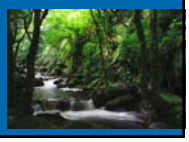
Sourcewater Protection – The Water Cycle – Maintaining a Balance

September 29, 2011
Lehigh Valley Clean Water Summit
Lower Mount Bethel Township Welcome Center

Protecting Our Groundwater / Surfacewater Resources
By Working as a Community



B.F. Environmental Consultants Inc.

Presented by:

Mr. Brian Oram, Professional Geologist (PG),
Soil Scientist, Licensed Well Driller,
IGSHPA Accredited Geothermal Installer

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http://www.bfenvironmental.com

http://www.water-research.net

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The Blatant Plug: B.F. Environmental Consultants Inc.

Professional/ Expert Services

- Baseline with Chain-of-Custody
- Provide Continuing Education Programs for Licensed Professionals
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- Informational Water Testing and Public Education Programs
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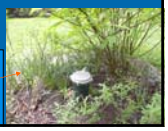
Agenda for Talk

- The Water Cycle
- Groundwater and Stream Flow
- The Hideout
- How Difficult is it to Maintain the Balance (Lets Try With Just One House)
- Need to Use the Word – NO More!
- Q & A Session

Note- This is a 500 foot well in Luzerne County – with 5 mg/L Methane



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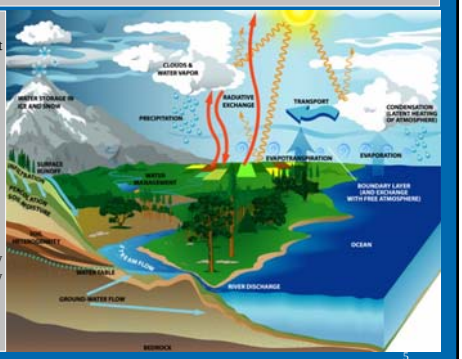
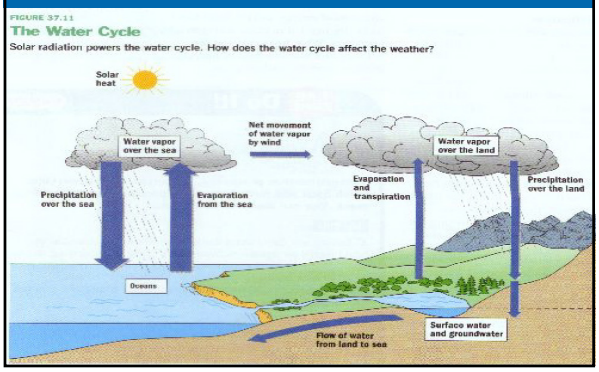
Components of the Water Cycle

First The Ins
Solar Energy Input
Precipitation
Condensation
Well Injection
Irrigation

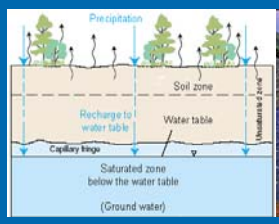
The Outs
Evaporation
Transpiration
Infiltration
Percolation
Runoff
Groundwater Flow
Surfacewater Flow
Well Pumping

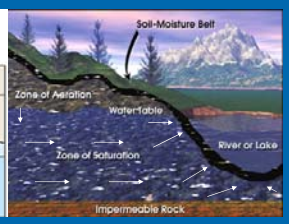


The Water Cycle
Powered by the Sun- Solar Power

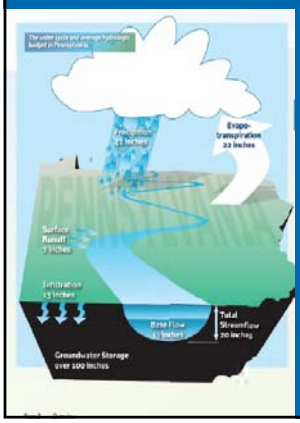


Groundwater Zone of Saturation





Our Groundwater and Streams are Connected



Water Budget for PA

In
Precipitation – 42 inches

Out
Evapotranspiration – 22”
Total Streamflow – 20”
Baseflow – 13”
Surface Runoff – 7”
Therefore, 65% of streamflow is groundwater discharge.

Other
Storage in Groundwater Aquifers over 100 inches*
* This is our “Water” Cushion.

Runoff / Overland Flow and Land-Use

When Rainfall Rate Exceeds Infiltration
More Runoff and Less Groundwater Recharge.

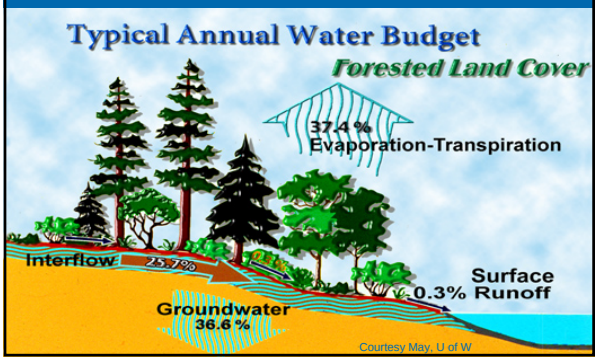
Point 1- Water is a Resource

- Water is not
  - Stormwater
  - Drinking Water
  - Recreational Water
  - Habitat Area
  - Recreation Source
  - A Problem

We are the Problem – We Put Roads, Houses, and Other Structures Where They do not belong !

Water is a Resource – not a Headache – Lets Learn to Use it Wisely. This requires us to change how we think, behave, and regulate.

Hydrology Under Natural Conditions



Courtesy May, U of W

The Hideout

The Hideout

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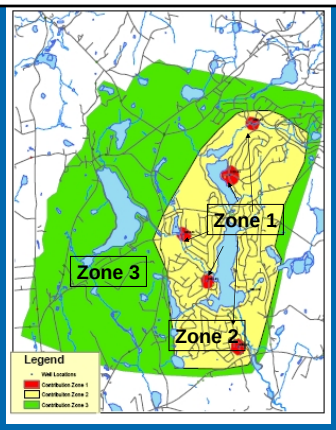
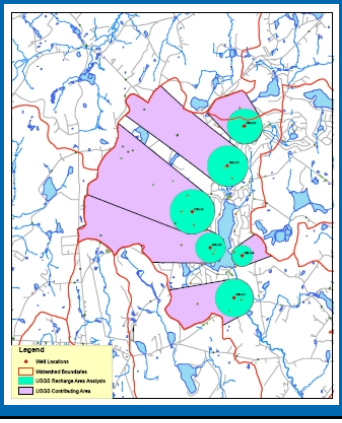
Steady State Analysis Average Pumping Rate

Capture Zones
Steady State
Average Pumping Rate
13 MG/Month
The 3 –Zones of Contribution

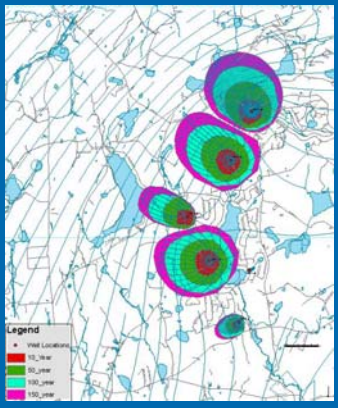


USGS Recharge Area and Contributing Area Analysis 13 MG/Month

Note Potential
Zones of Interference



Time Based Delineation



Recommendations For the Hideout

- Minimize Site Disturbance and Provide Maximum Lot Coverage.
- Encourage the Use of Rainwater Capture for Irrigation Use – Rather than Potable Water Use.
- Real-time monitoring of wells. Because of long-term concerns for over-pumping and surfacewater influence at peak withdrawal.
- Public Education and Outreach.

Recommendation
Reach Out, Inform, and Educate

Outside of the Hideout

- Local Well Ordinance (Siting, Construction, and Testing)
- Septic and Sludge Management Program
- Public Education – school students and new residents.
- Monitoring Select Private Wells within Zone II and Zone III.
- Stormwater Management System that promotes Recharge
- Promote- Low Impact Development Concepts
- Promote Decentralized Wastewater

Training – Water is a resource !

Point 2- Sourcewater Protection Applies to All Levels of Development

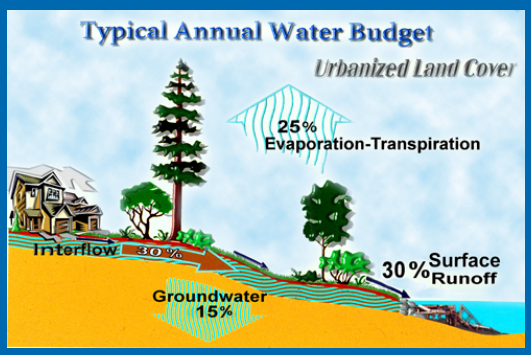
- To protect the resource – you must properly manage **surface activities and uses you control – Own the Watershed**.
- To protect the resource – you must encourage others to properly manage surface activities and uses that you do not control- **Sourcewater Protection Plans, Land-Use Ordinances, and Best Management Practices.**

Note- Are we ever going to regulate Gas Stations and Fuel Storage Facilities ?

High Lot Coverage – Increase Runoff and Decrease Natural Recharge

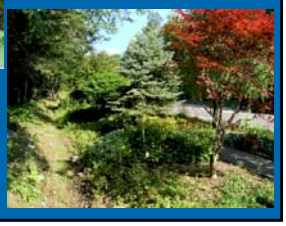
Paved Driveway – Roof runoff goes to driveway and immediately to road and stormwater system.

Developed Conditions



Low Lot Coverage / Natural or Enhanced Green Areas – Decrease Runoff and Promote Natural Recharge

Photos by:
Brian Oram (2005)

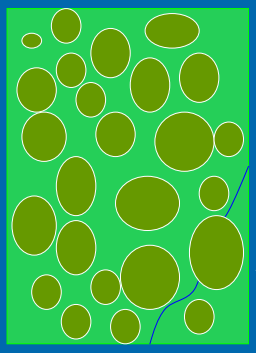


Lot Coverage – Gravel Driveway

Point 3- Take Baby Steps

- Making many small changes adds up fast.
- Fixing what we all can agree is wrong.
- Targeting funding to fix the problem where it starts.

1 acre Parcel



Forested Area – 1 acres

Rainfall – 42 ac-inches
1,140,500 gallons per year

Evaportranspiration – 22 inches
597,388 gallons per year

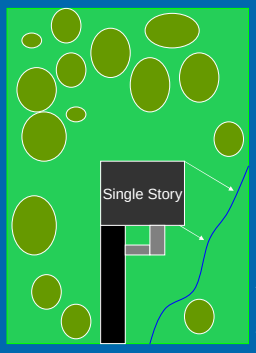
Runoff (5%) – 2.1 inches

Recharge – 17.9 inches

Baseflow to Stream (75%) – 13.4 inches

Total Stream Flow (13.4 + 2.1 = 15.5 inches)

1 acre Parcel



Forested Area – 75%
Lawn – 15%
House and Pavement – 10 %

Rainfall – 42 ac-inches
1,140,500 gallons per year

Evaportranspiration – 18 inches

Runoff (23 %) – 10 inches

Recharge – 14 inches

Baseflow to Stream – 10 inches

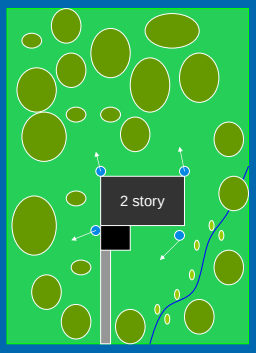
Total Stream Flow (10 + 10 = 20 inches)

25% increase in stream flow, but 500% Increase in runoff.

How Can We Change

- Baby Steps
  - Development Practices and Maintain Native Vegetation
  - Use Rainwater Capture Systems for outside water uses.
  - Use Water Features and Bioretention Systems
  - Use Rainwater Capture for More Uses
  - Going to a Green Roof Systems

1 acre Parcel



Forested Area – 80%
Lawn – 10% (native vegetation)
House and Pavement – 10 %

Rainfall – 42 ac-inches
1,140,500 gallons per year

Evaportranspiration – 20 inches

Add 4- 80 gallon Barrels / Gravel Driveway – capture portion of 2-year storm and divert discharges to overland flow.

Runoff (18 %) –7.5 inches

Recharge – 14.5 inches

Baseflow to Stream – 10.8 inches

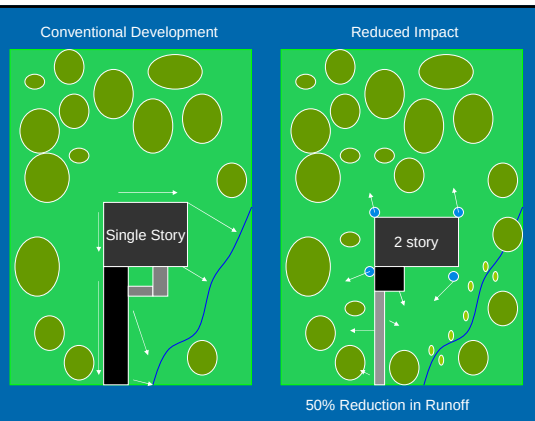
Total Stream Flow (10.8 +7.5 = 18.3 inches)

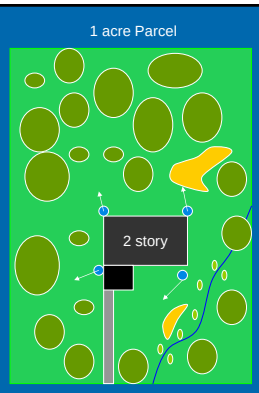
18% increase in stream flow, but 280% Increase in runoff.

Reducing Direct Runoff by Half – Maybe I could Save a Road or Two

Rain Barrel Concepts

Single Multiple – Add More.





Forested Area – 80%
Lawn – 10% (native vegetation)
House and Pavement – 10 %

Rainfall – 42 ac-inches
1,140,500 gallons per year

Evaportranspiration – 21 inches

Add 4- 80 gallon Barrels / Gravel Driveway – capture portion of 2-year storm and divert discharges to overland Flow and add Bioretention Structures.

Runoff (13 %) –5.5 inches

Recharge – 15.5 inches

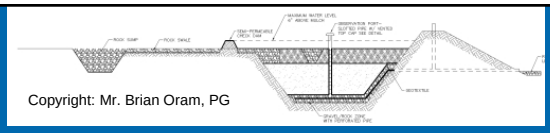
Baseflow to Stream (75%) – 11.6 inches

Total Stream Flow (11.6 +5.5 = 17.1 inches)

6% increase in stream flow, but 40% Increase in runoff.

Bio-Retention Systems

Surface Berms



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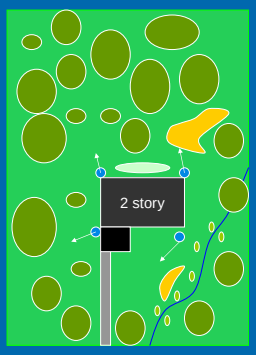
1 acre Parcel



To get back to a runoff of only 2.1 inches,

Would require a **water reuse** approach.

5.5 inches – 2.1 inches = 3.4 ac-in
3.4 ac – in = 92,300 gallons
Equivalent to 250 gallons per day.

This is the average daily water usage for a Single Family Home.

Long-term Solution – Could be a Third Pipe System

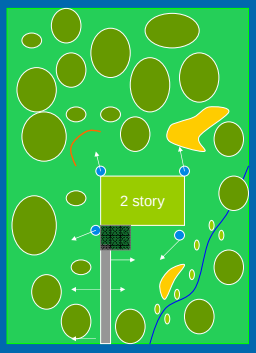
Solution were a portion of the rainwater is used To flush toilets and irrigate lawns. This gets us to virtually – Zero Change in Net Water Budget.

OK – Maybe Not a Baby Step !

Green Roof

Green Grid System

1 acre Parcel



Porous Pavers

Forested Area – 80%
Lawn – 10% (native vegetation)
House and Pavement – 10 %

Rainfall – 42 ac-inches

Evaportranspiration – 24 inches

Add 4- 80 gallon Barrels / More Porous Driveway, Green Roof, and surface berms

Runoff (7 %) –2 to 3 inches
Recharge – 15 inches

Baseflow to Stream (75%) – 11 inches
Total Stream Flow (11 +3 = 15 inches)

2% increase in stream flow, but 1 to 2 % Increase in runoff.

OK – Maybe Not a Baby Step !

Point 4- Our Current Regulations are Part of the Problem

- **How many parking spaces** are needed and roads **How Wide**?
- We are designing stormwater systems to recharge water in 3 days when normally it would take significantly longer ?
- Designing Stormwater Systems to Recharge More Water than actually rains?
- Allow Stormwater Recharge Banking to fix older Communities.
- Control the Problem at the Source.

Design Stormwater Management Systems using a Water Budget Approach to Determine the Recharge Volume- Not some Design Storm Concept

Summary Action

- We need Private Well Construction Standards – Some Private Wells are Conduits for Adverse Impact and Contamination.
- We need to update our Stormwater Management System to Use a Water Budget Approach to Determine Recharge Volumes.
- We need to encourage land-based disposal and balance the Use of Central Wastewater Treatment Systems with the Natural Groundwater Recharge Rate – then may be our streams would have water.
- We need to install stormwater management systems in older communities.
- We need to turn back the clock on Pavement.
- Going Green in Water Resource Management – Creates Jobs and is an Asset to the Community.
- Why ? If we do not take these steps, the long-term cost to maintain the infrastructure we have created is NOT Sustainable. This is a bigger problem then Marcellus Shale.

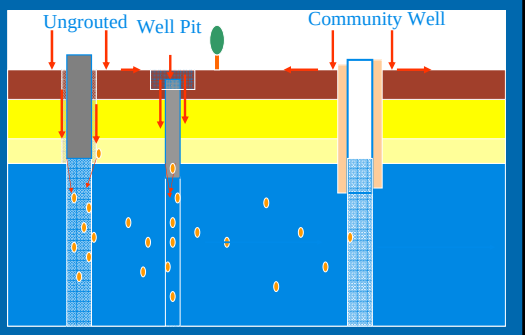
Stopping Putting on Bandages –
Lets Work as a Community and Fix the Problems
That We Created – Also You May Need to Use the Word - NO

Most Contamination appears to be associated with Total Coliform Bacteria- This is a Hazard !

- Insects, Larvae and Nests / Egg Masses
- Mouse Colonies
- Snakes
- Beehives
- Mud - when casing to close to ground

Therefore – In some cases - the Private Wells are Facilitating Groundwater Contamination- This is a Hazard and a Significant Concern Related to Sourcewater Protection.

How Contaminants Can Get In to the Aquifer (Surface)



What About Existing Developed Areas ?

1. The runoff from one acre of paved parking generates the same amount of annual runoff as:

a) 36 acres of forest
b) 20 acres of grassland
c) 14 acre subdivision – 2 acre lots
d) 10 acre subdivision – 0.5 acre lots

All of the above – Does this mean we are missing a possible effective means of "turning" back the stormwater clock. Maybe we need to consider – "greening" some of the existing impervious areas.

New Community Resource

1. We are Working on a Regional Citizen Water Quality (Groundwater and Surfacewater) Database.

2. Private Well Owner Survey – Please Participate
http://www.surveymonkey.com/s/NMG6RQ3

Add Your Data to the Citizen Database
Request a Consent Form
Email – bfenviro@ptd.net

Thanks For Not Throwing Tomatoes !

Download a Free Copy (pdf) or Link to a copy at
http://www.bfenvironmental.com/pdfs/Waterbooklet070610.pdf

Thanks

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