

The water budget myth and large-scale residential development in Western North Carolina



Photo: Mountain Air Country Club, Burnsville, NC



Dr. Jeff Wilcox
University of North Carolina at Asheville

Mountain Air Country Club

- Yancey County
- 900-1100 homes/1300 acres
- Over 15 miles of water and sewer mains and 30 lift stations
- Wastewater:
 - Municipal treatment
- Water:
 - Currently community wells
 - Plans to join county system

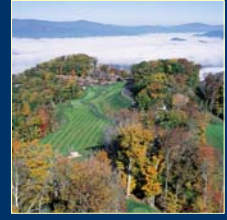


Photo: www.mountainaircc.com



Example: Seven Falls Golf and River Club

- Henderson County
- Arnold Palmer course
- 900 homes/1600 acres



- Water:
 - Can draw up to 450,000 gallons of water from French Broad River for irrigation
 - Extension of water lines from Hendersonville or community water system (French Broad)
- Wastewater:
 - Community sewer system
- In the meantime, temporary wells and septic systems may be installed for up to 2 years.

Example: The Cliffs at High Carolina

- Buncombe County
- Tiger Woods course
- 1000-1200 homes
- 3000 acres



Developer, residents assess new Cliffs project's impact

By Rick New

The developer of a new 1,000-home residential project is assessing the impact of the project on the local water supply and sewer system. The project, known as The Cliffs at High Carolina, is located in Buncombe County and is being developed by Tiger Woods. The project will include a 9-hole golf course and 1,000 homes. The developer is currently assessing the impact of the project on the local water supply and sewer system. The project is expected to be completed in 2010.

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Asheville Citizen Times, 9/6/08

- Concerned local residents (all with private wells)
- Water:
 - City of Asheville
- Wastewater:
 - Sewage treatment system will reuse wastewater for irrigating golf course

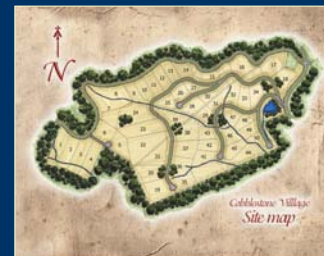
Residential development can be contentious

- Traffic
- Taxes
- Schools
- Tourism
- Aesthetics
- Environmental Quality
- Groundwater (and surface water) resources



Example: Cobblestone Village

- Henderson County
- 120 homes/2 phases
- 1-3 acre homesites



- Water: Originally planned for private wells
- Wastewater: Individual septic systems

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February 5, 2008
 Mr. Lee Smith
 Utilities Director
 Water & Sewer Department
 City of Hendersonville, North Carolina

Re: **Collaborative Recharge
 Water Line Extension
 200 West 10th
 EAS Project Number 07-071**

Dear Mr. Smith,

An extension of the 8-inch water main located along US Highway 225, at the existing hydro-
 recharge area, is currently being developed as a 60-lot residential subdivision and
 was originally designed for individual private water wells to serve each lot. However, recent well
 installations for several homes under construction have exceeded depths of 1,000-feet with little or
 no water available.

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 was originally designed for individual private water wells to serve each lot. However, recent well
 installations for several homes under construction have exceeded depths of 1,000-feet with little or
 no water available.

- Seeking over 2-mile water line extension
- Interbasin transfer of water from French Broad to Broad River Basin
- Not consistent with Henderson County 2020 Comprehensive Plan

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"Groundwater sustainability"

Tryon Daily Bulletin
 The Week's News for Tryon

Saluda now under mandatory water restrictions
 Tryon Daily Bulletin 8/8/08

Town well runs dry in Marshall
 Officials call for mandatory conservation

WNC springs, wells failing
 Drought seeps further into daily lives
 Asheville Citizen Times, 10/28/07

French Broad River at lowest level in at least 100 years
 Asheville Citizen Times, 8/12/08

What is groundwater sustainability?
 Groundwater recharge and discharge

Natural Conditions

Groundwater pumping causes a cone of depression and reduces discharge

Figure from Winter (1998)

Groundwater sustainability: A "traditional" view

"Groundwater pumping must not exceed average annual recharge"

Estimate groundwater recharge to determine the size of a sustainable development

Figure from Winter (1998)

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An application of a "traditional" view

1. Estimate average annual recharge rate
 (e.g. 5.51 inches per year or 412 gal/d/acre)
2. Estimate water usage rates
 (e.g. 100 gal/d/person or 400 gal/d/household)
3. Calculate minimum lot size
 (e.g. 400 gal/d/house / 412 gal/d/acre = 0.97 acres/house)

Data for Guilford County, NC by Daniel and Harned (1998)

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POLK COUNTY LAND USE PLAN

ADOPTED BY THE POLK COUNTY BOARD OF COMMISSIONERS
 OCTOBER 4, 2004

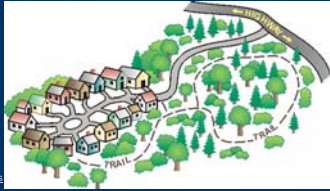
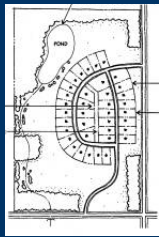
B. Preserve the supply of well water. (Proposition 14, Countywide 96%)
 (Saluda Township 98%; Columbus Township 99%; Tryon Township 99%; Green
 Creek Township 94%; White Oak Township 94%; Coopers Gap Township 83%)

1. Enact an ordinance that establishes a minimum residential lot size requirement (taking into consideration slopes and soil types) that will sustain the supply of water.
2. Seek grants to purchase development rights in water supply watersheds to protect ground water recharge areas.
3. Enact county water supply watershed protection measures, and periodically review their effectiveness, to ensure reliable, healthy supplies of raw water for area water supply systems.
4. Enforce current regulations for placement, construction and maintenance of wells and septic systems, including providing proper space and soil for a backup field.
5. Encourage residential and commercial development to locate where adverse impacts on ground and surface water are avoided or minimized.
6. Urge the State Sanitarian to investigate septic system compliance in Polk County, particularly in subdivisions.

Clustered Developments

Benefits

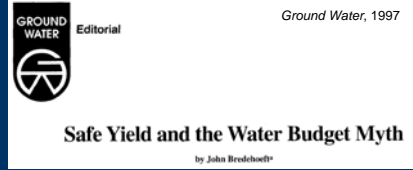
- Maintain rural character
- Provide open space for community members
- Preserve contiguous natural areas
- Cheaper site development costs
 - Roads
 - Utilities
 - Sewer



Photos from:
<http://www.uwsp.edu>
<http://www.dsp.state.pa.us>

“Groundwater pumping must not exceed average annual recharge”

The water budget myth



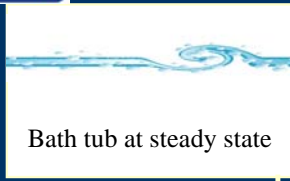
The persistence of the water budget myth and its relationship to sustainability

John F. Devlin · Marios Sophocleous

Hydrogeology Journal, 2005



Flow in = Flow out



Bath tub at steady state



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Pumping



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Effects of pumping



Pumping



Pumping reduces water level, outflow, or both

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- Natural inflow: Recharge
- Natural outflow: Discharge

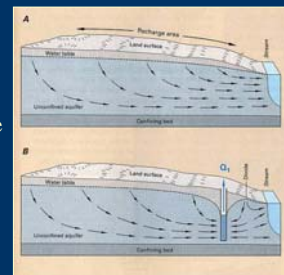


Figure from Winter (1998)

- ANY new outflow (pumping from a well) must be balanced by
 - Increased recharge
 - Decreased discharge
 - Change in storage (drawdown, lowering the water table)

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- The AMOUNT of drawdown and/or decrease in discharge depends on
 - Aquifer storage
 - Aquifer transmissivity
 - Pumping rates
 - Groundwater/surface water interactions

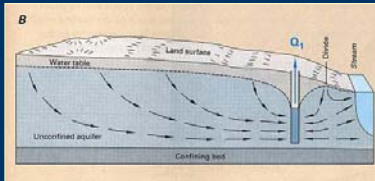


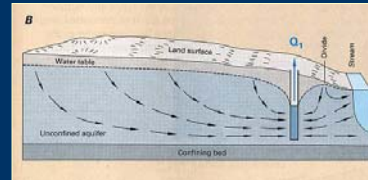
Figure from Winter (1998)

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Groundwater Sustainability

When considering new residential developments, it is essential that we ask the right questions:

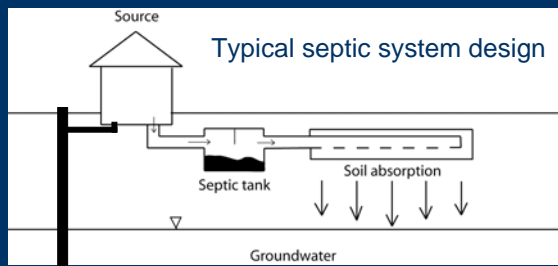
1. How much water is available?
2. How much drawdown ?
3. How much decreased discharge?



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Groundwater Sustainability

4. What are the effects on ground water quality?



Modified from Canter and Knopf 1985

5. What are the trade-offs between different water-supply and wastewater-treatment options?



Municipal well



Private well



Municipal treatment plant



Septic system

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Private well supply/on-site septic systems



Balsam Mountain Preserve
Jackson County
Arnold Palmer course
354 homes/4400acres
3000 acres in Balsam Mountain Trust

- Impact on water quality?
 - Septic systems
- Impact on water quantity?
 - Sufficient yield?
 - Potential for inter-aquifer transfer?

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Municipal supply/On-site septic systems



The Cliffs at Walnut Cove

- Buncombe County
- Jack Nicklaus course
- 650 homes/1500 acres

- Impact on water quality?
 - Septic systems
- Impact on water quantity?
 - Adds burden to water utility
 - Potential for interbasin transfer?

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• Groundwater wells/community sewer



Bright's Creek

- Polk County
- Nick Fazio course
- 1200 homes/5100 acres

- Impact on water quality?
- Impact on water quantity?
 - Potential for significant drawdown?
 - Sufficient yield?
 - Potential for interbasin or interaquifer transfer?

Take-home message 1:

There are no perfect water-supply/wastewater treatment options

Water Supply	Water Treatment	Water quantity	Water quality
Municipal	Municipal	Strain on municipal system	Minimal
Municipal	Septic system	Strain on municipal system Potential transfer of water between aquifers and across groundwater divides	Septic effluent
Private	Municipal	Sufficient well yield? Potential drawdown and transfer of water across groundwater divides	Minimal
Private	Septic system	Sufficient well yield? Potential inter-aquifer transfer	Septic effluent

Take-home message 2:

Predicting the impacts of proposed developments requires moving beyond average recharge rates and minimum lot sizes and instead taking an integrated approach to understand and model the entire system.

Issue Paper/

**The Water Budget Myth Revisited:
Why Hydrogeologists Model**

by John D. Bredehoeft¹

Ground Water, 2002

Thank You!