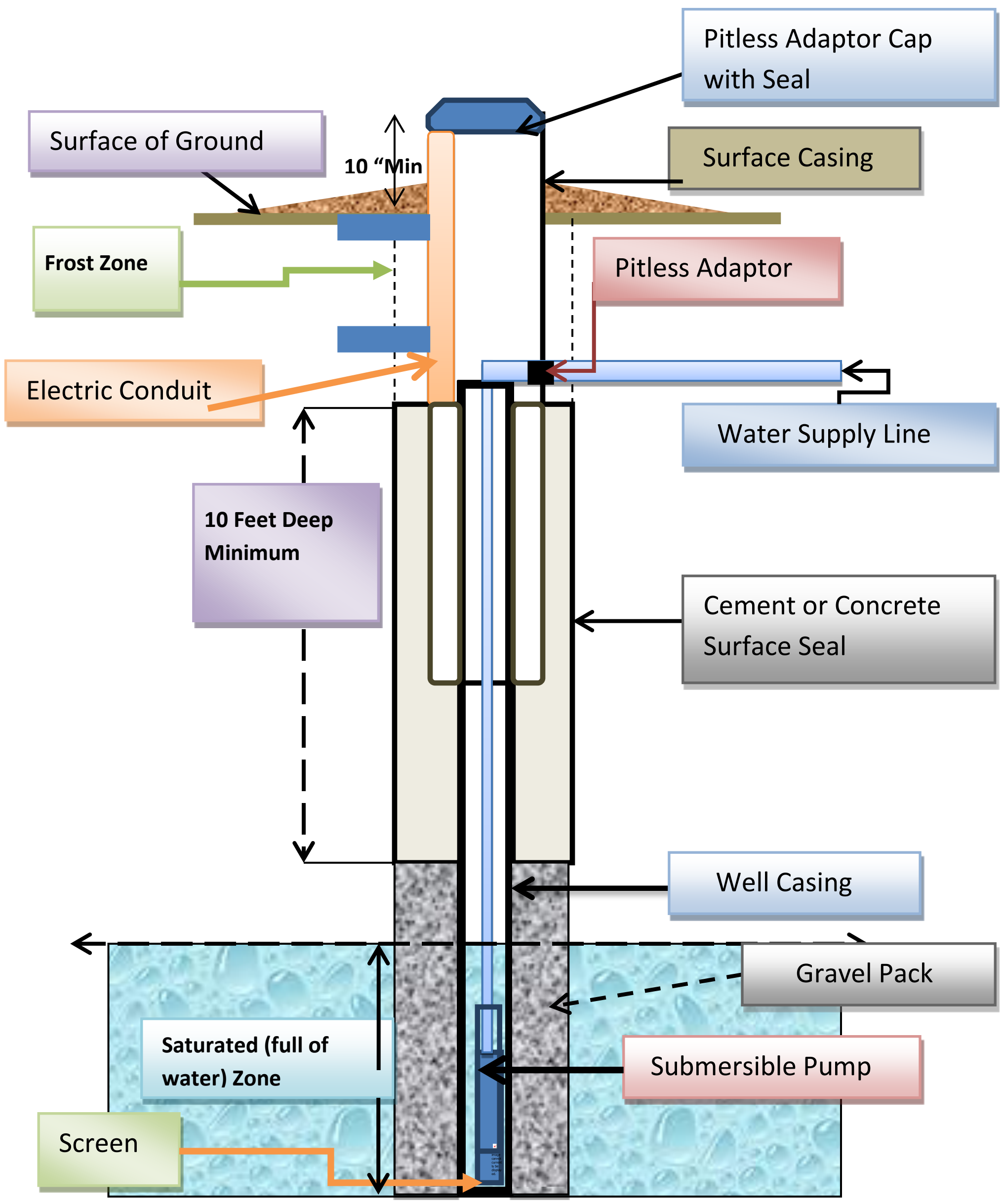
Pit Well



A well pit is a pipe that extends up above the concrete pad that gives access to the pump and well and where water can be pumped through pipes coming out of the pit and to the house.

New wells: casing 10 feet into the ground, or farther until a water tight material just above the water source. All casing joints threaded, welded, or glued with water well construction glue so they are water tight. The casing should extend 12 inches about the natural ground level or 8 inches above the floor surface for surface pad completions. If the well is in a known flood area, the casing is to be extended up to 2 feet above the maximum flood level.

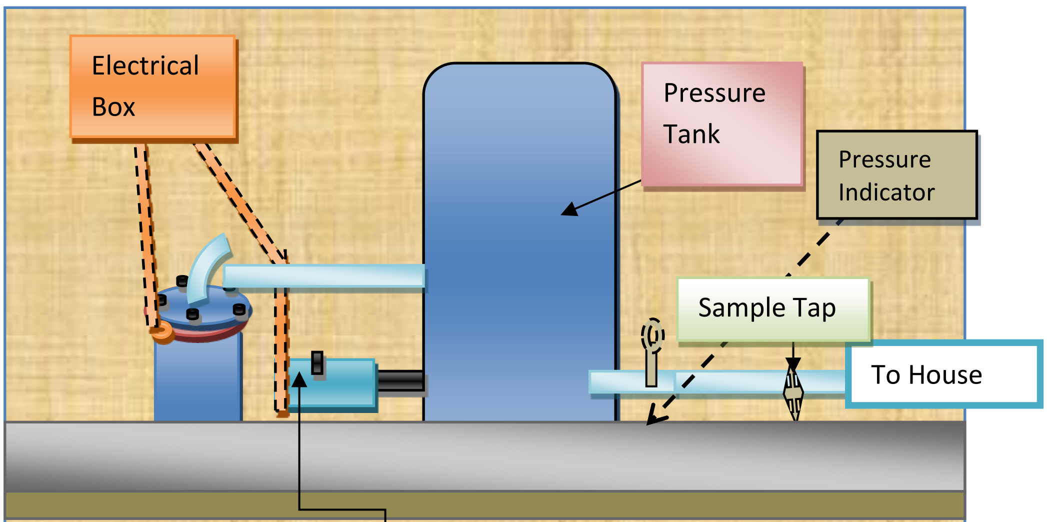
Pitless Well



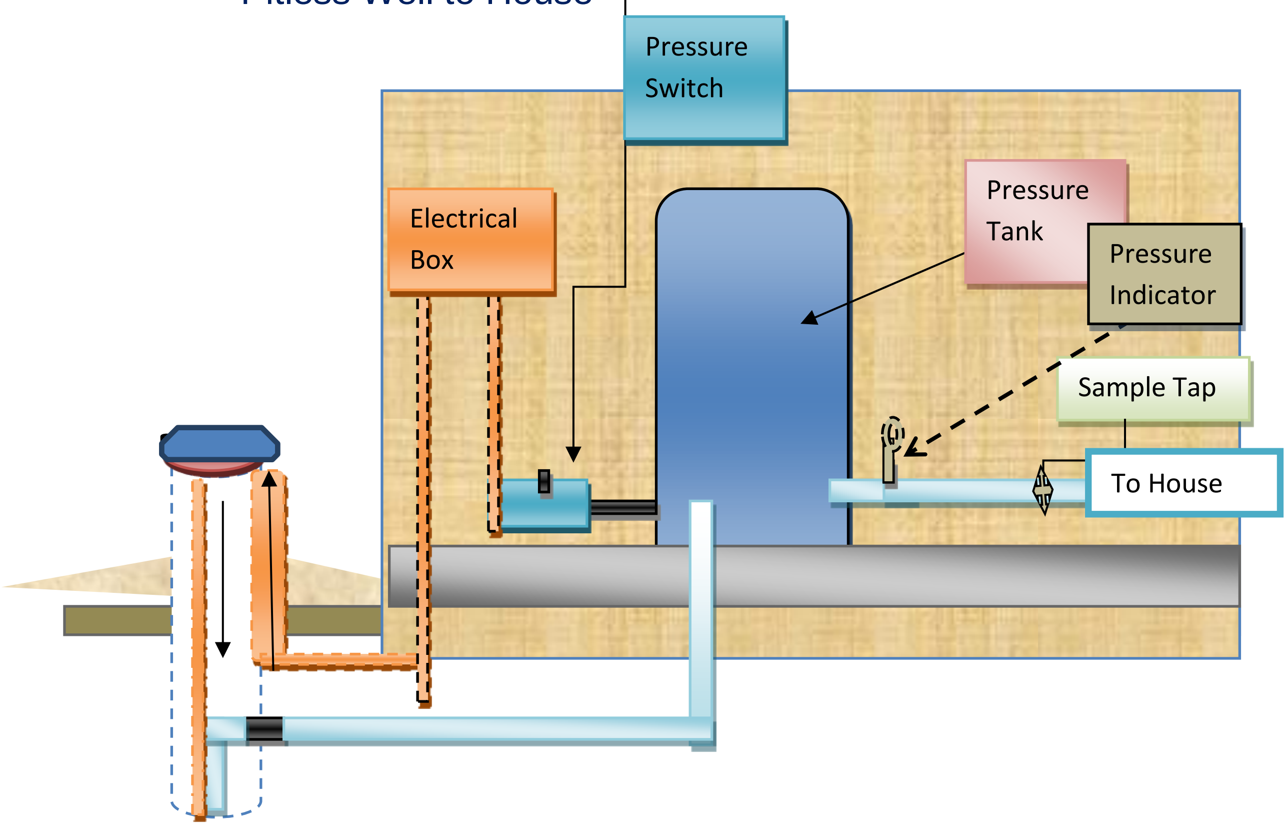
Most modern drilled wells incorporate a pitless adapter designed to provide a sanitary seal at the point where the discharge water line leaves the well to enter your home.

The device attaches directly to the casing below the frost line, and provides a watertight sub-surface connection, protecting the well from frost and contamination.

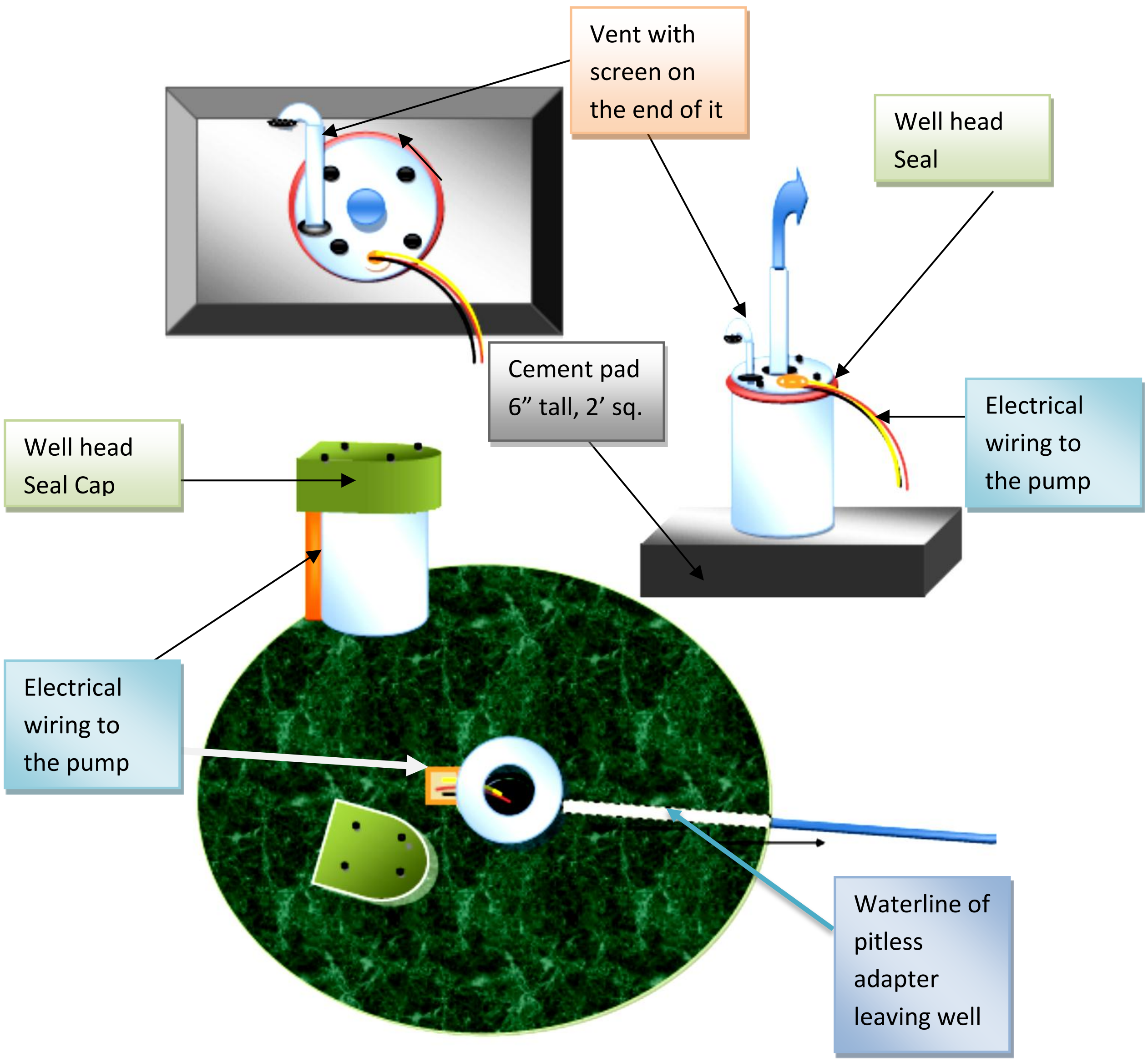
Pit Well to House



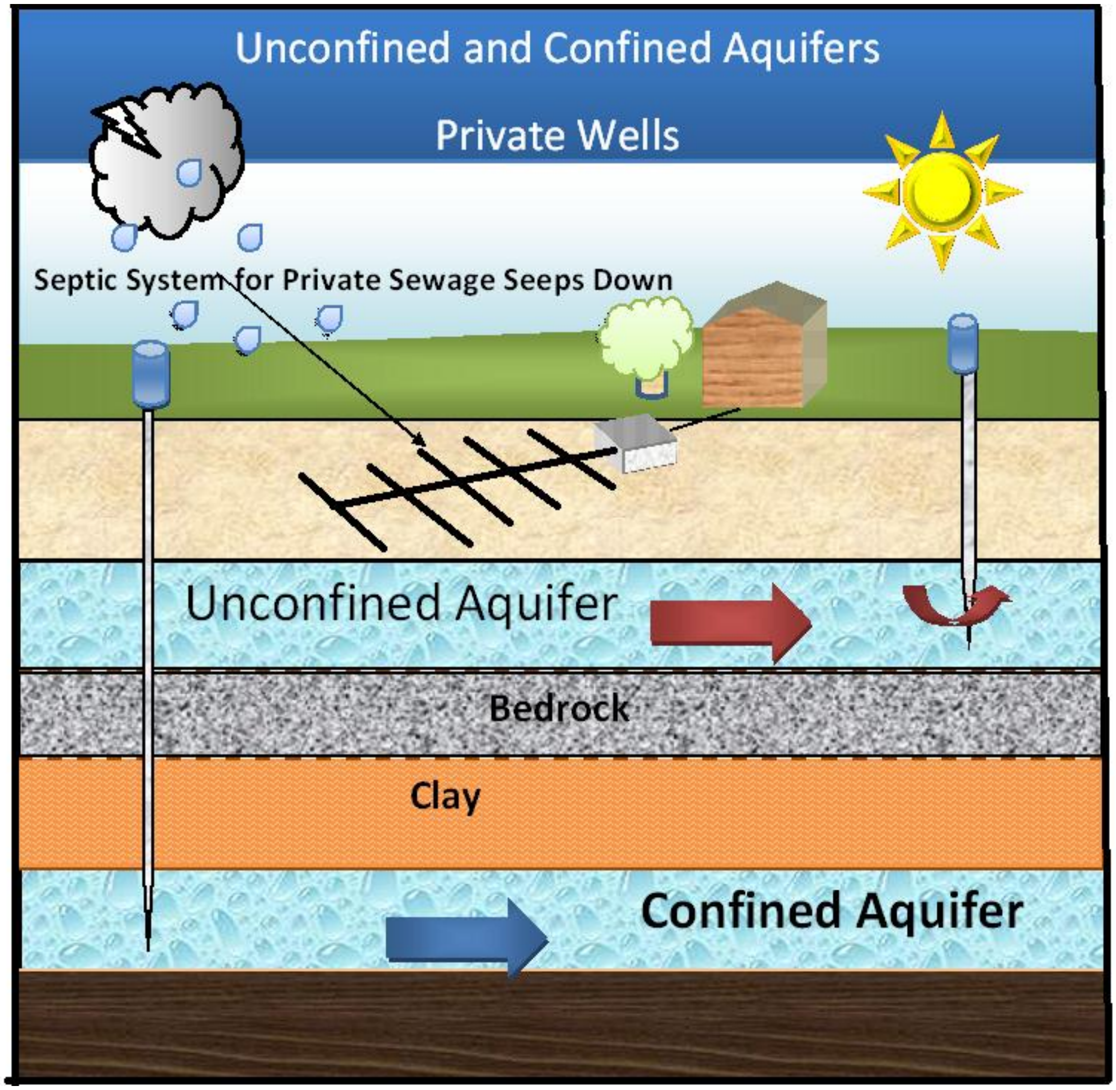
Pitless Well to House



Well heads: With Pit and Pitless



NOTE: <u>Drilled and Driven wells both have the same well houses and well heads: pit or pitless.</u>

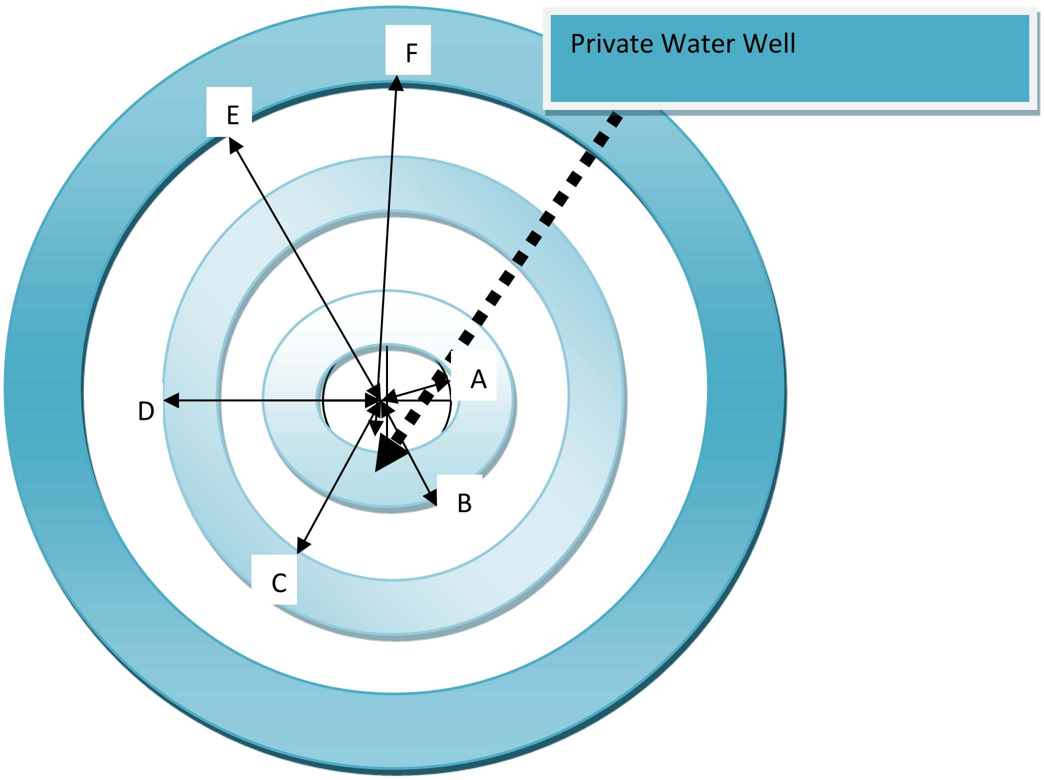


Septic systems are for your sewage to be disposed of and treated properly. Keep hazardous chemicals: paint, fertilizer, pesticides, and motor oil far away from your well.

Maintain a clean zone of at least 50 feet between your well and any kennels or livestock operations. See other important distances that follow

and are located as well at http://www.owrb.ok.gov/util/rulespdf
_rul/chap35.pdf.

Distances: Well Drillers Title 785 Chapter 35



A: 10 feet from a closed or tight sewer line

B: 15 feet from aerobic sprinkler spray

C: 50 feet from aerobic sprinkler head and up gradient from other pollution sources

D: 75 feet from all pollution sources if the well is level ground grade of the pollution source.

E: 100 feet from all pollution sources if well is down gradient of these source

F: 300 feet from the outside perimeter of a lagoon for waste from a feedlot or confined animal operation

- Good water can go bad if there is contamination of a water source we all use above and below the ground.

- Always maintain the listed proper separation between your well and buildings, waste systems, dump areas, or chemical storage facilities.

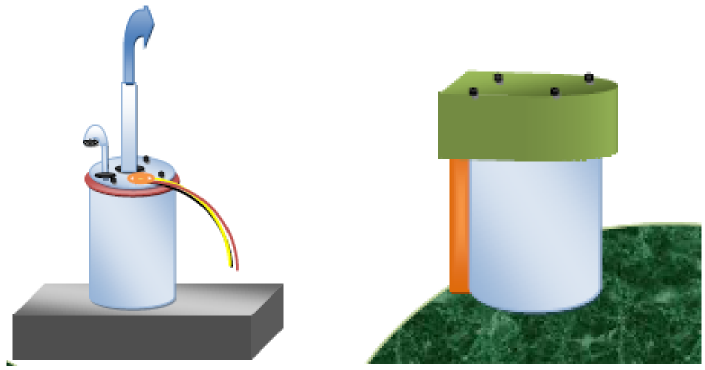
- Always use licensed or certified water well drillers and pump installers when a well is constructed, a pump is installed or the system is serviced. The Service may include:
  - A flow test to determine system output, water level before and during pumping (if possible), pump motor performance, pressure tank and pressure switch contact, and general water quality.
  - A well should be serviced annually. A bacterial test and nitrate test (if nitrates are a local concern) during this time is recommended.
  - Note: any source of drinking water should be checked any time there is a change in taste, odor or appearance, or anytime a water supply system is serviced.

- Periodically check the well sanitary cap, well seal, and casing to ensure they are still good shape. A cracked casing, seal, or cover can allow contamination of your well to occur.

- Don't allow back flow (water going back into a well due to pressure loss) when mixing anything. Especially pesticides, fertilizers or other chemicals. This means: don't put the hose inside the tank or container and use back flow preventers on all taps to the well. You can get these at your local store that has plumbing supplies.

- If you decide to landscape or garden, do not landscape toward a well. Make sure the surface around the top of the well is sloped away so water does not pool there. It can eventually slide down the casing and possibly contaminated the well.

- Take care in working or mowing around your well. A damaged casing could jeopardize the sanitary protection of your well.



Pit or Pitless

- Keep your well records in a safe place. These include the construction report, as well as annual water well system maintenance and water testing results.
- When your well has come to the end of its serviceable life (usually more than 20 years), have your qualified water well contractor properly decommission your well after constructing your new system. Private water wells also allow consumers to take more control of their water quality.
- Chapter 35 has the regulatory instructions on how to plug a well so it cannot contaminate a water supply by being unused and forgotten.
- Don't pile snow, leaves, or other materials around your well.
- Take care of your well and your water will stay as safe as you make it (wellowners.org, 2010).

When and How to Disinfect Your Private Water Well

When: a well is newly drilled, when it has been repaired, or when an unsafe water sample is returned by the lab who ran the tests for bacteria in your water. How to disinfect a well:

1. Use ordinary liquid bleach to disinfect a well (don't use scented bleach!)
2. Pump the well enough (run water) to remove sediment and other debris caused by construction or repairs.
3. Remove the vent or well lid/seal and pour in bleach. Use the table below for the amount necessary.
4. Circulate the solution by inserting a garden hose through the well seal (or vent hole) at the top of the well and pumping until the chlorine is thoroughly mixed (at least fifteen minutes).
5. Open each water tap in your house until a strong chlorine odor is present and then close the tap. This will disinfect the house service lines.
6. Let the bleach in the well and lines stand for at least 24 hours, if possible, but no less than two hours.
7. Flush the system thoroughly (open all taps) until the bleach smell is not as strong or goes away.
8. Resample after a one week period to allow for the possibility of bacterial regrowth.
9. If a sample has tested positive, the disinfection has been done and another sample is collected for testing, please write 'RETAKE' in the Samplers Remarks.

Well Diameter	**Well Depth**	**Bleach Amt.**	**Well Depth**	**Bleach Amt.**	**Well Depth**	**Bleach Amt.**
3 inch	50 feet	3 oz.	100 feet	6 oz. or (3/4 cup)	150 feet	8 oz. or (1 cup)
6 inches	50 feet	8 oz. or (1 cup)	100 feet	20 oz. or (2 ½ cups)	150 feet	30 oz. or (3¾ cups)
9 inches	50 feet	25 oz. or (3 1/8 cups)	100 feet	50 oz. or (6¼ cups)	150 feet	75 oz. or (9¼ cups)
12 inches	50 feet	50 oz. or (6 ¼ cups)	100 feet	100 oz. or (12½ cups)	150 feet	150 oz. or (19 cups)

(DEQ, 2010)

Section 5: OWRB and Well Drillers Organization

1. The OWRB issues permits to use water, both surface and ground water, in the state of Oklahoma.
   a. This is done to keep the water safe by keeping the rules of well construction enforced.
   b. And by supervising the licensing program for well drillers and pump installers.
2. The licensing program requires that licensed drillers to submit a well log by entering it on-line or by mailing this information to OWRB. These logs are kept for every completed well that a licensed driller has established.
3. If you need the well log information you can find it on the OWRB website, www.owrb.ok.gov, and go to the "Water Well Record Search Program. Individual well records can be accessed by legal description, county, or Well ID number".

Things you might ask:

1. Is there enough water for me to have a well on land I am purchasing or have purchased?
"While OWRB staff are unable to predict with absolute certainty whether or not groundwater is available in a specific area, agency hydrologists can utilize available aquifer and water well yield data to assist citizens in identifying the locations most likely to produce sufficient well yields".

2. Maps of Aquifers of Oklahoma are published by the Oklahoma Geological Survey, called Hydrologic Atlases for Oklahoma. Go to the Publication Section.

3. If you want to have a well drilled, you can find a list of licensed well drillers on the OWRB website.

4. "What is considered "domestic use"?
Domestic use is the use of water for household purposes, for farm and domestic animals up to the normal grazing capacity of the land, and for the irrigation of land not exceeding a total of three acres in

area for the growing of gardens, orchards, and lawns. Domestic use also includes water used for agricultural purposes by natural individuals, use for fire protection, and use by non-household entities for drinking water, restrooms, and watering of lawns, provided such uses don't exceed five acre-feet per year" (OWRB, 2010).

References

Centers for Disease Control. (2010). Private water wells. Retrieved from http://www.cdc.gov/healthywater/drinking/private/wells/

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Department of Environmental Quality. (2010). Disinfection of individual water wells. http://www.deq.state.ok.us/factsheets /local/dsinfctwtr.pdf

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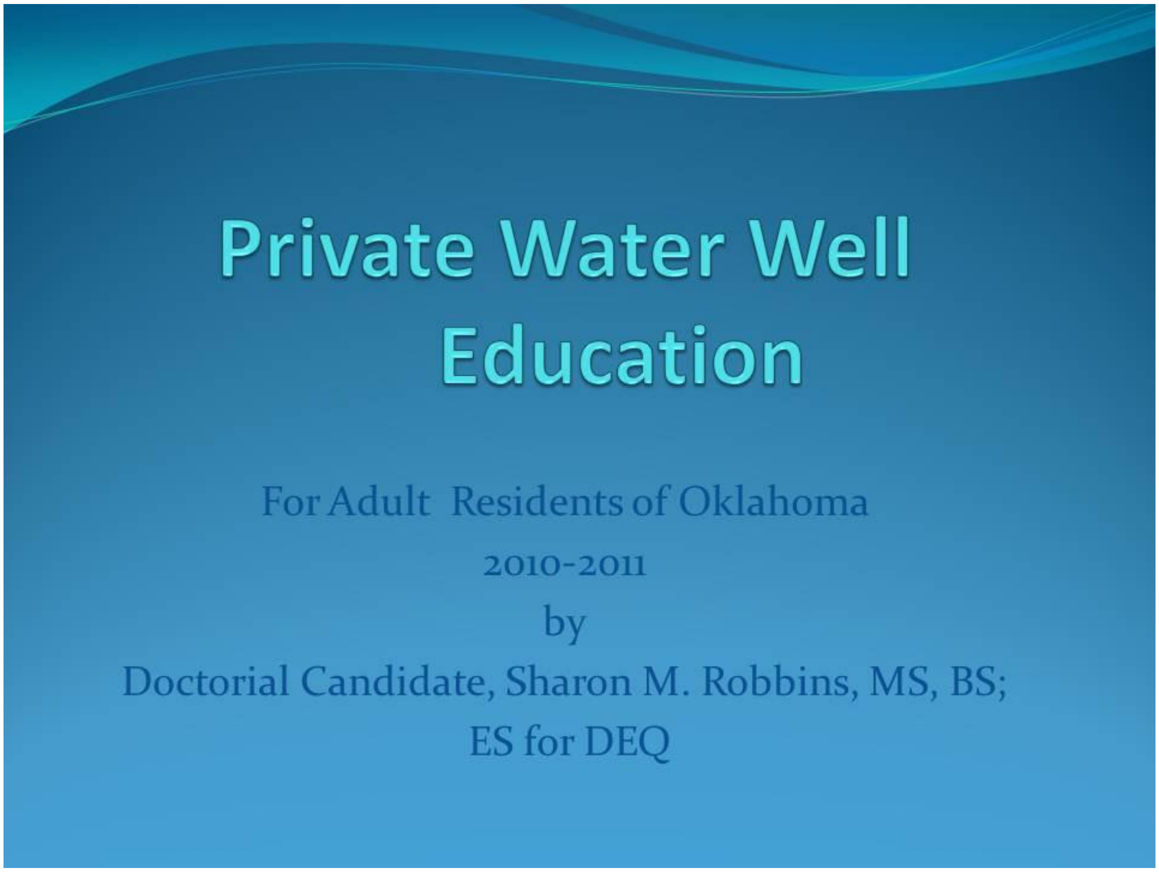
United States Geological Survey. (2010). Well types. Retrieved from http:/./ga.water.usgs.gov/edu/graphics/welltypes.gif

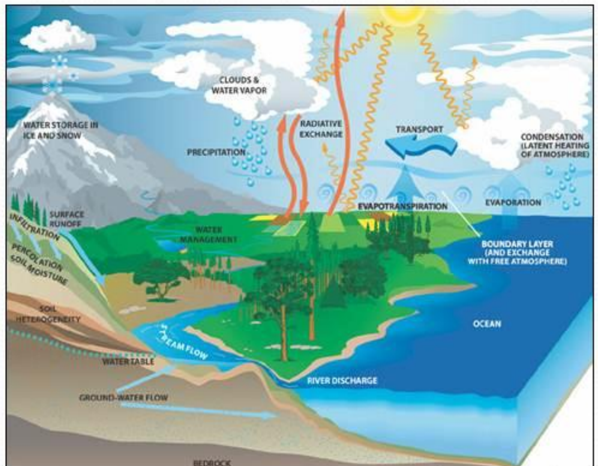
Wellowner.org. (2009). *Understanding groundwater.* Retrieved from http://www.wellowner.org/agroundwater/understand inggw.shtml

Appendix B

Powerpoint Program Presentation to Groups 1 and 2



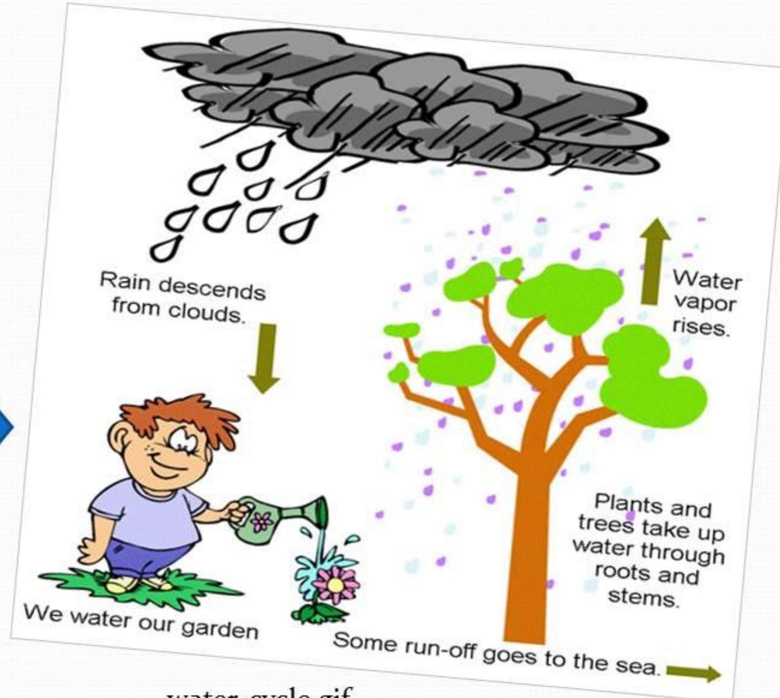
The Life Cycle of Water



water_cycle.jpg

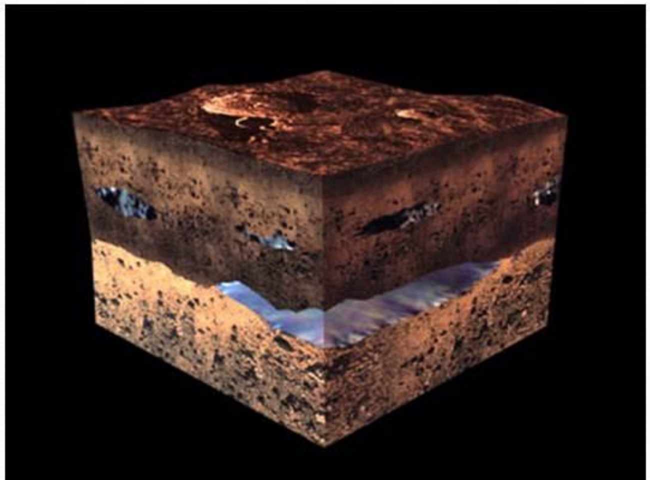
Life Cycle of Water

Friendly version!



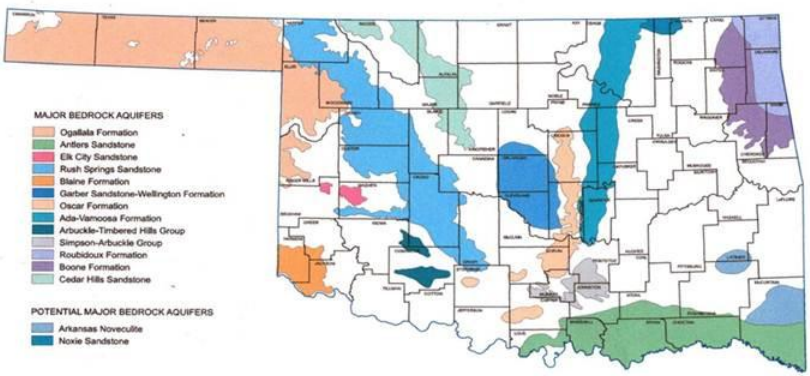
water-cycle.gif

Ground Water

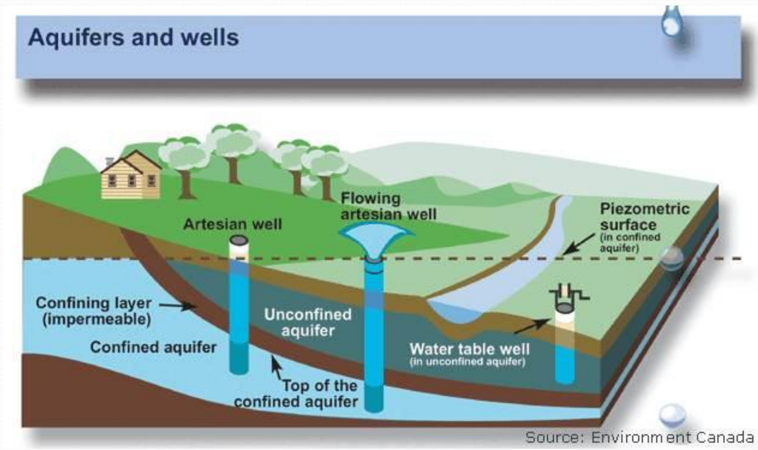


13_WATER_L.jpg

Map of Major Bedrock Aquifers in Oklahoma

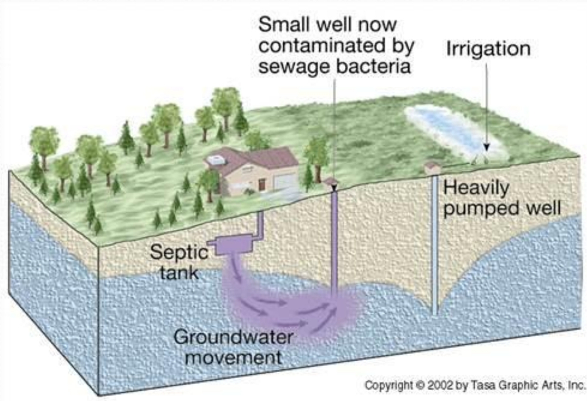


http://ga.water.usgs.gov/edu/graphics/gwcontamination.gif



http://ga.water.usgs.gov/edu/graphics/aquifersandwells.gif

Contamination and Water Use



Clean or Dirty? Just Cause it Looks like it's clean water and acts like clean water does not make it clean water. Dirty water (unsafe) is easy to see with color.

http://t3.gstatic.com
/images?q=tbn:AN
d9GcS1uk
UzQs6o3QrSDOLp
syzvgTdWkIISxX_-
nIkbyJn33hQRbT-
ZYA&t=1

http://t3.gstatic.com/images?q=tbn:ANd9GcSN
lAlj36fJ16gUiHMuZVx7PTooZbKqloRGfs8Wgy
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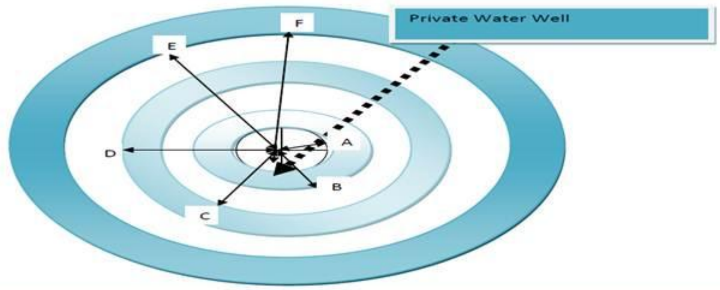
http://t1.gstatic.com/images?q=tbn:ANd9GcREkNV
fhuXliQLp_eJBhFyEn61pLANeyEUKHFw88Kf-9q1QIJdglw

Distances from your well head

Distances: Well Drillers Title 785 Chapter 35



A: 10 feet from a closed or tight sewer line

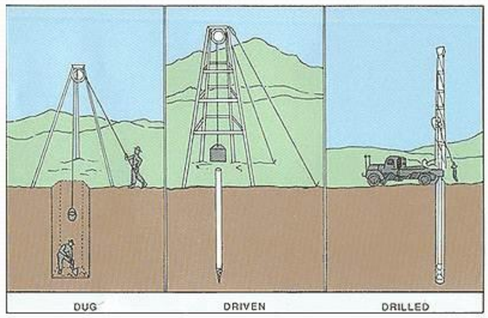
B: 15 feet from aerobic sprinkler spray

C: 50 feet from aerobic sprinkler head and up gradient from other pollution sources

D: 75 feet from all pollution sources if the well is level ground grade of the pollution source.

E: 100 feet from all pollution sources if well is down gradient of these source

F: 300 feet from the outside perimeter of a lagoon for waste from a feedlot or confined animal operation



http://ga.water.usgs.gov/edu/graphics/welltypes.gif

Dug well lined in bricks

http://t2.gstatic.com/images?q=tbn:ANd9GcSoPFo1qJUI86_LodomPrUFhowLqrtmU4iicxi7gMLoNAMqWySq4g&t=1

Is this a good well seal?

- http://www.nmenv.state.nm.us/dwb/images/taped_sani_seal.jpg

Is this a good wellhead and a protection area? What is missing?

http://www.grandpappy.info/ywawell.jpg

Pitless Well head, Concrete pad

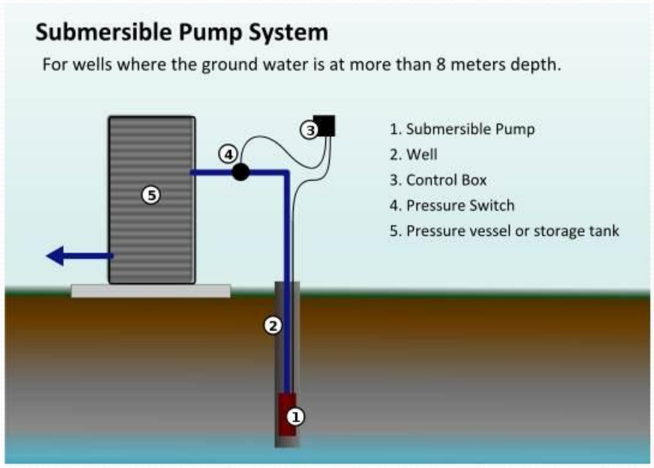
http://www.maine.gov/dhhs/eng/water/images/drilled_well2.gif

Rules to remember:

Fundamental Wellhead Protection elements:

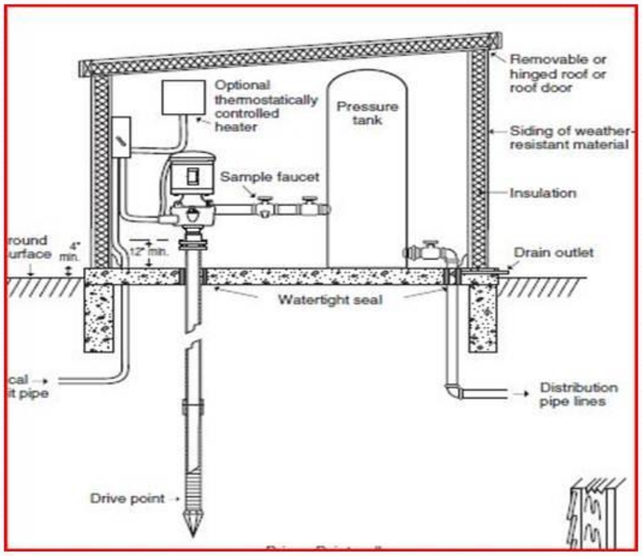
1. Ensuring the well has a properly constructed sanitary seal
2. Placing a "2 x 2" (OK rule) foot cement pad around the well
3. Constructing a wellhouse to guard against contamination and vandalism
4. Eliminating all sources of contamination within the Wellhead Protection Area

http://www.nmenv.state.nm.us/dwb/whpp.html



http://upload.wikimedia.org/wikipedia/en/thumb/2/28/Submersible-pump_System.svg/538px-Submersible-pump_System.svg.png

Sandpoint well head and house



Sandpoint wells are installed by driving or injecting a pointed head through the sandy soil. Continuous-slot stainless steel screened Sandpoint's will provide the most efficient, trouble-free service for the longest time. The point is driven on the end of the of a pipe (1-2" diameter). The pipe will be sectional allowing new lengths to be added on as the Sandpoint is driven deeper.

* Sandpoint wells; also known as driven point wells, are typically installed in areas where access to the aquifer is within 40 feet of the surface and the ground is composed predominantly of sand. Sandpoint wells are particularly susceptible to contamination through ground penetration and runoff, making them a less desirable choice if other options exist.

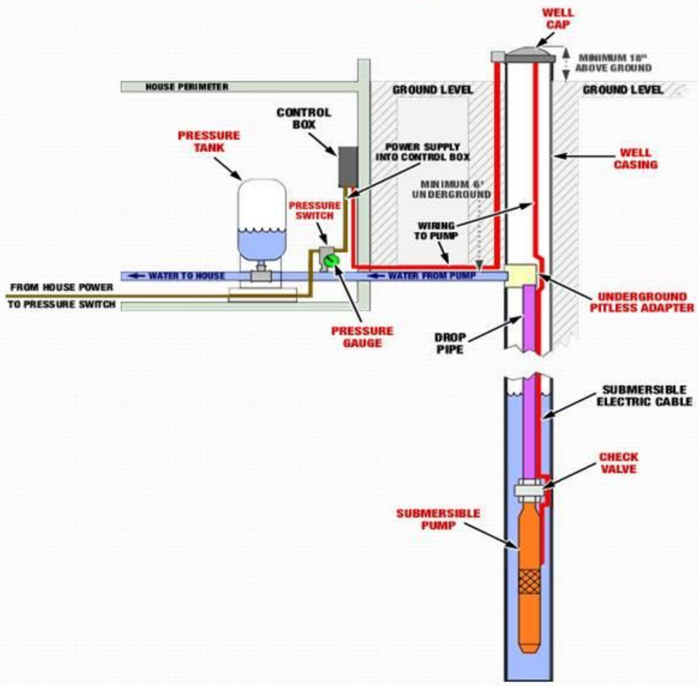
Typical Pitless Well Cap

http://www.flatheadwatershed.org/water/images/fig4_6b_Sanitary-Well-Cap-Photo-2.jpg

Pitless Well Head…if it has a good seal might just be safe. No matter what, all things that can get in through the well head/seal can contaminate your water.

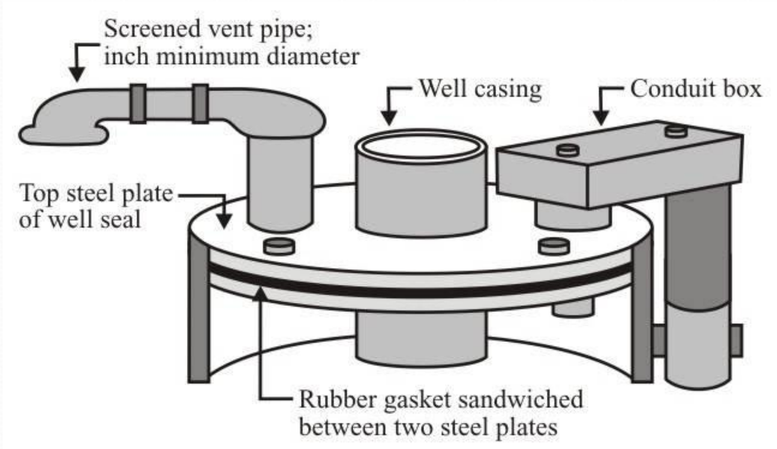
http://york.extension.psu.edu/NResources/Images/Std%20cap.jpg

Pitless Well Diagram with Tank



http://www.lindsaydrilling.com/images/pumpsystemschematic.gif

Typical Well head Pit Well



http://www.cdc.gov/nceh/publications/books/housing/Graphics/chapter_08/Figure8.03.jpg

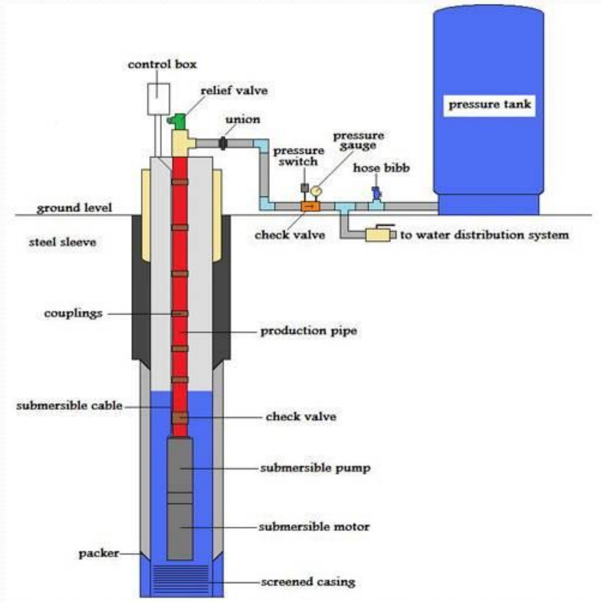
Typical Pit Well Head

http://static.racingjunk.com/63/ui/3/36/3323160876772.jpg

Pit Well with Vent.

http://t3.gstatic.com/images?q=tbn:ANd9GcSKk1dFc7PO8Nm1ObczAKZUVXq40bbc5FRLjKbTnMOl2mOszr48

Pit Well Diagram with Tank



http://www.beecavedrilling.com/assets/images/basic-well.jpg

Well head and Pressure Tank

http://groundwater.orst.edu/images/14567672.jpg

Needs a slab and a house

http://homebuilding.thefuntimesguide.com/images/blogs/A-O-Smith-water-well-pump0.JPG

This is a well built well house.

http://t0.gstatic.com/images?q=tbn:ANd9GcSM4L5HNzRdFYqd6-ZcdUjXf3c6DAWGnHz2N1pwwAfvbplTVjbBfg

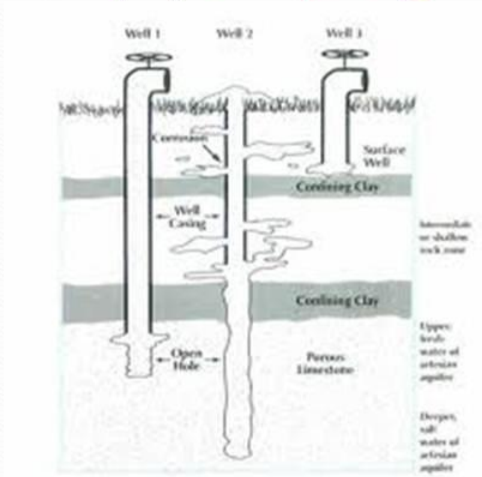
Typical Well House … not very big.

http://media.photobucket.com/image/water+well+pump+/ttownjeff/100_2929.jpg

Cross Connection…what is that?

http://preppernation.com/wp-content/uploads/2009/09/09-20-09-008-300x225.jpg

Why you plug wells…



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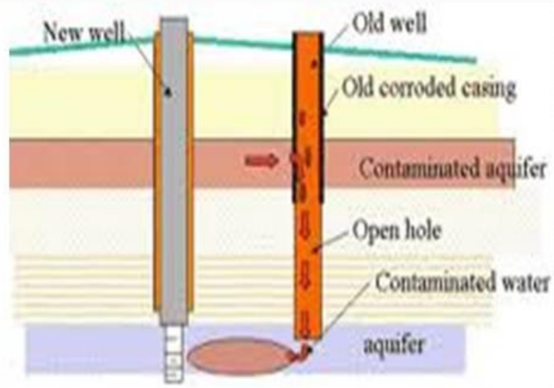

http://t1.gstatic.com/images?q=tbn:ANd9GcSsmOKoMWd6S5thcKscnwTO46cA6gntCndhltcBiqT14aSnLfq5Pg

Plugging a Well

Plugging well: Call a professional from the listing on OWRB website.

Do not attempt this at home by yourself!!

For your benefit the rules are located at:

Title 785. OWRB. Chapter 35
Subchapter 11

www.OWRB.ok.gov

WATER

DISINFECTION OF INDIVIDUAL WATER WELLS

A water well should be disinfected (1) when the well is newly drilled; (2) when repairs to the well or pumping equipment are completed; (3) when an unsafe sample has been reported or (4) after a disaster situation which has impacted your home or business. Ordinary liquid laundry bleach may be used to disinfect a well. Liquid laundry bleach contains 5.25 percent chlorine. Care should be taken to avoid using scented bleach as this will contaminate the well.

In order to disinfect a well:

1. Pump the well enough in advance to completely remove sediment and other debris caused by construction or repairs.
2. Add enough chlorine to make 50 to 100 parts per million solution (use table below).
3. Circulate the solution by pumping the discharge back into the well. This can be done by inserting a garden hose through the well seal at the top of the well and pumping until the chlorine is thoroughly mixed (at least fifteen minutes).
4. Open each water tap in the system until a strong chlorine odor is present, then close the tap. This will also disinfect the house service lines.
5. Let the chlorine stand for at least 24 hours, if possible, but no less than two hours.
6. Flush the system thoroughly.
7. Resample after a one week period to allow for the possibility of bacterial regrowth.

If a sample has tested positive, the disinfection has been done and another sample is collected for testing, please write "RETAKE" in the Samplers Remarks.

The volume of laundry bleach needed to make a 50 parts per million (ppm) solution may be found from the table below if one knows the depth of the water in the well and the casing (pipe) size. This volume may be doubled to achieve a 100 ppm solution if desired. Further assistance regarding disinfection of your well may be obtained from your local environmental specialist. Questions about the testing can be answered at the State Environmental Lab (405) 702-1000.

Amount of Chlorine Bleach Needed

	Well Diameter			
Depth of Well	3 in.	6 in.	9 in.	12 in.
50 ft.	3 oz.	8 oz.	25 oz.	50 oz.
100 ft.	6 oz.	20 oz.	50 oz.	100 oz.
150 ft.	8 oz.	30 oz.	75 oz.	150 oz.
8 oz. = 1 cup	25 oz. = 3 cups	50 oz. = 6 1/4 cups	100 oz. = 12 1/2 cups	150 oz. = 19 cups, 1 1/4 gals.

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Fact Sheet | February 2009

WATER

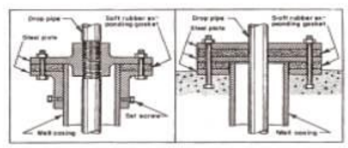
How To Properly Maintain Your Private Water Well

Once disinfected, a properly protected and constructed water well should yield bacteriologically safe drinking water until the well is opened. Recontamination can be prevented if the following measures are taken:

1. In order to protect the well from surface water, grade around the well to divert surface water away from the well.
2. Maintain at least 100 foot separation between the well and all up-slope pollution sources such as septic systems and ponds. Maintain at least 50 foot separation on down-slope and 75 foot on same elevation pollution sources.
3. Maintain at least 50 foot separation between the well and all buildings (which may be termite treated).
4. The well should be cased to at least 10 feet below ground level.
5. The casing should extend at least 8 inches above ground level.
6. The upper terminal of the well casing should be capped with a commercial, sanitary well seal. Old deteriorated seals may no longer be effective and should be replaced. Electrical cables passing through the seal should be caulked to prevent airborne contamination.
7. Any necessary vents in the well seal should be turned down and screened.
8. Any time you remove the well seal, you should chlorinate in accordance with the DEQ fact sheet on chlorinating your private water well.

For additional information contact your local Department of Environmental Quality office or call DEQ Environmental Complaints and Local Services at (405) 702-6100.

v



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Appendix C

Oklahoma State University Institutional Review Board

Date:	Thursday, February 10, 2011
IRB Application No	GU112
Proposal Title:	Private Water Well Education for Adult Residents of Oklahoma
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 2/9/2012

Principal Investigator(s):

Sharon M. Robbins	Lowell Caneday
1002 3rd Ave. NW	180 Colvin Center
Miami, OK 74354	Stillwater, OK 74075

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia M. Kennison

Shelia Kennison, Chair
Institutional Review Board

Appendix D

011:_____________________________

Survey and Pretest

Survey

Please fill out the demographic data before you take the test as this will aide our research. It is voluntary (based on the census questionnaire of the US Census Bureau for 2010).

1. Your age as of April 2010: ____________

2. Ethnicity: (Please check box(s) that apply to you only)

   - ☐ White
   - ☐ Black, African American, Negro
   - ☐ Hispanic, Latino, or Spanish
   - ☐ Asian Indian
   - ☐ Japanese
   - ☐ Native Hawaiian
   - ☐ Chinese
   - ☐ Korean
   - ☐ Guamanian or Chamorro
   - ☐ American Indian : Tribe____
   - ☐ Alaska Native
   - ☐ Filipino
   - ☐ Vietnamese
   - ☐ Samoan

3. Do you own or rent or live in a home with a private water well? Please circle.

   Yes No

Pretest

Multiple Choice

1. A private water well construction is regulated by ___________
   a. USGS (United States Geological Society)
   b. ODOT (Oklahoma Dept. of Transportation)
   c. DEQ (Department of Environmental Quality
   d. OWRB (Oklahoma Water Resources Board)
2. An aquifer is a river under the ground that runs in between limestone layers and not in sand.
   a. True b. False
3. Surface water is all water that is on the surface of the ground or comes to the surface of the ground.
   a. True
   b. False
4. The water cycle is the path of water from your well to your house.
   a. True
   b. False
5. All water is safe water that comes from the ground. If it looks like clean water, it is clean water.
   a. True
   b. False
6. How many types of well excavation are there? Such as dug or driven.
   a. 3
   b. 2
   c. 4
7. A pitless adapter is the electrical line to the electrical source.

a. True

b. False

8. A ___________ keeps out unwanted bugs and animals from the private well source.

   a. Sanitary seal

   b. Cement slab

   c. Pest control and insecticide

9. The pump in a well pumps water from the aquifer. How does it keep out the sand the water is being drawn from?

   a. Sock on the end of the pump

   b. Filter at the house

   c. Screen around the pump

10. What is a private water well? ___________________

   a. Any source of ground water not regulated by the EPA (Environmental Protection Agency).

   b. Any source of ground water not regulated by the DEQ.

   c. Any source of water that is used for domestic use.

   d. Any source of groundwater that is used for domestic use.

Posttest and Evaluation

011-______________________

Posttest

Multiple Choice

1. Do you know where your private water well is?
   a. Yes
   b. No
2. A bact-t tests water for what item?
   a. chlorine
   b. metals
   c. coliform bacteria
3. ___________ or _________ can disinfect the water from a private water well.
   a. UV and Acid
   b. Chlorine and Bromine
   c. UV and Chlorine
   d. None of the above
4. An aquifer is________________
   a. A confined source of groundwater
   b. An unconfined source of groundwater
   c. Both A and B
   d. None of the above
5. If you are not an electrician, do you work on the electrical lines to your well?
   a. Yes

    b. No

6. Water is safe if
    a. It comes from a ground water source
    b. If it is disinfected by an approved product or method
7. Ground water can be orange and not be considered nonpotable.
    a. True
    b. False
8. What is Potable water?
    a. Water you can drink
    b. Water you cannot drink
    c. Water from the toilet
9. What is the distance a private water well should be upslope of a septic system?
    a. 100 feet
    b. 30 feet
    c. 50 feet
    d. 70 feet
10. You can store anything you like around or in a well house that only houses the pressure tank and disinfection unit.
    a. True
    b. False
11. Water is the essence of life. To protect that resource, all who have access to it must be responsible for it.
    a. Yes
    b. No

12. A private well head is located in the well house or outside the well house?

    a. Inside

    b. Outside

    c. Doesn't matter as long as it is protected from contamination

13. All ages would benefit from learning all they could about a private water well.

    a. Yes

    b. No

14. A final question is never final. If you were the teacher, what question would you finish this posttest with and how would you answer it?

____
____
____
____
____
____
____

Evaluation

1. Would you rather have been given the education materials and allowed to view them by yourself on your own time?

    a. Yes

    b. No.

2. Do you feel a seminar or classroom presentation is beneficial in the learning process about private water wells?

    a. Yes

    b. No

3. If you are Group 1, does the material provided to you answer the questions you might have or have about a private water well?

    a. Yes

    b. No

4. If you are Group 2, does the material provided to you answer the questions you might have or have about a private water well?

    a. Yes

    b. No

5. If given the opportunity to attend a seminar again on another subject presented by the researcher and/or DEQ, would you attend?

    a. Yes

    b. No

6. Was this education program worth your time?

    a. Yes

    b. No

7. If you know a person who has a private well or gets water from a private well, would you tell them about the information provided in your seminar or classroom and where to find it?

a. Yes

b. No

Appendix E

CONSENT TO PARTICIPATE IN A RESEARCH STUDY
OKLAHOMA STATE UNIVERSITY

PROJECT TITLE: Private Water Well Education for Adult Residents of Oklahoma

INVESTIGATORS: Sharon Robbins, MS, Doctoral Candidate.

PURPOSE:

This study, which is research conducted for a doctoral candidate student dissertation, is being conducted through Oklahoma State University and in conjunction with employment through the Oklahoma Department of Environmental Quality (ODEQ). The purpose of this research is to examine how education materials can alter the pathway of understanding a complicated subject that is highly important to all who have, will have, or potentially do have exposure to or use of private water wells.

PROCEDURES:

The project will involve completion of a pre-test and post-test regarding knowledge related to private water wells, demographic questionnaire and a post survey related to educational programs provided through ODEQ. The pre-test will cover general information about a private well before the educational meeting/class. The first questionnaire will ask for demographic information such as your age, gender, race or ethnicity. The post-test will cover information covered in the educational curriculum: the new and the old. Following this will be the Survey to analyze the needs and wants of an individual on educational material and method of delivery.

The study is designed to last approximately 45-60 minutes.

RISKS OF PARTICIPATION:

There are no risks associated with this project, including stress, psychological, social, physical, or legal risk which are greater, considering probability and magnitude, than those ordinarily encountered in daily life. If, however, you begin to experience discomfort or stress in this project, you may end your participation at any time.

BENEFITS OF PARTICIPATION:

You may gain knowledge on private water well regulations, requirements, maintenance and general information in a research based environment.

CONFIDENTIALITY:

Do NOT put your name or other personally identifiable information on the papers provided to you. We do not need that information!

All information about you will be kept confidential and will not be released. Questionnaires and record forms will have identification numbers, rather than names, on them. Research records will be stored securely at the researcher's home and only researchers and individuals responsible for research oversight will have access to the records. This information will be retained for one year. Results from this study may be presented at professional meetings or in publications. You will not be identified individually; we will be looking at the group as a whole. It is possible that the consent process and data collection will be observed by research oversight staff responsible for safeguarding the rights and wellbeing of people who participate in research.

Confidentiality will be maintained except under specified conditions required by law. For example, current Oklahoma law requires that any ongoing child abuse (including sexual abuse, physical abuse, and neglect) of a minor must be reported to state officials. In addition, if an individual reports that he/she intends to harm him/herself or others, legal and professional standards require that the individual must be kept from harm, even if confidentiality must be broken. Finally, confidentiality could be broken if materials from this study were subpoenaed by a court of law.

COMPENSATION:

During the delivery of the educational component of this research, you will receive a bacteriological test kit and instructions on how to perform a test on your private water well.

CONTACTS:

You may contact any of the researchers at the following addresses and phone numbers, should you desire to discuss your participation in the study and/or request information about the results of the study: Sharon Robbins, MS, Doctoral Candidate, P. O. Box 1027, Miami, OK, 74355. 918-540-0150. If you have questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu

PARTICIPANT RIGHTS:

Your participation in this research is voluntary. There is no penalty for refusal to participate, and that you are free to withdraw your consent and participation in this project at any time, without penalty

CONSENT DOCUMENTATION:

I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and the benefits of my participation. I also understand the following statements:

I affirm that I am 18 years of age or older.

I have read and fully understand this consent form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my participation in the study.

____________________________________ ____________________

Signature of Participant Date

I certify that I have personally explained this document before requesting that the participant sign it.

____________________________________ ____________________

Signature of Researcher Date

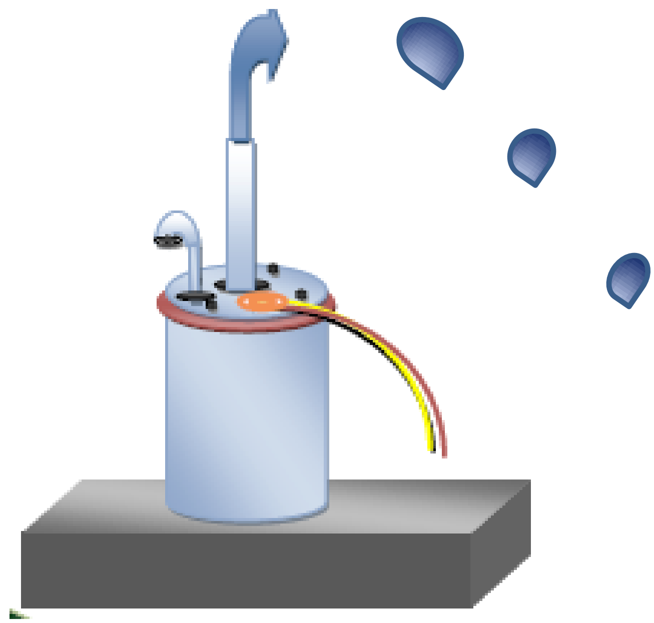
Appendix F

Test Scores

Wyandotte meet Gp 2				Neo Gp 2				OCHE Conference				Wyandotte Env	
C1	C2	C3	4	C5	C6	C7	(	C9	C10	C11	2	C13	C14
011-110	20	100		.011-061	70	91		011-159	80	82		011-195	60
011-111	30	100		.011-062	30	91		011-160	60	73		011-196	50
011-112	60	100		.011-063	50	91		011-167	30	82		011-198	60
011-114	70	82		.011-080	80	100		011-171	30	73		011-199	40
011-115	100	91		011-100	50	73		011-172	70	82		011-203	40
011-118	50	91		011-103	50	100		011-177	50	91		011-205	90
011-119	100	91		011-104	60	91		011-184	70	82		011-207	50
								011-186	60	82		011-208	60
								011-188	60	100		011-209	40
								011-190	40	64			

Appendix G

Private Well Education



Where: Wyandotte Nation Artie Nesvold Community Center on Hwy 60.

What: Public Informative Meeting to Present a Private Well Education Program

When: April 12th or 14th. Attend either night. Registration will start at 630 pm. The program is scheduled to start no later than 7 pm. The program will end at 8 pm or earlier.

Why: If you own a private well or will own one, you need to know the basics of private well ownership and maintenance.

Presented By: Sharon M. Robbins, ES, DEQ & Doctoral Candidate, OSU.

Sponsored by: Wyandotte Nation Environmental Department.

Appendix H

VITA

Sharon Marie Robbins

Candidate for the Degree of

Doctor of Philosophy

Thesis: PRIVATE WATER WELL EDUCATION FOR ADULT RESIDENTS OF OKLAHOMA

Major Field: Environmental Science

Biographical:

Education:

Doctor of Philosophy in Environmental Science at Oklahoma State University, Stillwater, Oklahoma in December 2012.

Master of Science in INDM (Industrial Management) at Northeastern State University, Tulsa, OK, in 2000.

Bachelor of Science in Biology at Oklahoma Panhandle State University, Goodwell, OK, in 1997.

Experience:

Oklahoma DEQ 1997-Present

NEO A & M Adjunct Science Instructor at Grove, OK Campus 2003-2008