HOUSEHOLD AND ROADSIDE SPRINGS
OUTLINE

• What is a groundwater spring and how does it differ from a groundwater well?

• How are springs developed for drinking water supplies?

• Why are groundwater springs important?

• What are the unique water quality issues associated with springs?

• What are roadside springs and how often are they used for drinking water?

• What types of water treatment are most often needed for springs?
Wells and Springs Utilize Groundwater Aquifers

40 inches of precipitation

40 inches of precipitation

Groundwater feeds streams

Aquifer #1

Aquifer #2

Impermeable layer (aquitard)

Groundwater Flow

Recharge (12-15 inches)

Spring

Well

Well

Penn State Extension
Household Spring Developments
Concentrated Spring Development

Figure 1. Development of a concentrated spring. (Adapted from Safeguarding Wells and Springs from Bacterial Contamination, Department of Agricultural and Biological Engineering, The Pennsylvania State University.)

Figure 2. Alternative collecting system and cross sectional view of concentrated spring. (Adapted from Safeguarding Wells and Springs from Bacterial Contamination, Department of Agricultural and Biological Engineering, The Pennsylvania State University.)
Figure 3. Spring development in a seep area. Note: Trench should be 18”-24” wide, extend 6” into (but not through) the impervious layer, and reach 4’-6’ beyond the seep area on each side. (Adapted from Safeguarding Wells and Springs from Bacterial Contamination, Department of Agricultural and Biological Engineering, The Pennsylvania State University.)
Components of Proper Spring Development

• Collection system to concentrate flow

• Reinforced and sealed concrete spring box

• Easily accessible for emptying and cleanout

• Method of disinfection (if necessary)
Spring Considerations

• They are susceptible to drought

• Most (> 75%) contain bacterial contamination and will need disinfection treatment (including roadside springs!)

• They are more easily contaminated by surface activities – watch land uses around spring
ROADSIDE SPRINGS
The Importance of Household Springs

- more than 30%
- 20 to 30%
- 10 to 20%
- 5 to 10%
- Less than 5%

Map of Pennsylvania showing the percentage of households with springs in different counties.
## Drinking Water Sources by County

<table>
<thead>
<tr>
<th>County</th>
<th>1980</th>
<th>1990</th>
<th>2000</th>
<th>% public</th>
<th>% private</th>
<th>% drilled wells</th>
<th>% hand-dug wells</th>
<th>% springs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler</td>
<td>26,272</td>
<td>29,648</td>
<td>33,024</td>
<td>50</td>
<td>50</td>
<td>88</td>
<td>4</td>
<td>9</td>
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<tr>
<td>Indiana</td>
<td>15,196</td>
<td>16,178</td>
<td>17,160</td>
<td>53</td>
<td>47</td>
<td>73</td>
<td>9</td>
<td>19</td>
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<tr>
<td>Lancaster</td>
<td>45,351</td>
<td>53,474</td>
<td>61,597</td>
<td>66</td>
<td>34</td>
<td>88</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>McKean</td>
<td>7,650</td>
<td>8,601</td>
<td>9,552</td>
<td>60</td>
<td>40</td>
<td>69</td>
<td>4</td>
<td>27</td>
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<tr>
<td>Mercer</td>
<td>18,145</td>
<td>19,400</td>
<td>20,655</td>
<td>60</td>
<td>40</td>
<td>87</td>
<td>5</td>
<td>7</td>
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<tr>
<td>Monroe</td>
<td>21,129</td>
<td>37,246</td>
<td>53,363</td>
<td>32</td>
<td>68</td>
<td>93</td>
<td>5</td>
<td>2</td>
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<tr>
<td>Perry</td>
<td>9,493</td>
<td>12,189</td>
<td>14,885</td>
<td>29</td>
<td>71</td>
<td>86</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>
“Colcom” Project Summary

• Detailed testing of private water wells and springs in northcentral PA

• Parameters
  – pH, TDS, Cl, Fe, Mn, TSS, Ba, Sr, hardness, methane/ethane, coliform, *E. coli*, SO4, Br, Ca, Mg, SPC, Al, alkalinity, acidity

• 689 water supplies (547 wells, 141 springs, 1 pond)

• All samples collected by professionals from DEP accredited labs between November 2011 and June 2012
PARTICIPANTS BY COUNTY  
(N=689)

<table>
<thead>
<tr>
<th></th>
<th>Clearfield</th>
<th>Jefferson</th>
<th>Elk</th>
<th>Centre</th>
<th>Clinton</th>
<th>Cameron</th>
<th>Potter</th>
<th>McKeans</th>
<th>Total</th>
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<tbody>
<tr>
<td>Water supplies</td>
<td>102</td>
<td>94</td>
<td>96</td>
<td>68</td>
<td>94</td>
<td>47</td>
<td>108</td>
<td>80</td>
<td>689</td>
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<tr>
<td>Drilled Wells</td>
<td>74</td>
<td>71</td>
<td>66</td>
<td>62</td>
<td>84</td>
<td>40</td>
<td>92</td>
<td>58</td>
<td>547</td>
</tr>
<tr>
<td>Springs</td>
<td>28</td>
<td>23</td>
<td>29</td>
<td>6</td>
<td>10</td>
<td>7</td>
<td>16</td>
<td>22</td>
<td>141</td>
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<tr>
<td>Workshop attendees</td>
<td>100</td>
<td>17</td>
<td>116</td>
<td>41</td>
<td>95</td>
<td>41</td>
<td>85</td>
<td>86</td>
<td>581</td>
</tr>
</tbody>
</table>

Approximately 75% of water supply owners attended an educational workshop.
PSU Water Testing Project
(Eight North Central PA Counties)

547 water wells
141 springs

% with Bacteria

Springs
Hand-Dug Wells
Drilled Wells

Type of Water Supply

Coliform Bacteria
E. coli Bacteria
### Water Quality in Springs vs. Wells
#### Eight Northcentral PA Counties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Springs (n=141)</th>
<th>Wells (n=547)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.13</td>
<td>6.71</td>
</tr>
<tr>
<td>Alkalinity (mg/L)</td>
<td>24.1</td>
<td>75.1</td>
</tr>
<tr>
<td>Hardness (mg/L)</td>
<td>42.7</td>
<td>87.4</td>
</tr>
<tr>
<td>Chloride (mg/L)</td>
<td>7.2</td>
<td>34.2</td>
</tr>
<tr>
<td>Total Suspended Solids (mg/L)</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Total Dissolved Solids (mg/L)</td>
<td>75.9</td>
<td>170.3</td>
</tr>
<tr>
<td>Coliform bacteria (#/100mL)</td>
<td>174</td>
<td>67</td>
</tr>
<tr>
<td><em>E. coli</em> bacteria (#/100mL)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Barium (mg/L)</td>
<td>0.04</td>
<td>0.19</td>
</tr>
<tr>
<td>Iron (mg/L)</td>
<td>0.34</td>
<td>1.99</td>
</tr>
<tr>
<td>Manganese (mg/L)</td>
<td>0.05</td>
<td>0.28</td>
</tr>
<tr>
<td>Methane (mg/L)</td>
<td>0.12</td>
<td>0.44</td>
</tr>
</tbody>
</table>
Roadside Springs - Background

- Number and use of roadside springs is largely unknown

- Referrals from physicians and homeowners with gastrointestinal issues has increased
  - High % consume spring water

- Summer 1990
  - 13 of 23 roadside springs in northeast PA found to contain coliform bacteria

- Users of roadside springs are passionate!
Giardiasis Illness Rates

PA County Health Profiles, 2013, PA Department of Health
Annual Cases per 100,000
Roadside Spring Users are Passionate!
FREQUENCY OF ROADSIDE SPRING USE
SURVEY OF 1,034 RESIDENTS

Never, 70%
Every few years, 12%
Yearly, 6%
Few months, 4%
Monthly, 5%
Weekly, 3%
WHY ARE ROADSIDE SPRINGS USED?

Of the 30% who use roadside springs, why did they use them?

Common “Other” Uses
- Water for house plants/garden
- Water for aquarium
- Drinking while hiking/biking

- Tastes better
- "Natural"
- Camp/seasonal use
- Convenience
- Bad home water
- Other
2013-15 Roadside Spring Research

- Single samples collected from 35 roadside springs by 7 Extension Educators in 2013.
- Most springs located in PennDOT or local road right-of-ways
- Samples analyzed by Penn State laboratory for 20 inorganic and microbiological parameters
- Seasonal and more detailed testing of 10 springs in 2014-15.
Roadside Springs Locations

△ = roadside springs sampled in 2013
〇 = roadside springs re-tested in 2014-15 for additional parameters
WHAT DO THEY LOOK LIKE?

Surface water?

Extensive infrastructure

Beautiful stonework

Very inviting
Liability Concerns
Additonal Roadside Spring Testing

- 10 roadside springs which contained *E. coli* bacteria in 2013 were selected for seasonal water quality testing during 2014-15.
  - Samples delivered to Penn State Ag Analytical Lab within 24 hours for analysis of 20 inorganic/microbiological parameters.

- 8 springs tested for Giardia and Crypto in Fall 2014 and Spring 2015 by Analytical Services, Williston, VT
  - 10 Liter delivered within 24 hours
  - EPA Method 1623.1
## Giardia and Cryptosporidium

*(Oocysts per L)*

<table>
<thead>
<tr>
<th>Spring</th>
<th>September 2014</th>
<th>March 2015</th>
<th>Coliform Bacteria</th>
<th>E. coli Bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycoming</td>
<td>5.28</td>
<td>0.09</td>
<td>62</td>
<td>0</td>
</tr>
<tr>
<td>Orviston</td>
<td>0</td>
<td>0</td>
<td>59</td>
<td>5</td>
</tr>
<tr>
<td>McKean</td>
<td>0</td>
<td>6.49</td>
<td>&gt;201</td>
<td>0</td>
</tr>
<tr>
<td>Rippling Run</td>
<td>5.7</td>
<td>0</td>
<td>&gt;201</td>
<td>0</td>
</tr>
<tr>
<td>Ridge Road</td>
<td>0</td>
<td>6.29</td>
<td>&gt;201</td>
<td>8</td>
</tr>
<tr>
<td>Warren</td>
<td>4.07</td>
<td>6.75</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>Heffley</td>
<td>6.32</td>
<td>0</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>Laurel Forge</td>
<td>0</td>
<td>6.82</td>
<td>&gt;201</td>
<td>0</td>
</tr>
</tbody>
</table>
Seasonal Variability of Coliform Bacteria

Coliform Bacteria (colonies per 100 mL)

- Lycoming
- Orviston
- McKean
- Rippling
- Ridge
- Warren
- Heffley
- Laurel
- Waterville
- Middlesex

Dates:
- 6/1/2014
- 7/1/2014
- 8/1/2014
- 9/1/2014
- 10/1/2014
- 11/1/2014
- 12/1/2014
- 1/1/2015
- 2/1/2015
- 3/1/2015
## Typical Spring Treatment

<table>
<thead>
<tr>
<th>Process</th>
<th>Treats</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV light</td>
<td><strong>Bacteria</strong></td>
</tr>
<tr>
<td>Chlorine</td>
<td><strong>Bacteria</strong>, iron, sulfur</td>
</tr>
<tr>
<td>Softener</td>
<td>Hardness, some iron</td>
</tr>
<tr>
<td>Carbon filter</td>
<td>Organics, radon, sulfur</td>
</tr>
<tr>
<td>Sediment filter</td>
<td><strong>Turbidity</strong></td>
</tr>
<tr>
<td>Oxidizing filter</td>
<td>Metals, sulfur</td>
</tr>
<tr>
<td>Acid neutralizing filter</td>
<td>Low pH, <em>corrosive water</em>, lead, copper</td>
</tr>
</tbody>
</table>

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**Images:**
- Water flow through a filter system.
- Filter components such as limestone chips or calcite and gravel.

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**Penn State Extension**
Springs are still common sources of drinking water accounting for 20% or more of the private water supplies in 17 counties.

Roadside springs are used routinely by 12% of the population.

Nearly all springs fail drinking water standards, most frequently for bacteria, corrosivity and sediment.

The consumption of untreated spring water represents a significant public health risk.

Springs typically require treatment with disinfection and perhaps acid neutralizing filters (where metal plumbing exists) and sediment filters.
Spring Development and Protection

Springs occur wherever groundwater flows out from the earth’s surface. Springs typically occur along hillside, low-lying areas, or at the base of slopes.

A spring is defined when natural pressure forces groundwater above the land surface. This can occur at a distinct point or over a large seepage area. Springs are sometimes used as water supplies and can be a reliable and relatively inexpensive source of drinking water if they are developed and maintained properly.

Spring Development Considerations

When considering using a spring as your source of drinking water, it is important to ensure that the rate of flow is reliable during all seasons of the year. Spring flow that fluctuates greatly throughout the year is an indication that the source is unreliable or may have the potential for contamination. It may be possible to learn about historical spring flow from the previous owner or a neighbor.

Water quality is also important to consider before using a spring as a water supply. Before developing the spring, collect a sample of water and have it analyzed at a local water testing laboratory to ensure that it can be efficiently and economically treated to make it safe for human consumption (see Water Facts #9: Testing Your Drinking Water for a list of tests to have run). Springs are highly susceptible to contamination since they are fed by shallow groundwater, which usually flows through the ground for only a short period of time and may interact with surface water. For this reason, most springs will need some treatment before the water is considered a safe source of drinking water. Testing will help determine exactly how much treatment will be necessary and may help determine if other sources of water would be more economical.

Preparing for Spring Development

Since springs are usually fed by shallow groundwater, water quantity may be an issue during certain times of the year. If possible, the flow rate for your spring should be monitored for an entire year, but it is most critical to measure the flow rate during late summer and fall when groundwater levels and spring flows are usually at their lowest. Springs used for drinking water supplies should yield at least 7 gallons per minute throughout the entire year unless water storage is going to be used. The amount of water you will need from your spring depends entirely on your household’s daily water needs. Water needs for an individual household vary depending on water use, water storage, and water-saving devices within the home. However, the average home will require approximately 50 to 75 gallons of water a day per person. To determine your household water needs, consult Water Facts #3: Water System Planning—Determining Water Needs, located at the Penn State Extension Water Quality website.

The flow rate of a spring can be tested by digging a 5-gallon bucket into the slope of the spring and allowing the water to flow into the bucket. Determine the flow rate by timing how long it takes the water to fill the bucket. Obtain a sample collection container from a certified water lab and send a sample of the spring water to the lab for water quality testing. A list of labs is available at the Penn State Extension Water Quality website or from your local county extension office. You can start development of your spring once you determine that the quantity and quality are acceptable.

Spring Development

A spring can be developed into a drinking water supply by collecting the discharged water using a bucket and running the water into some type of sanitary storage tank. Protecting the spring from surface contamination is essential during all phases of spring development. Springs can be

http://extension.psu.edu/natural-resources/water/drinking-water/cisterns-and-springs/spring-development-and-protection
Roadside Springs

Roadside springs are pervasive across many parts of Pennsylvania. Residents seek out these springs when travelling or to avoid the use of aesthetically inferior private or public water sources that supply their home.

What is a Spring?
Springs occur wherever groundwater flows out from the earth’s surface. Springs typically occur along hilltops, low-lying areas, or at the base of slopes. A spring is formed when the water table intersects the ground surface due to geological or topographical factors. This can occur at a distant point or over a large seepage area. Spring water is groundwater, but it is groundwater that is close to the surface and more open to surface contamination than typical well water.

Household springs are used by up to 21% of residents in some counties and are most commonly used in rural homes in northcentral Pennsylvania (Fayette, Forest, and Clinton Counties). Household springs must be developed and maintained properly for drinking water use.

Roadside springs are especially visible to travelers and may be accessed by a large number of local residents and travelers. Roads cut often intersect shallow, natural springs allowing the groundwater to flow to the surface. Many roadside springs have stone or concrete structures and metal or PVC pipes built by someone years or decades ago. The springs may be on public or private property. The vast majority of roadside springs are not regularly tested or treated, and a few municipalities have posted warning signs about the lack of testing.

Understanding the actual source of water for a roadside spring can be important. One roadside spring we investigated looked very much like a roadside spring at the collection point, but when following the pipe back up the hill, the end of the pipe was sitting in a stream and was collecting surface water, and not groundwater.

http://extension.psu.edu/natural-resources/water/drinking-water/cisterns-and-springs/roadside-springs
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  [https://www.surveymonkey.com/s/webinarview](https://www.surveymonkey.com/s/webinarview)

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Next Advanced Topic Webinar

- **Water Well Yield – Planning, Measuring and Improving on Well Flow**
- **Wednesday, December 9, 2015**
Questions?