

# Water Resources and Water Quality

## Water and Environmental Health Training

December 15, 2011

(revised January 2012)

Navajo Division of Health CHR Outreach Program

Presenter:

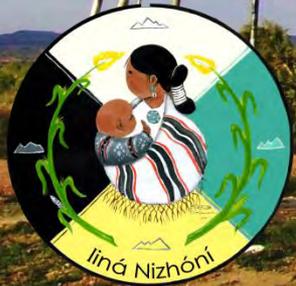
**Chris Shuey**

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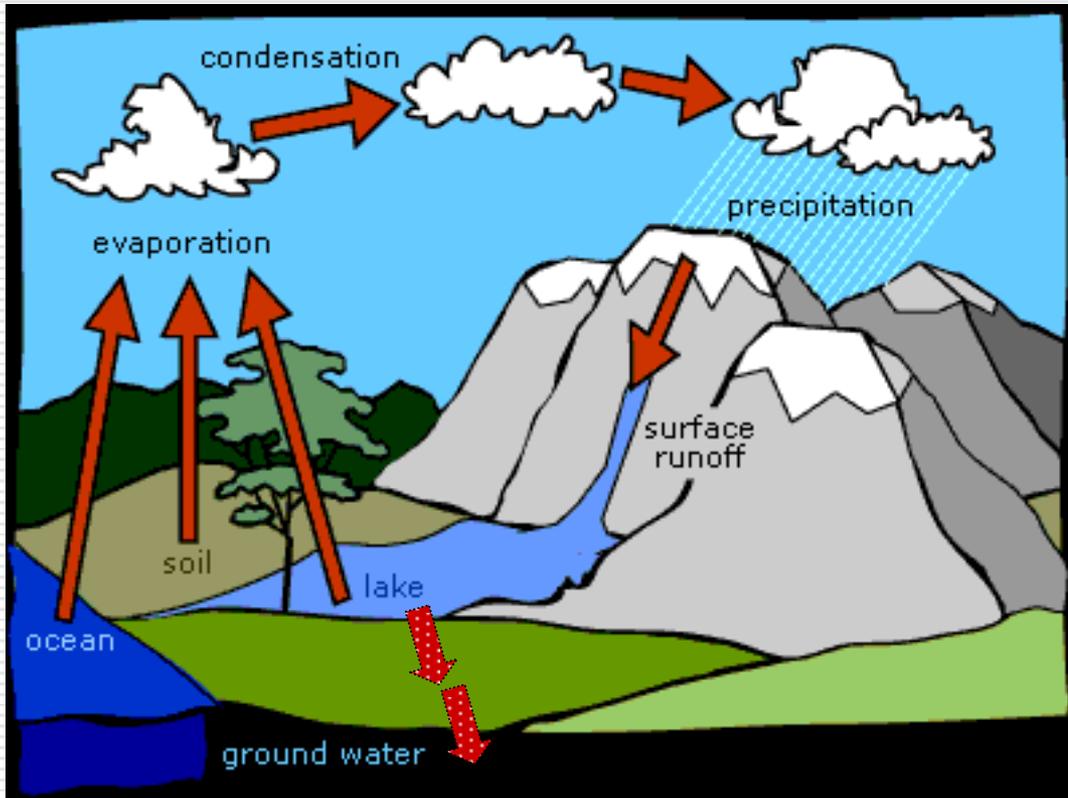
*This work funded by USEPA/ERRG pass-through contract to UNM-CEHP*

# Learning objectives of this presentation

- ❑ Recognize importance of water as critical component of public health, as sacred element in *Diné* culture
- ❑ Be able to identify and categorize water sources in communities
- ❑ Acquire and apply basic skills for interpreting water quality data
- ❑ Become knowledgeable of the range and distribution of contaminants in unregulated water supplies



# Where Does Water Come From?



**The hydrologic cycle; also called the water cycle.**

Water is the most essential element of life. It is the life blood of our Mother Earth and is the very foundation of all living beings on the planet, whether plant, animal, or human.

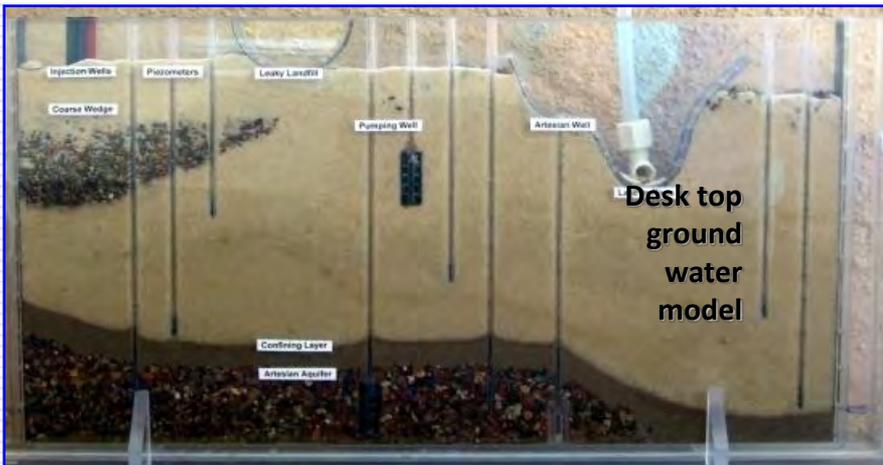
In the native way of life, water is sacred to our very existence. It is alive, continually moving, constantly swaying from side to side, bending, curving, spiraling, flowing over rocks and stones.

From these actions, a strong renewal occurs and is revitalized. Water returns to the state Mother Earth intended: clean, clear and complete. The scientific term for this cycle is the hydrologic cycle or the water cycle.

Miranda Cajero, Jemez Pueblo

## Ground Water

- ❑ The earth acts as a "sponge" with water filling the spaces between particles of soil and rocks.
- ❑ Ground water moves slowly, typically in feet per year.
- ❑ An aquifer is a layer of sand, gravel or permeable rock containing enough water to discharge at the surface



## Surface Water

- ❑ Water that is open to the air and surroundings such as in lakes, streams, rivers, and ponds. In some cases the water may be seasonal or run-off, as found in arroyos.

# Water Sources and Their Uses

**Unregulated dug well; livestock use**



**Unregulated windmill; livestock use**



**Drilled well; formerly, public water supply, now livestock-use only**



**Developed spring, unregulated; human ceremonial use, livestock use**

**Family's private well (drilled); domestic and livestock uses**



**Public water supply water-hauling station; human drinking water**



**Bottled water: safe to drink?**

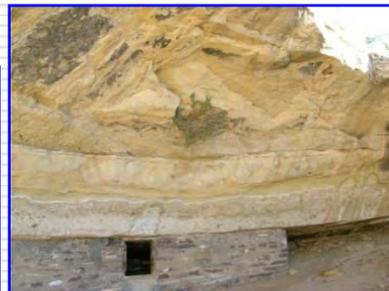


# Regulated Water →

- ❑ “Safe” drinking water
- ❑ Regularly tested and treated pursuant to NNEPA regulations
- ❑ Complies with primary drinking water standards
- ❑ NTUA water piped to homes or available at water-hauling stations



Regulated water at two hauling stations

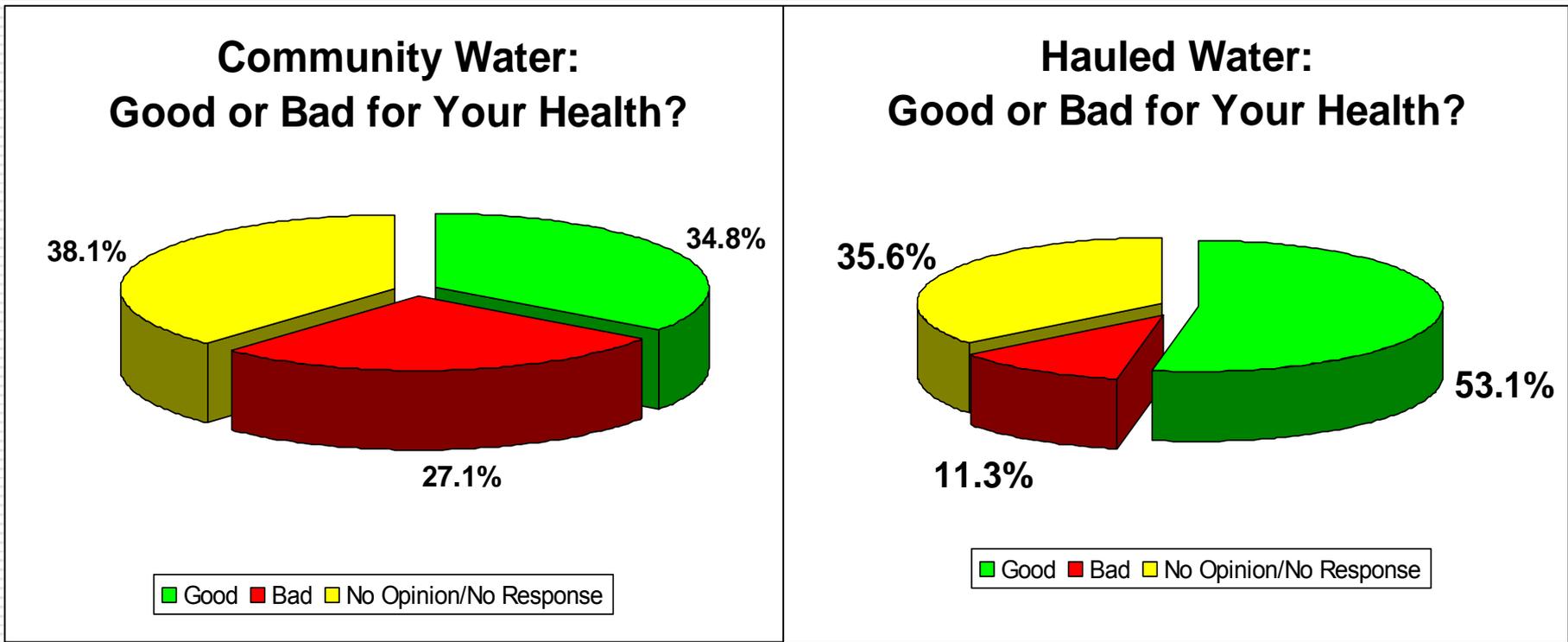


Examples of unregulated water sources

# ← Unregulated Water

- ❑ *Not* regularly tested or treated
- ❑ Windmills, springs, artesian wells, private wells, stock ponds
- ❑ Originally intended for livestock watering, irrigation
- ❑ Navajo Nation policy is that this water is not to be used for drinking

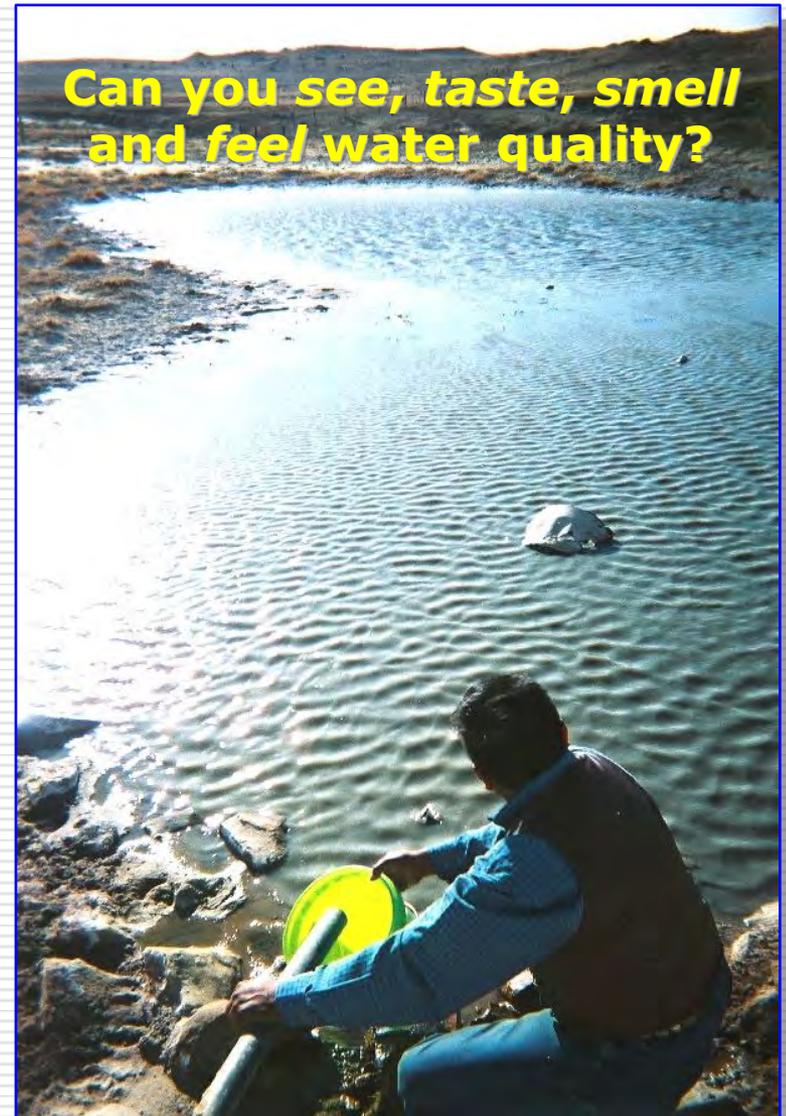
# DINEH Survey Results (N=1,304): Perceptions About Water Quality



**64% of DiNEH survey participants said their homes are connected to a public water system, which means 36% are NOT connected to a PWS**

# What is Water Quality?

- ❑ Sum of all substances contained in the water.
  - TOTAL DISSOLVED SOLIDS
  - CONDUCTIVITY
  
- ❑ **Water contaminant:** Any substance that alters the physical, chemical, biological or radiological qualities of water.
  
- ❑ Water contaminant becomes a **pollutant** when it exceeds an acceptable level (or, concentration) or drinking water standard.



# Water Quality Standards

- ❑ Federal Safe Drinking Water Act (SDWA) of 1974
- ❑ Protects public health by limiting contaminants in human drinking water
- ❑ Gives USEPA legal authority to establish and enforce “**primary**” and “**secondary**” drinking water standards for public water supplies
  - Navajo Nation has primacy to regulate PWSs
- ❑ Tribes, states, territories must implement and enforce federal standards
- ❑ May set more stringent standards

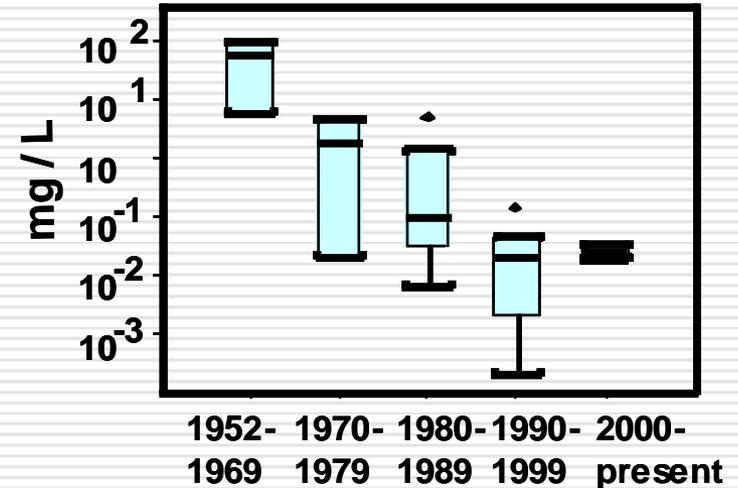


# Primary v. Secondary Standards

- ❑ National Primary Drinking Water Regulations (40 CFR 141)
  - Limits levels of contaminants that affect health
  - Public water systems must be monitored to ensure water quality complies with standards
    - ❑ Bacteriological tested every month
    - ❑ Heavy metals, radionuclides, pesticides, solvents tested every 1 to 3 years for small community systems, like NTUA
  - Violations of standards requires public notice
  
- ❑ National Secondary Drinking Water Regulations (40 CFR 143)
  - Non-enforceable guidelines
  - For contaminants that may cause skin or tooth discoloration (cosmetic effects) and or poor taste, odor and colors odor (aesthetic effects)

# Maximum Contaminant Levels (MCLs) — Health-based Standards

- Numerical limits established by USEPA, states or tribes
  - Based on continuing and evolving medical and scientific research
  - Ex: uranium in drinking water
- Intended to eliminate or reduce human health risks from ingestion of contaminants
- MCLs v. MCL Goals (MCLGs)
  - MCLs: “acceptable” risks
  - MCLGs – set at zero for contaminants that cause cancer



***Standards Evolve Over Time***  
— Regulatory limits on uranium in drinking water *decreased* over time as new health studies on uranium ingestion were conducted.

# Water Quality Units, Sampling Methods

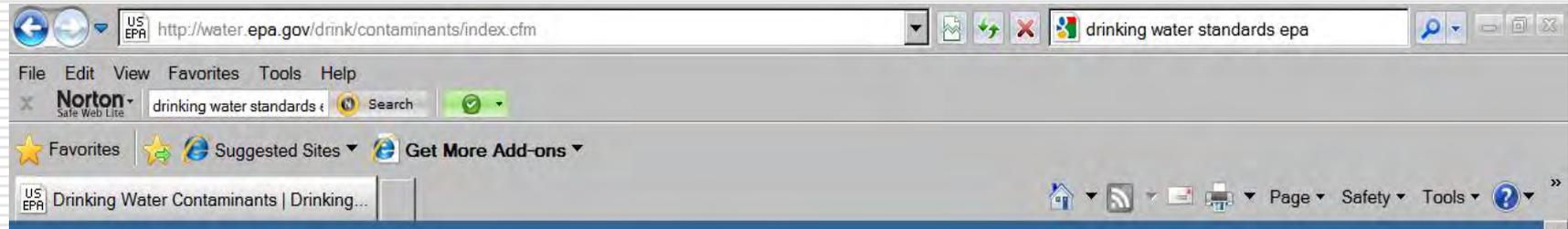
- General chemistry, metals, solvents
  - Milligrams per liter (mg/l), or parts per million (ppm)
  - Micrograms per liter ( $\mu\text{g/l}$ ), or parts per billion (ppb)
  - $1 \text{ mg/l} = 1,000 \mu\text{g/l}$
  
- Radioactivity
  - picoCuries per liter (pCi/l)
  
- USEPA-recommended sampling protocols
  - Field instruments, appropriate containers
  - QA/QC, chain-of-custody
  - Analyses at EPA-certified labs



Below: pH, temperature, salinity meter for field assessment; 1 liter plastic sample bottles



Find primary and secondary drinking water standards on the Internet at <http://water.epa.gov/drink/contaminants/index.cfm>



**If the U level is given in radioactivity (pCi/l), can it be converted to mass (µg/l)?**

**Yes! Multiply pCi/l by 1.5.**

**To convert mass to radioactivity, multiply ug/l by 0.67.**

**If the MCL for uranium is 30 micrograms per liter, what is the equivalent concentration in milligrams per liter? (Hint: divide by 1,000)**

United States Environmental Protection Agency

SCIENCE & TECHNOLOGY | LAWS & REGULATIONS | ABOUT EPA

### Drinking Water Contaminants

You are here: [Water](#) » [Drinking Water](#) » [Drinking Water Contaminants](#)

[Drinking Water Contaminants Home](#) | [Basic Information about Drinking Water Contaminants](#)

#### National Primary Drinking Water Regulations

National Primary Drinking Water Regulations (NPDWRs or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. Visit the list of regulated contaminants with links for more details.

- List of Contaminants & their Maximum Contaminant Level (MCLs)
- Regulation Development
- EPA's Regulated Contaminant Timeline (PDF) (1 pp, 86 K) (About PDF)
- National Primary Drinking Water Regulations- The complete regulations regarding these contaminants available from the Code of Federal Regulations Website

#### List of Contaminants & their MCLs

An alphabetical listing with links to fact sheets on the primary drinking water regulations.



**On this Page**

- National Primary DW Regulations
- List of DW Contaminants & MCLs
- National Secondary DW Regs
- List of Secondary DW Regulations

Internet | Protected Mode: On | 100%

# Measures of Overall Water Quality

**Total dissolved solids** — amount (milligrams) of minerals, salts or metals dissolved in a given volume (liter) of water, abbreviated mg/l.

**Conductivity** — the ability of water to conduct an electric current; the higher the dissolved solids, the higher the conductivity; units in microSiemens per centimeter ( $\mu\text{S}/\text{cm}$ )

	Very Good	Good	Fair	Poor to Saline
<b>Total Dissolved Solids (mg/l)</b>	300	500*	1,000	10,000
<b>Conductivity (<math>\mu\text{S}/\text{cm}</math>)</b>	470	780	1,560	15,650

\*USEPA secondary drinking water standard for TDS = 500 mg/l

# Have Unregulated Water Sources on the Navajo Nation Been Tested?

- ❑ Yes, some have been tested more than 1 time, other but many other water sources have never been tested
- ❑ Many windmills, dug wells, developed springs were constructed in the 1920s-1960s
- ❑ USEPA, USACE Abandoned Uranium Mine Atlas, 1994-2000
  - 225 water sources in Western Navajo only
- ❑ Recent testing; water quality data sources
  - Centers for Disease Control and Prevention
  - Diné Environmental Institute at Diné College
  - DiNEH Project in 20 Eastern Agency Chapters
  - Navajo EPA
  - Northern Arizona University in Western Navajo Agency
  - USEPA Region 9



# Major water contaminants found in Navajo Nation water sources and their principal health effects

<b>Bacteria</b>	<ul style="list-style-type: none"> <li>▪ Gastrointestinal effects, diarrhea, cramps, nausea, vomiting</li> </ul>
<b>Uranium</b>	<ul style="list-style-type: none"> <li>▪ Kidney toxicant; DiNEH study showed link to hypertension, immune and autoimmune disease</li> </ul>
<b>Arsenic</b>	<ul style="list-style-type: none"> <li>▪ Changes skin pigment by interacting with UV light;</li> <li>▪ Increases risk of skin, lung, and bladder cancer;</li> <li>▪ Can damage nerves, affect nervous system, kidneys, cardiovascular system</li> </ul>
<b>Selenium</b>	<ul style="list-style-type: none"> <li>▪ Contributes to bone, fingernail loss;</li> <li>▪ Affects circulation;</li> <li>▪ Causes numbness in fingers and toes; GI distress</li> <li>▪ Essential nutrient at low doses</li> </ul>
<b>Fluoride</b>	<ul style="list-style-type: none"> <li>▪ At high doses, causes mottling of teeth, disturbs bone formation</li> <li>▪ At low doses, aids in dental health</li> </ul>
<b>Nitrate</b>	<ul style="list-style-type: none"> <li>▪ Blue-baby syndrome — blocks delivery of oxygen to tissue</li> </ul>
<b>Gross alpha</b>	<ul style="list-style-type: none"> <li>▪ Increases cancer risk through ingestion of alpha particles;</li> <li>▪ Organ systems affected depend on specific radionuclides</li> </ul>
<b>Radium</b>	<ul style="list-style-type: none"> <li>▪ Causes bone cancer; may also affect teeth</li> </ul>

# SRIC ongoing compilation thru Nov. 2011: 376 Navajo Water Sources\* Tested Over Last Decade

Water Sources Exceeding at least 1 MCL at least 1 time	103	27.4%
Arsenic	65	17.3%
Uranium	38	10.1%
Gross alpha radioactivity	9	2.4%
Selenium	8	2.1%
Nitrate	7	1.9%
Radium-226+228	7	1.9%
Fluoride	6	1.6%
Thallium	5	1.3%
Lead	3	0.8%

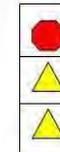
 STOP! Don't Use!

 USE CAUTION!

 OK TO USE!

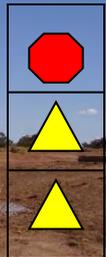
H	Human Use
D	Domestic Use
L	Livestock Use

example



**17T-545**  
**Steamboat Chapter**

As, U



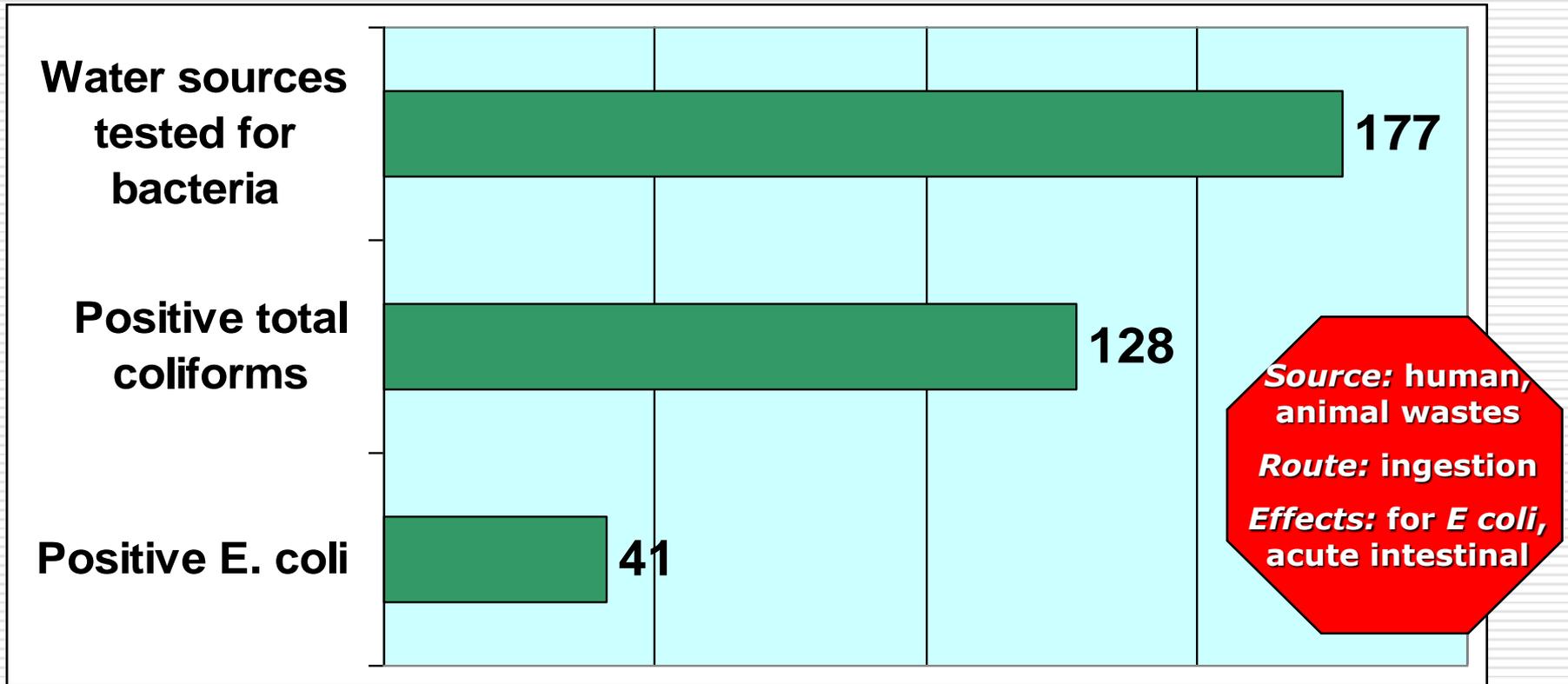
**17-8, Snakewell**  
**Greasewood Springs Chapter**

As, U



# Exposure to Pathogens

**Bacteria\* Were Present in About 72% of Unregulated Water Sources in Tests Done by CDC and NDOH in Central Navajo, 2006-2007**



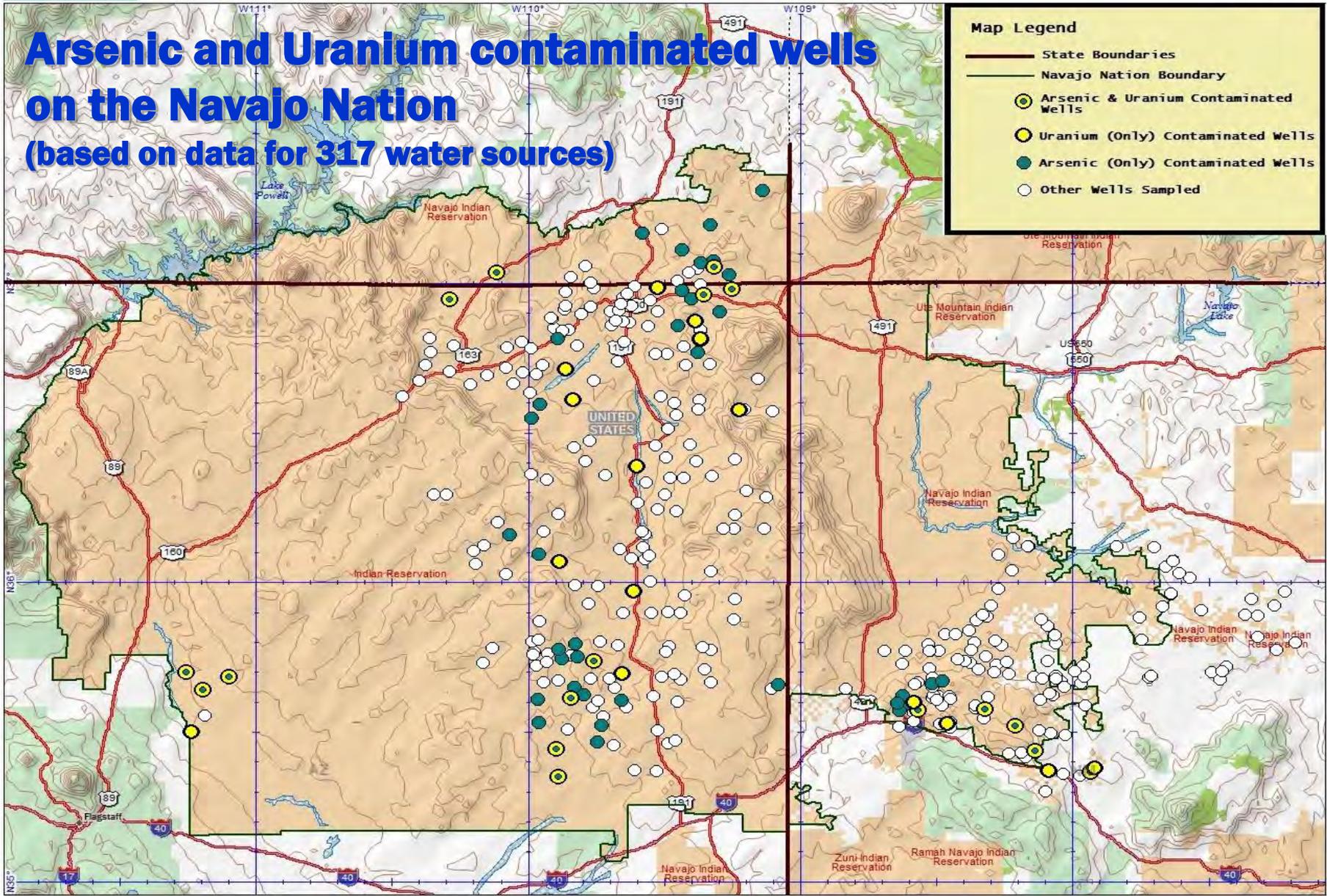
\*Based on presence of total coliforms; more harmful *E. coli* were present in about 23% of water sources. More information: <http://water.epa.gov/drink/contaminants/basicinformation/ecoli.cfm>.

**NAVAJO NATION POLICY:** Unregulated water sources are not to be used for human drinking.  
NO TESTING YET FOR PETROLEUM PRODUCTS OR PESTICIDES.

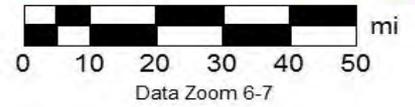
# Arsenic and Uranium contaminated wells on the Navajo Nation (based on data for 317 water sources)

**Map Legend**

-  State Boundaries
-  Navajo Nation Boundary
-  Arsenic & Uranium Contaminated Wells
-  Uranium (Only) Contaminated Wells
-  Arsenic (Only) Contaminated Wells
-  Other Wells Sampled

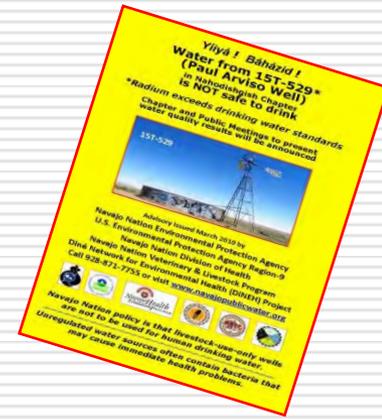


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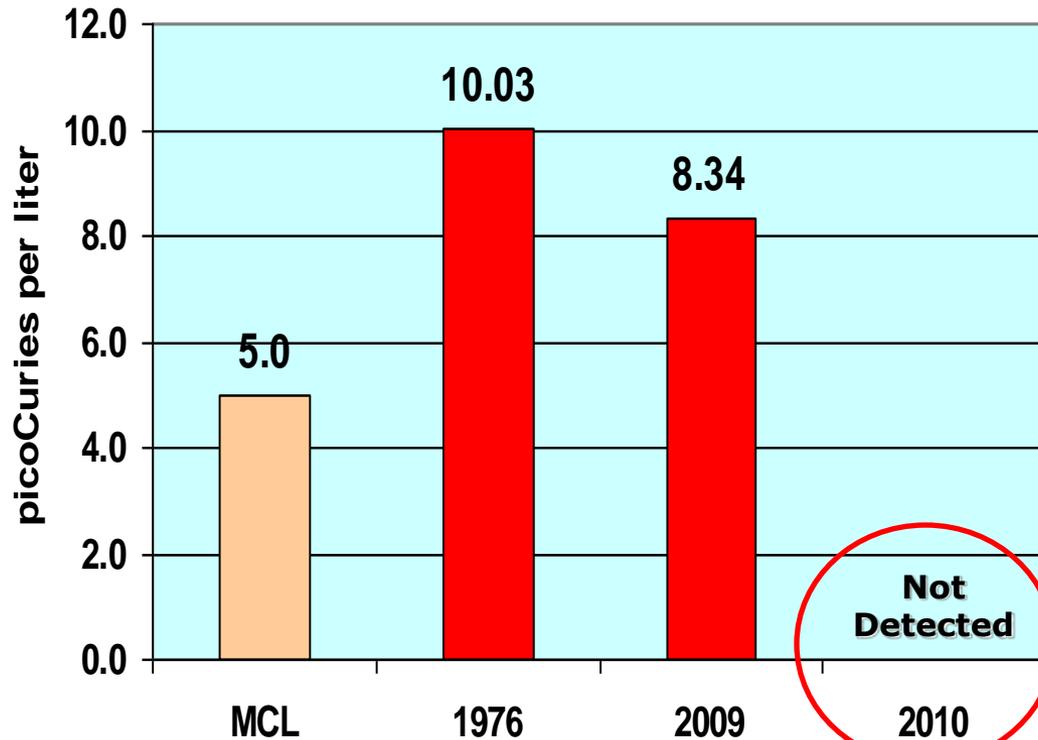


Can water quality change over time?

# Don't drink from 15T-529, it's contaminated with radium – or is it?



15T-529 Radium Levels



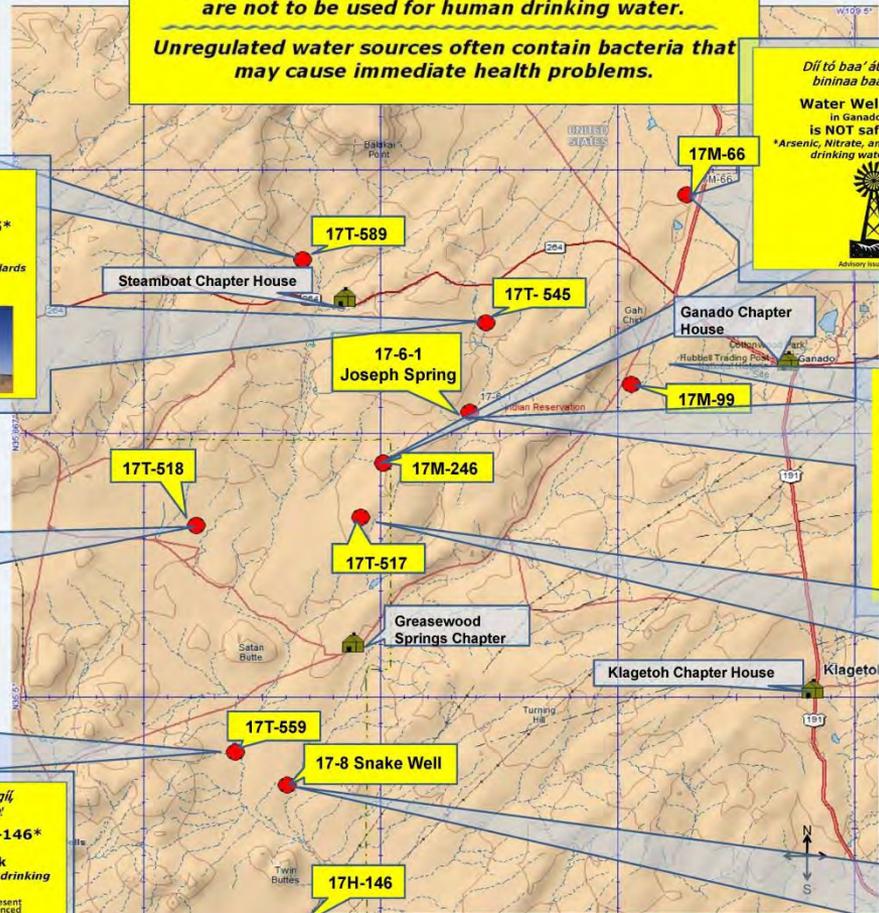
- Ingesting radium in water over long periods increases risk of bone cancer
- May be from natural deposits or uranium exploration
- 2010 test found NO radium!
- What's the prudent thing to do?



# Ft. Defiance Agency Water Poster

Fort Defiance Agency Wells with Maximum Contaminant Level Exceedances  
2007 – September 2010

**Navajo Nation policy is that livestock-use-only wells are not to be used for human drinking water.**  
**Unregulated water sources often contain bacteria that may cause immediate health problems.**



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Well 17T-589\***  
in Steamboat Chapter  
is **NOT** safe to drink  
*\*Arsenic exceeds drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Well 17T-545\***  
in Steamboat Chapter  
is **NOT** safe to drink  
*\*Arsenic exceeds drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Well 17T-518\***  
in Steamboat Chapter  
is **NOT** safe to drink  
*\*Arsenic exceeds drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Yíiyá! Báháázid!*  
**Water from Well 17T-559\***  
in Lower Greasewood Chapter  
is **NOT** safe to drink  
*\*Uranium and arsenic exceed drinking water standards*



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Well 17H-146\***  
in Indian Wells Chapter  
is **NOT** safe to drink  
*\*Arsenic and Uranium exceed drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water Well 17M-66\***  
in Ganado Chapter  
is **NOT** safe to drink  
*\*Arsenic, Nitrate, and Uranium exceeds drinking water standards*



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Well 17M-246\***  
in Steamboat Chapter  
is **NOT** safe to drink  
*\*Arsenic exceeds drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Yíiyá! Báháázid!*  
**Water from Well 17M-99\***  
in Cornfields Chapter  
is **NOT** safe to drink  
*\*Uranium exceeds drinking water standard*



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Joseph Spring Well 17-6-1\***  
in Steamboat Chapter  
is **NOT** safe to drink  
*\*Nitrate exceeds drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from Well 17T-517\***  
in Steamboat Chapter  
is **NOT** safe to drink  
*\*Arsenic exceeds drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



*Díí tó baa' át'e' hólónígíí, bininaa baa'ákonosin'*  
**Water from 17-8 Snake Well\***  
in Greasewood Spring Chapter  
is **NOT** safe to drink  
*\*Arsenic and Uranium exceed drinking water standards*  
Chapter and Public Meetings to present water quality results will be announced



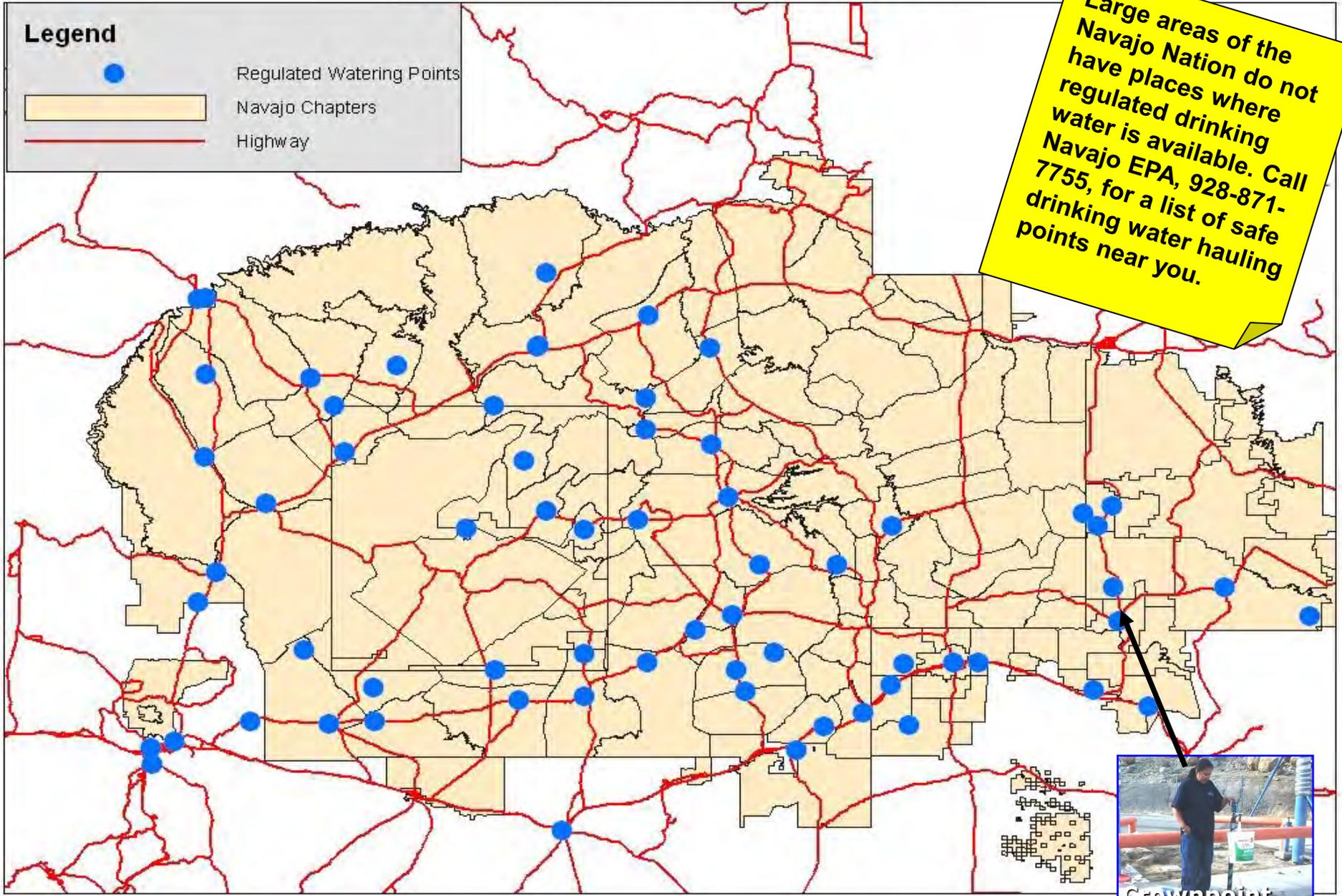
For a complete list of public water supply (PWS) locations and safe drinking water hauling stations, contact Navajo EPA at  
1-928-871-7755 or visit [www.navajopublicwater.org](http://www.navajopublicwater.org)



# Regulated Watering Points on the Navajo Nation

## Legend

-  Regulated Watering Points
-  Navajo Chapters
-  Highway



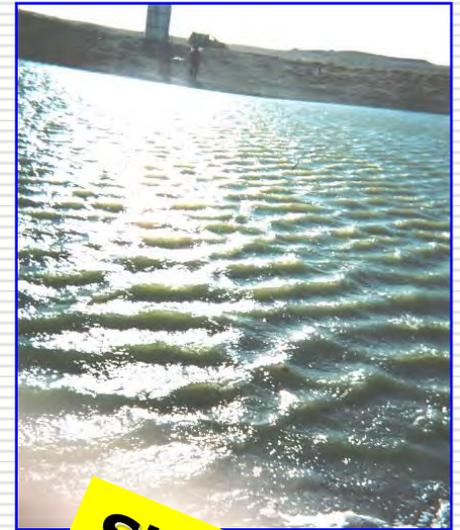
Large areas of the Navajo Nation do not have places where regulated drinking water is available. Call Navajo EPA, 928-871-7755, for a list of safe drinking water hauling points near you.



0 10 20 40 60 80 Miles

**Audience exercise:**

# **Would you drink this unregulated water?**



**Can you tell just by looking at the water?**

**Should you smell the water?  
Taste it?**

# Remember the measures of overall water quality



When tested in 2003, 2004 and 2008, water from Lime Ridge Well (16-4-10) was cold, clear and tasted good. Tests showed the water had average conductivity of 346  $\mu\text{S}/\text{cm}$  and average TDS concentration of 256 mg/l.

*Is this good water to drink?*

	Very Good	Good	Fair	Poor to Saline
<b>Total Dissolved Solids (mg/l)</b>	300	500*	1,000	10,000
<b>Conductivity (<math>\mu\text{S}/\text{cm}</math>)</b>	470	780	1,560	15,650

\*USEPA secondary drinking water standard for TDS = 500 mg/l

# Don't be fooled by appearance!

## Water in Lime Ridge Well is *not* good to drink – contaminated with uranium, radium, gross alpha

***Díí baa' ádahotłchijh!***  
**Water from Lime Ridge Handpump\*  
 (16-4-10) in Churchrock Chapter  
 is NOT safe to drink**

*\*Uranium, gross alpha radioactivity and radium exceed drinking water standards*



Advisory issued May 2008 by

Navajo Nation Environmental Protection Agency  
 U.S. Environmental Protection Agency Region-9  
 Navajo Nation Division of Health  
 Navajo Nation Veterinary & Livestock Program  
 Diné Network for Environmental Health Project  
 Call 928-871-7755 or 505-262-1862  
 or visit [www.navajopublicwater.org](http://www.navajopublicwater.org)



*\*Navajo Nation policy is that this well is for livestock use only and is not to be used for human drinking water.*



**WATER FROM THIS WELL IS NOT SAFE TO DRINK**

This water has been tested and found to exceed Navajo EPA and U.S.EPA human drinking water standards for uranium or other contaminants.

Navajo Nation policy is that livestock-use-only wells are not to be used for human drinking water.

**Lime Ridge Handpump Uranium Levels over Time Compared with MCL**

