Sustainable Water Management

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What is Sustainable Water Management?

- Ability to have sufficient supply of quality and quantity water.
- Quality of water
  - Safe to drink and use
- Quantity of water
  - Sufficient to meet your personal and farming needs
  - Understanding the total farm system and managing accordingly
  - Using an appropriate amount without causing water shortages for others

Understanding the total farm system

- In Sustainable water management we try to think holistically
  - Everything is inter-related
  - Economically viable
  - Environment integrity
  - Socially acceptable
  - Other

Water Needs

- Private water system capacity needs to be large enough to supply daily water need in 10 to 12 hours. Some designers assume 5 to 8 hours to supply daily need.
- Maximum pump size needs to be slightly smaller than maximum well yield capability.
- Can a well system be constructed to meet water need for location?

Determining How Much is Needed

- Average rule of thumb for each person – 100 gallons per day for kitchen, laundry and bathroom use.
- Example:
  - Family of 5 people (2 adults and 3 children)
  - 5 people x 100 gallons x 365 days = 182,500
  - Will a well supply what is needed each day
  - If using a precipitation catchment system:
    - 182,500/30 in of rain/yr = 6,083 must be captured each time it rains an inch. Each sqft of roof surface yields .6-.7 gallons of water for a 1 inch rain you would need over 10,000 sqft of catchment area and a very large holding tank.

But is that all we need water for?

- Lawn and garden –
  - 600 gallon per day during growing season for 1,000 sqft garden
  - 600 gallon per day during dry season per 1,000 sqft of lawn
- Recreation
  - Maintaining swimming pool levels per 100 sqft surface area 30 gallons per day

Outdoor use for water supply

- Water needs for 1000 sqft garden during dry season 600 gallons per day x average of 20 days = 12,000 gallons for dry season

- Water needs for 1000 sqft lawn during dry season 600 gallons per day x average of 20 days x sqft of yard divided by 1000 sqft = gallons to water yard.

Example of additional water needs:

- Basic rural activities
  - 1,000 sqft garden and flowerbed
  - 300 x 100 sqft yard area
  - 20 ft x 30 sqft Swimming pool

- 1,000 sqft garden during dry season 600 gallons per day x average of 20 days = 12,000 gallons for dry season

- Water needs to water 30,000 sqft of lawn/1,000sqft = 30 x 600 gallons x 20 days 360,000 = gallons to water yard.

- Swimming pool surface area 600sqft/100 sqft = 3 x 30 gal x 90 days of use = 8,100 gallons to keep pool filled

- Total other water needs for the year would be 380,100 gallons

  - Water use can vary dramatically

  - Can we justify all this water use or just the part that is critical

Livestock Water Needs

Type of animal	Water needs 50 degree day	Water needs 90 degree day	Average cow herd 50 head
Dry beef cattle	8-12	20-30	
Lactating Beef cow	12-20	25-35	
Lactating Dairy cow	20-30	30-40	
600 # calf	6-9	10-15	

Water Resources

- Determining how much water you have may determine what you are capable of doing.
- Identifying how you can increase or improve water quality and quantity provides opportunities for growth.
- Don’t under estimate what you need.

What is Affecting Our Water Resources (Quality/Quantity)?

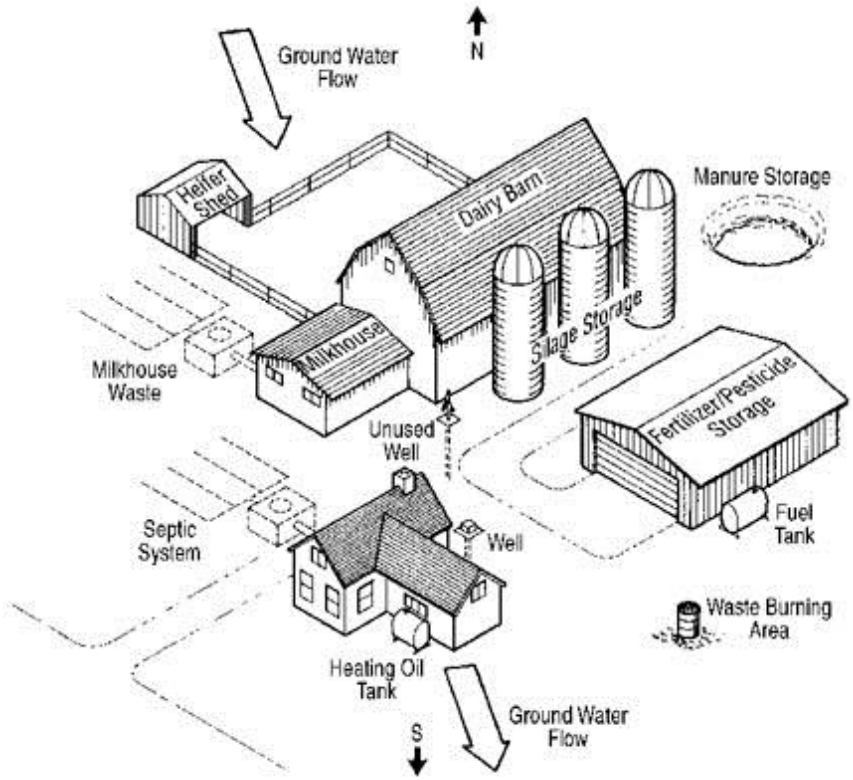
Natural Effects - Water availability is affected by:

- Rainfall – amounts, frequency, duration
- Temperature
- Evaporation rates
- Geology and soil characteristics (chemical & physical)
- Vegetation type
- Percolation and runoff

Human Effects:

- Population growth and the demands associated with growth will reduce water availability per person and stress biodiversity
- Land use decision-making
- Industry requirements

Potential Water Quality Concerns Around the Farm



Improving Water Quantity

- Management practices that are effective at increasing infiltration
  - Native warm season grasses
  - Long-term cover/cover crops
  - Ripping of soil layers
- Surface water storage
  - Ponds/lakes
  - Rain barrels
  - cisterns
- BMPs to effectively reduce water use
  - Scheduling crop irrigation for efficiency and need
  - Cover crops

Production and Sustainability

What practices would enhance water resource protection:

strip cropping, managed intensive grazing, no-till farming, agro-forestry practices, variable rate application, increase organic matter, cover crops, improved soil health, etc

A variety of practices that can protect water quality and quantity, create less runoff and increase more infiltration and groundwater storage create a sustainable component to farming operations of all sizes

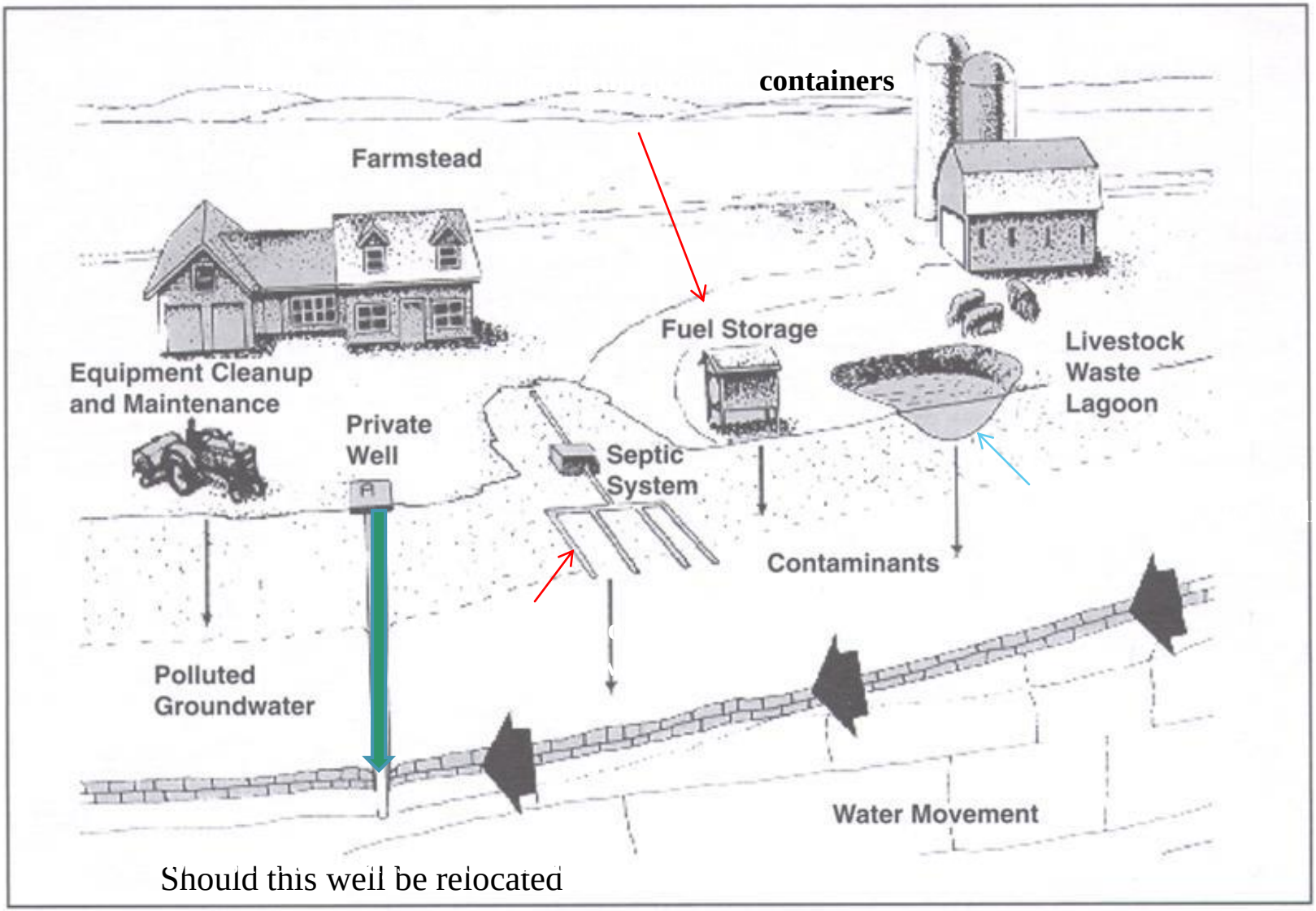
Types of Water Supplies

- Wells
- Cisterns
- Springs
- Ponds
- Streams
- Public Water Supplies

MWPS -14 Private Water Systems Handbook

https://www-mwps.sws.iastate.edu/catalog/country-rural-living/private-water-systems-handbook

1. Wells – Site Selection

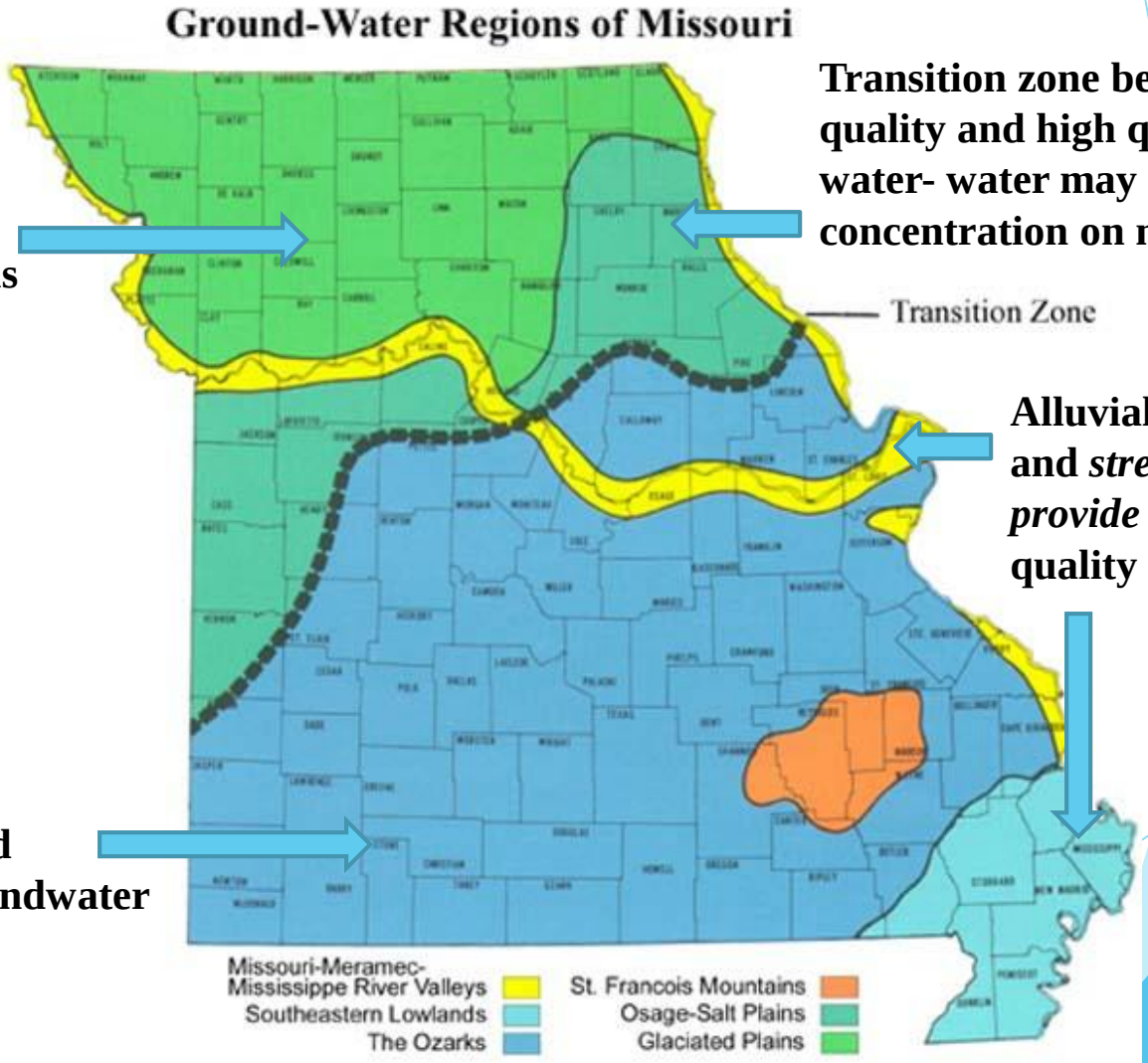


Should this well be relocated

Figure 1. Many potential groundwater contaminants exist around the farmstead.

Missouri Groundwater Regions

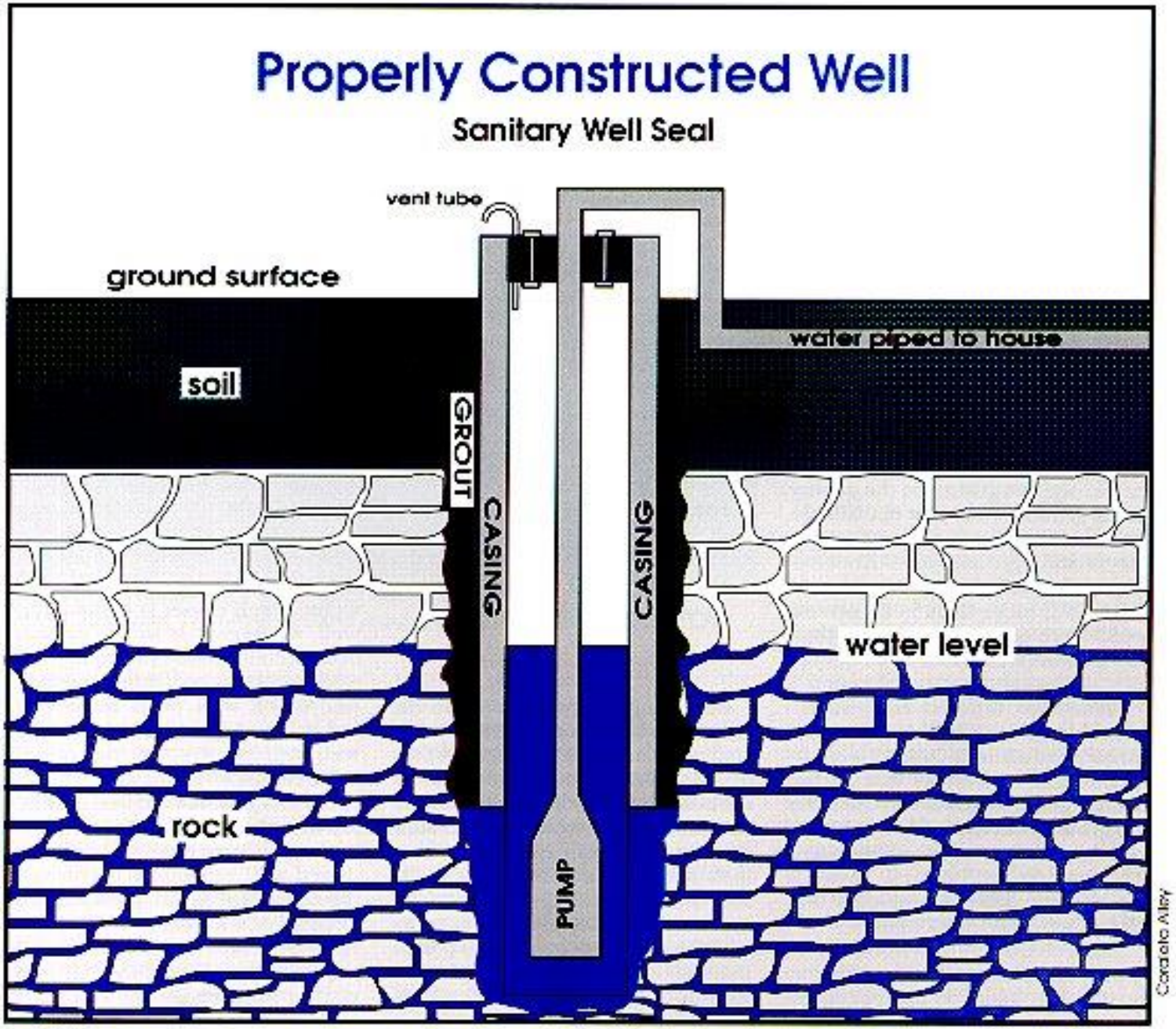
Poor deep ground water quality and quantity - most wells 35-55 feet deep



Transition zone between low quality and high quality ground water- water may have high concentration on mineral and salts

Alluvial soils along rivers and *streams and flood areas provide high quantity* and quality of ground water

High quality and quantity of groundwater



The important elements in a properly constructed well include the proper amount of casing, grout and a tight seal. These items all help to ensure that ground water is not polluted by rainwater or other hazardous liquids.

Websites for Water Well Decisions

- Two tools from DNR-Division of Geology and Land Survey - One identifies monitoring wells and levels of recharge, the other allows you to locate wells in a given area that were drilled after 1987 (with minimal information) and look at depth of well, depth of pump, what types of materials were drilled through and at what depth, and gallons per minute.

Monitoring Wells Info

- Monitoring well website: http://dnr.mo.gov/env/wrc/groundwater/education/gwwhymonitor.htm -This page provides a variety of information but at the lower part of the page you need to go to the link:
- Interactive map to groundwater observation well information and real time data is at
- http://dnr.mo.gov/env/wrc/groundwater/gwnetwork.htm

Well Information Management System (WIMS)

- A database of all wells that have been built since 1987 at http://dnr.mo.gov/geology/geosrv/wellhd/

1. Under the section Online Services "click" on Well Information Management Systems http://dnr.mo.gov/mowells
2. Go to next page and "click" on Search the Well Information Management System (WIMS)
3. Put in information you have (the more info you have the narrower the search) – names of people and addresses need to be exactly as to when the well was registered
4. Click on the word SEARCH and to get results of wells in that area.

2. Cisterns

- Basics
  - Should be water tight with smooth interior surfaces
  - Can be made from a variety of materials
    - Concrete, coated steel, fiberglass, plastic, etc.
  - Exclusion of light to prevent algae growth
  - Located where surrounding slope will divert surface water run in and contamination
  - Rainfall events will determine how often cistern is refilled and what size it may need to be
  - Need to size it for a minimum of a 3 month supply
  - Water should be continuously filtered & chlorinated for domestic use

2. Cisterns

- What do you need to know to determine if a cistern will work for you?
  - What are your yearly water needs
  - Is there sufficient rainfall to take care of yearly needs
  - How large must a cistern be to take care of the worst drought conditions
- Information needed to determine how much a cistern catchments system may supply your needs:
  - Minimum yearly rainfall recorded for the area
  - Longest period of drought recorded for the area
  - Roof area you have available for drainage into the cistern

Determining water availability and size of cistern

- Determine daily or weekly needs and multiply accordingly to get yearly needs
- A = minimum annual rainfall for your area
- B = Multiply 0.6 gallons per sqft by the number of sqft of catchment area you have available
- C = A x B gallons available for collection in one year.
- Compare yearly needs with gallons available (c) to determine if you can collect enough water.
- This will also determine the size cistern you may want to install.

Determining How Much is Needed

- Average rule of thumb for each person – 100 gallons per day for kitchen, laundry and bathroom use.
- Example:
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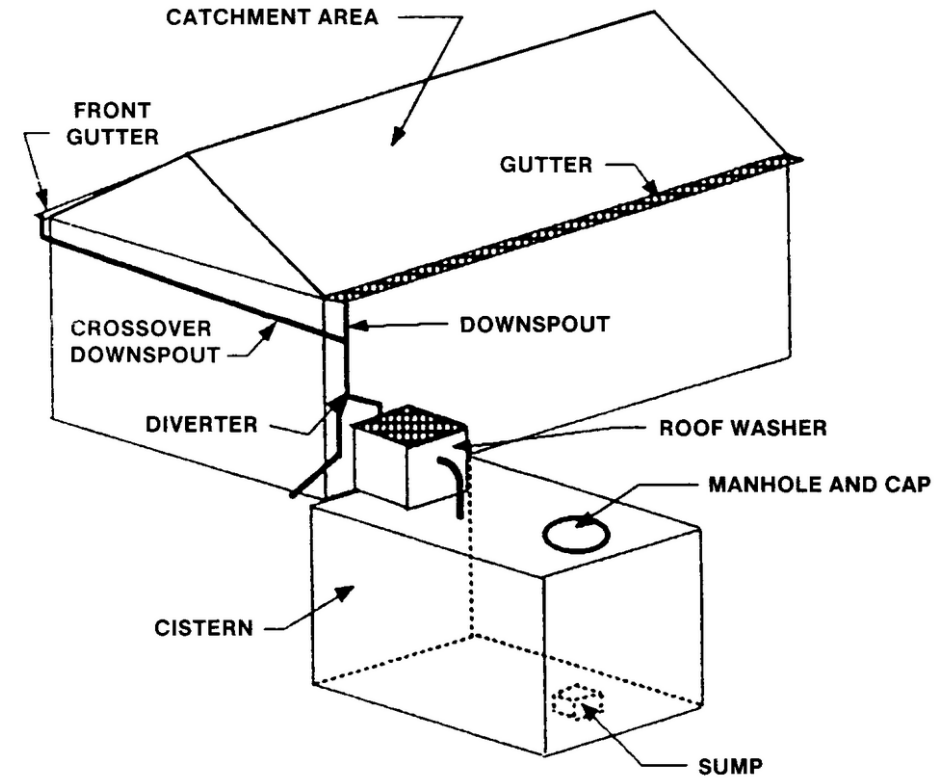
2. Cisterns 2

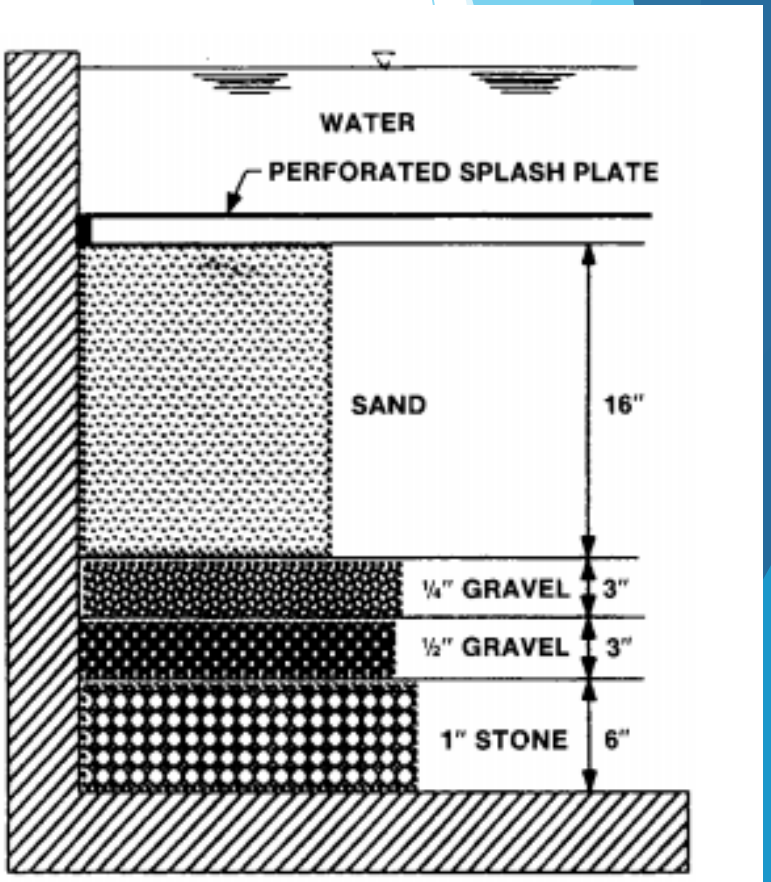
- Each square foot of surface areas will produce between 0.6 and 0.7 gallons of useable water.
- 1500 sq.ft. home yields approximately 1,000 gallons roof runoff per inch of rain
- 1500 sqft home x 0.6 inches of water per sqft per inch of rain = 900 gallons.
- Look at water needs to determine size of cistern.

Basic components of a cistern and catchment system



2. Cisterns

- Sand and Gravel Filter
  - Removes unwanted materials
  - Reduce acidity of rain water
  - Top 1-2 inches of sand must be replaced regularly
  - Backwash so it won't clog

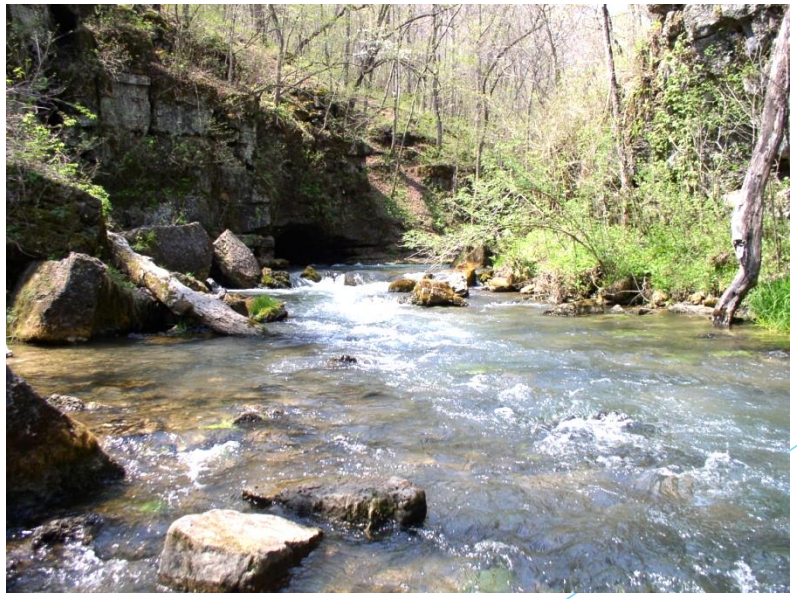


2. Cisterns

- Before a cistern is used, it should be cleaned and disinfected.
  - scrub the interior with a solution of 1/4 cup of 5% chlorine bleach mixed in 10 gallons of water.
  - Hose down the interior until the chlorine odor disappears and then drain.
  - Clean at least every five years. This might be needed more often where blowing dust, leaves and fireplace or stove ash fall on the roof.
  - Inspecting and cleaning the gutters, downspout, roof washer and filter will help to keep a cistern cleaner.
  - Cistern water is only as clean as the cistern itself and the water allowed to enter.

3. Springs

- A spring is groundwater that emerges to the surface naturally. Generally along hillsides, at the base of slopes or in low areas.
- If for human use springs should be treated continuously and tested regularly.



3. Springs 1

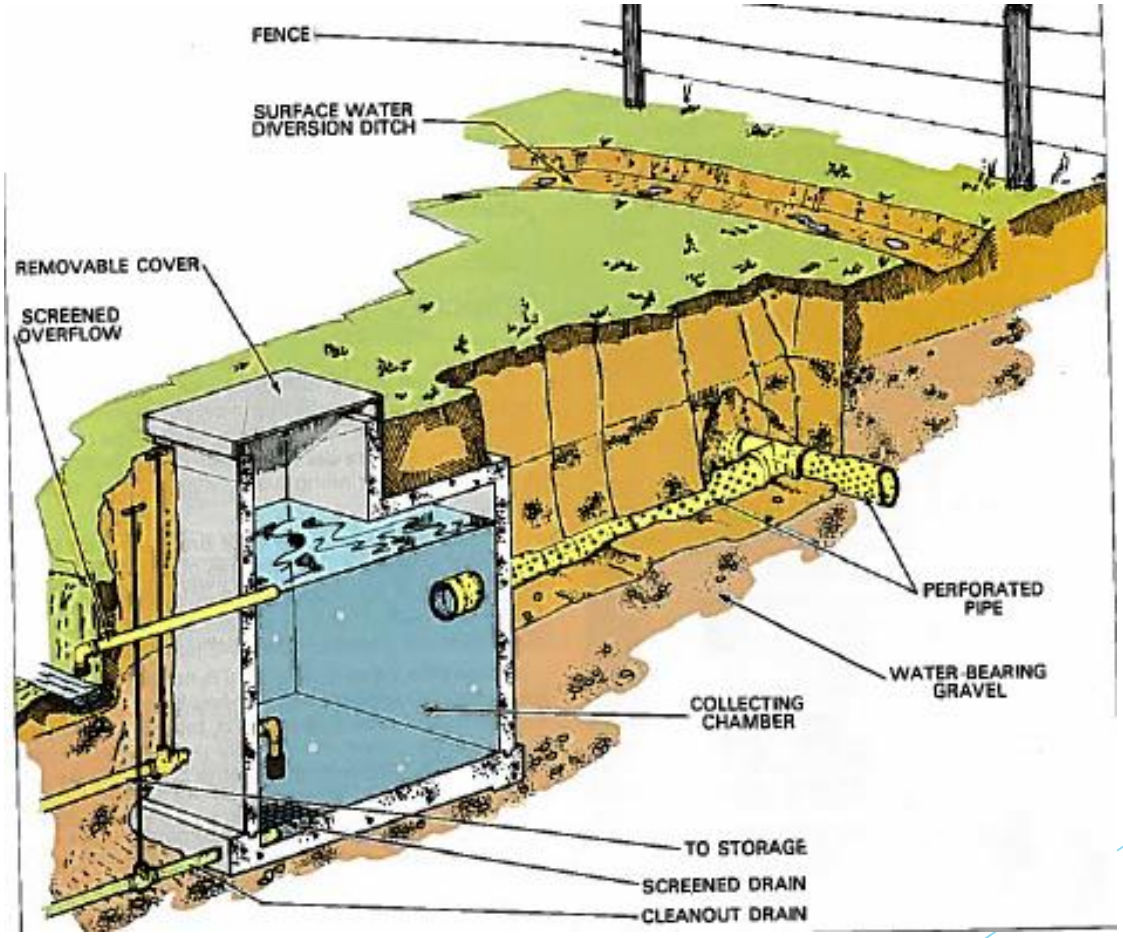
- Flow usually driven by seasonal rainfall and may not be reliable year round
- Upslope springs usually first to dry up in summer
- May be high in sulfur, iron or other minerals
- Generally require treatment before used for human consumption
- May need to put in a storage tank to meet daily or weekly needs.

3. Springs 2

Springs can be harnessed and protected from some outside influences.

3. Springs

- Springs with constant year round flow are generally cleaner water and are more reliable
- Determining flow or yield from a spring will help you decide if the spring is a reliable source for your needs.
- Spring development generally requires
  - A spring box for storage that has a tight fitting lid or cover
  - Porous collection pipe
  - May need to be excavated for capture and retention


FENCE
SURFACE WATER DIVERSION DITCH
REMOVABLE COVER
SCREENED OVERFLOW
PERFORATED PIPE
WATER-BEARING GRAVEL
COLLECTING CHAMBER
TO STORAGE
SCREENED DRAIN
CLEANOUT DRAIN

4. Ponds

- Generally not the first choice for human water supply.
- Must be continuously treated, disinfected and monitored. May need the following:
  - Screened intake chlorinator
  - Filter
  - Settling equipment
  - Storage tank
  - Pump
  - Pressure tank
  - Chemical coagulation
  - Additional filters

- Entire watershed should be protected to reduce pollutants
- Recreation use is possible

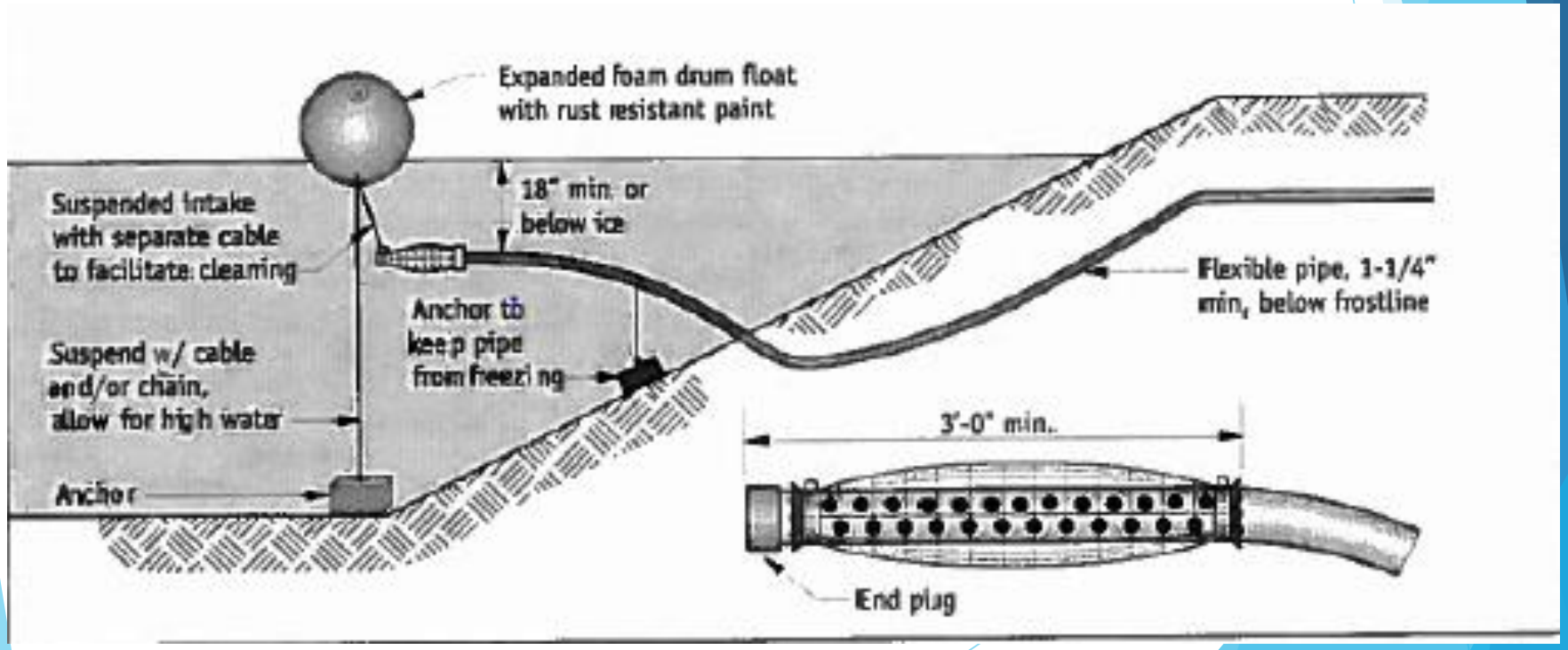
4. Ponds – Site Selection

- Must be sized to the watershed and expected use
  - If the sole supply of water it should hold 2-3 years supply (approximately 200,000 gallons)
  - Pond 8' deep, 100' dia. holds 280,000 gallons of water when full
  - 1 acre of pond surface area per 10-15 acres of watershed
  - One-half of water volume is usable while rest is seepage & evaporation
  - If watershed drainage is too small the pond cannot be maintained and may go dry during periods of drought

4. Ponds – Water Quality

- Grass between 8”-24” high will filter sediment and nutrients from runoff water

Pond as water source



5. Streams

- Flow usually driven by seasonal rainfall
- Hard to control water quality
- Can be high in sediment
- Requires high level of treatment as other surface water sources.

5. Streams

- Many of the same issues identified with ponds and springs apply to streams when looking at water quantity, flow and water quality considerations.
- Water purity, water supply and water availability are concerns

Meeting Water Demands

- If well system can not provide daily need, re-evaluate operation's goals and adjust water use or find additional water supply capability.
- If water source can deliver daily need but not meet peak demand, then an intermediate water storage system needs to be designed and installed.

Intermediate Storage shown from a well

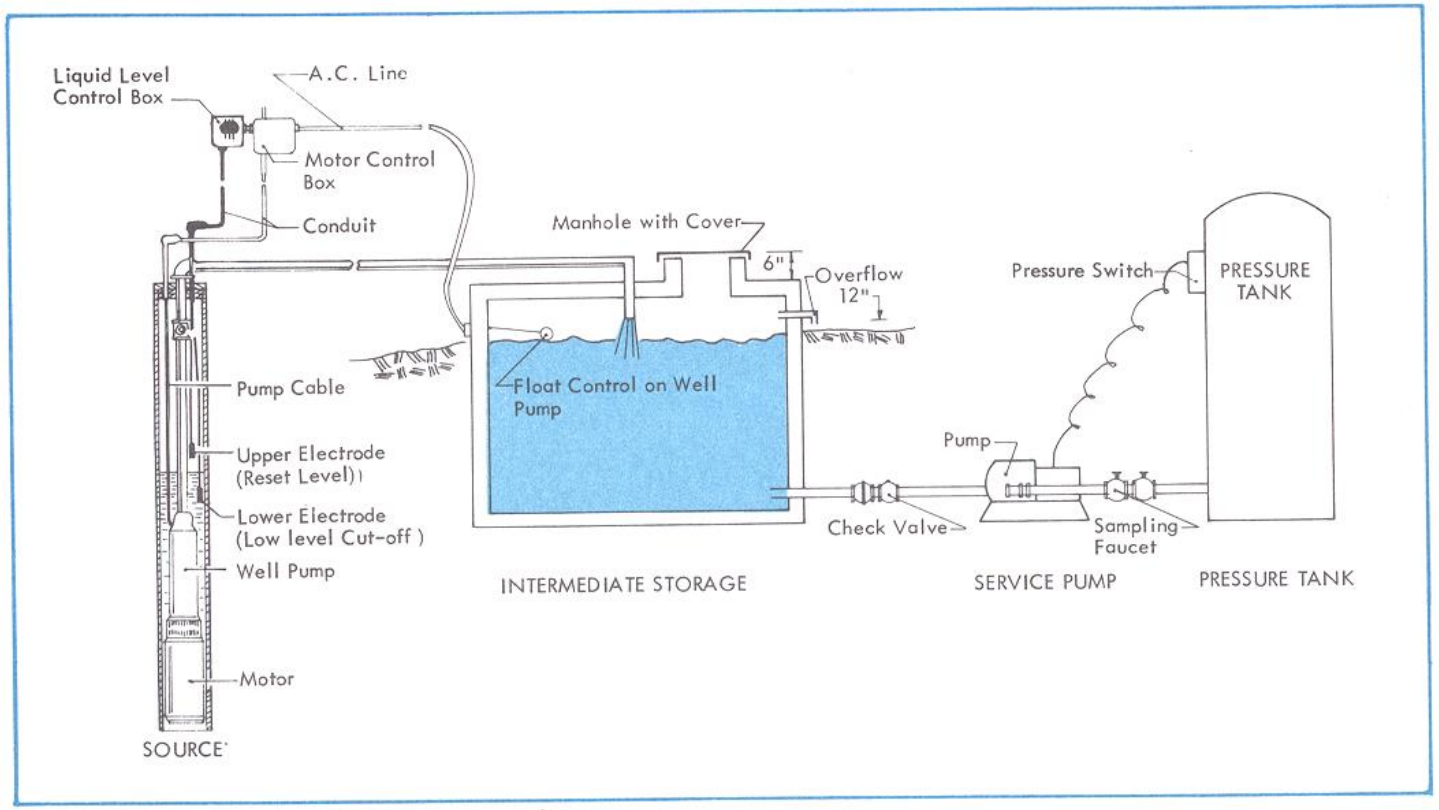


Fig 2. Intermediate storage with 2 - pump system.

Public Water Systems

- Can be obtained from surface or ground water supplies.
- Must meet government set water quality standards
- Supply is very reliable, except during major drought conditions
- Cost of water is highly variable
- During drought conditions some PWDs restrict amount of water outside users can have
- Cost of water varies across state

Public Water Supplies

- Water quality will meet all health requirements but may not meet personal requirements
  - Taste
  - Odor
  - Color
  - Hardness
  - etc
-

Rural Water Districts

- How they work
  - Deep well or surface water lake with water storage tower nearby
  - Must meet all federal and state regulations from the Safe Drinking Water and Clean Water acts
  - Supply lines buried to individual or group(s) of rural homes
  - Homeowners share cost of system upkeep through monthly use bills
  - Requires certified operator at water treatment plant
    - Monitors treatment processes
    - Collects samples for water chemistry analyses
    - Maintains & repairs equipment
    - Keeps records & budgets for future needs

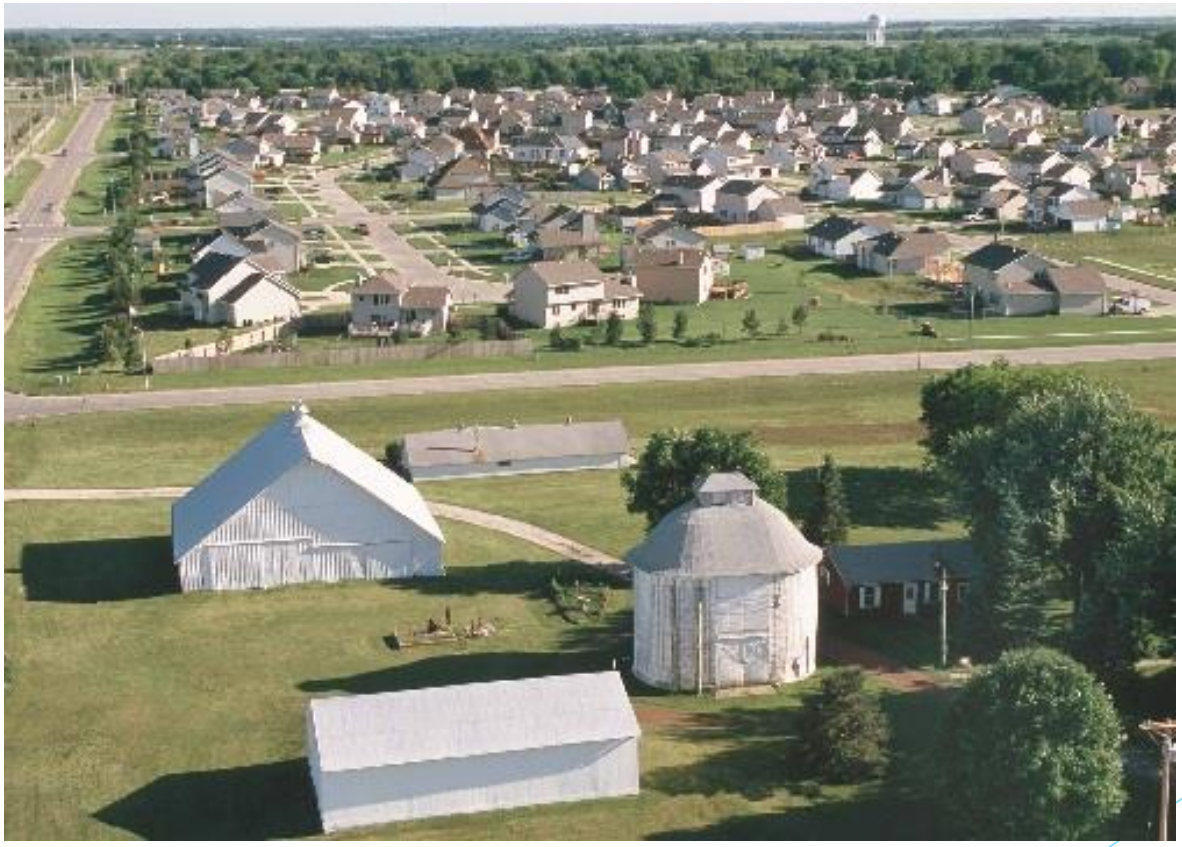
Water Treatment

- Not all water is safe to drink without some form of treatment.
  - Chlorine – for bacteria
    - Not effective in treating parasites such as Giardia or cryptosporidium
  - Ultraviolet light – effective on bacteria, viruses
    - Not on protozoan parasites
    - May need to filter water first to reduce turbidity
  - Ozone – no residual provided

Water Treatment

- Filtration – removes particles and some micro-organisms
- Microfiltration – to remove giardia and chryptosporidium but may need bacteria treatment
- Reverse osmosis
- Carbon filtration
- Distillation
- Etc.

Rural/Urban Junction



Domestic Water Needs from Private Wells - for one year

- National average is 120 gallons of water per person per day or 43,800 gallons per year.
- Humans use approximately 13,227,600,000,000 gallons each year. Over 13,227 trillion
- In Missouri alone we average approximately 4,000 new private wells drilled each year.
- 4,000 new wells x 120 gallons/day/365 = 175,200,000 gallons/year for new wells
- MoDNR started keeping well drilling records in 1987 – and average 3,500 each year = 28 years x 3500 wells x 120 gallons x 365 = 4,292,400,000 gal/yr

Bio-Mass Energy Needs

- Ethanol - each gallon of ethanol takes approximately 4 gallons of water in processing.
- A plant producing 100,000,000 gallons per year would need 400,000,000 gallons of water per year or 1.096 million gallons per day.

Ag industry Needs

- Poultry processing - 1200 gallons per 1000 pounds of live weight.
- One house at 20,000 birds @ 2 pounds times 6 flocks = 240,000 lbs of live weight
- 70 poultry CAFO permits in 3 county area so minimum of 16,800,000 lbs. live weight
- 16,800 x 1200 gallons = 20,160,000 gallons of water to process birds from 70 houses.

Conclusions

- Focus of the long-term goals for economic and environmental sustainability.
- Recognize that there are BMPs that do work for water resource protection
- Understand that we are all responsible for water resource protection
- Water resource issues are only going to get worse - the laws they are a changin
- Learn as much about water resource protection and get involved if given the opportunity

Questions????????

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