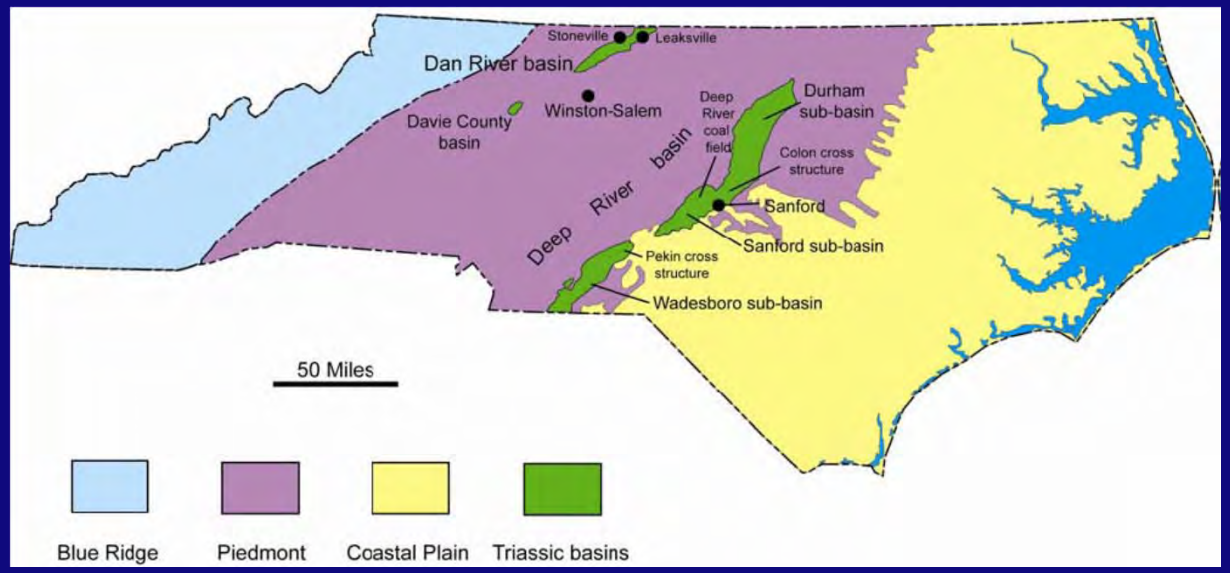
Shale Gas Development Water Quantity Evaluation

Don Rayno

Division of Water Resources

North Carolina

Department of Environment and Natural Resources



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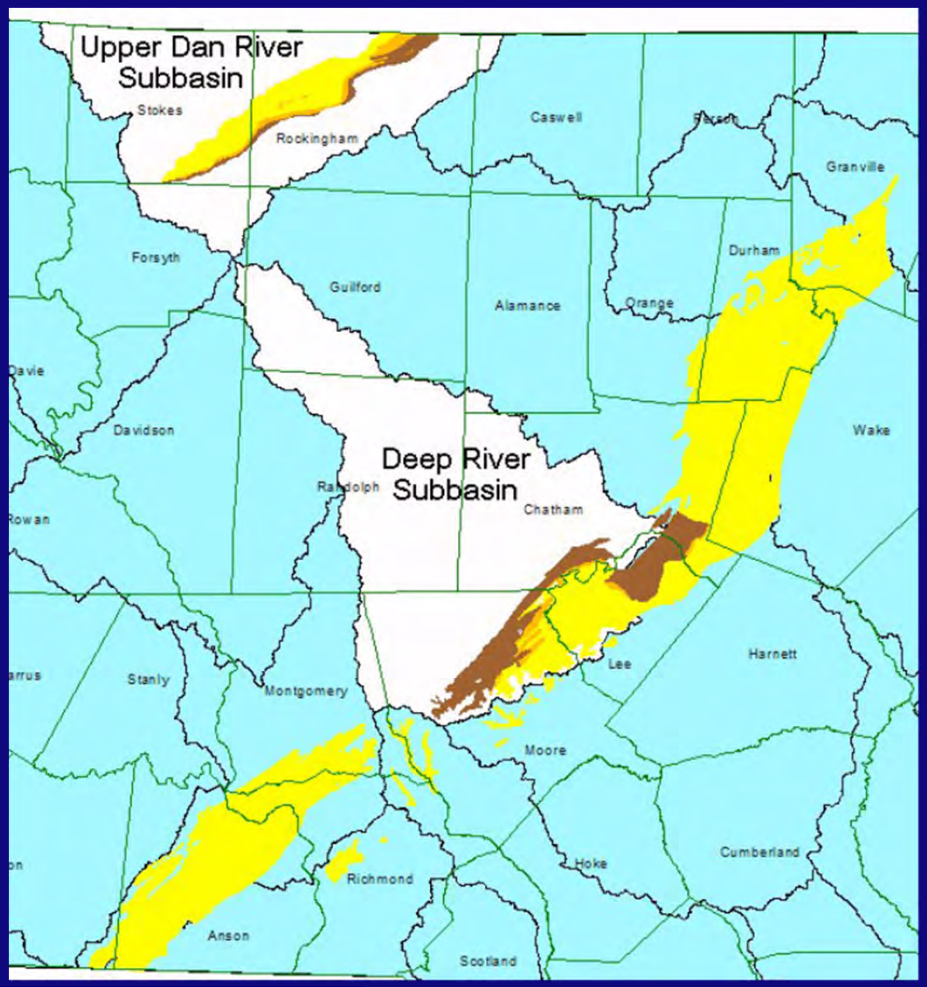
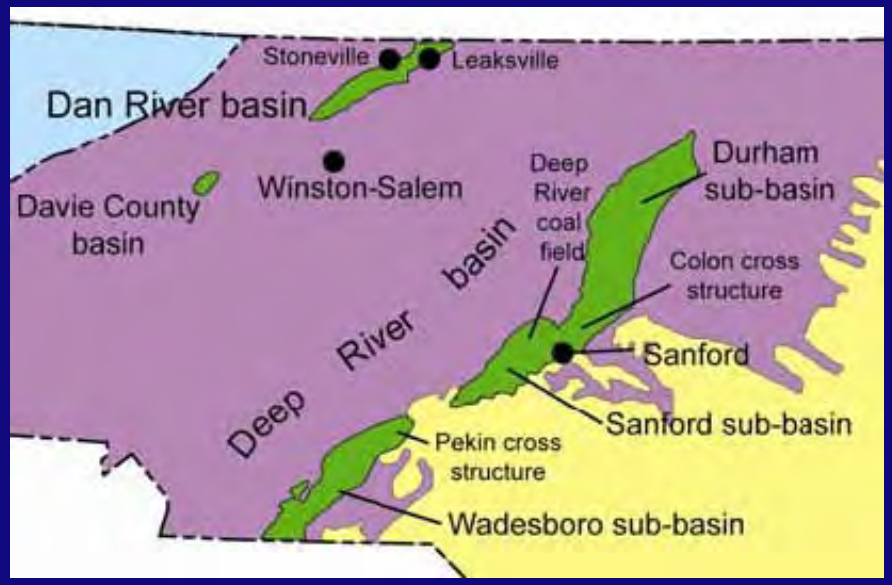
Water quantity concerns:

- Where will gas exploration occur?
- Current water users?
- How is water used?
- How much water is needed?
- How will water be withdrawn?
- Current withdrawal regulations?
- Recommended water management regulations?

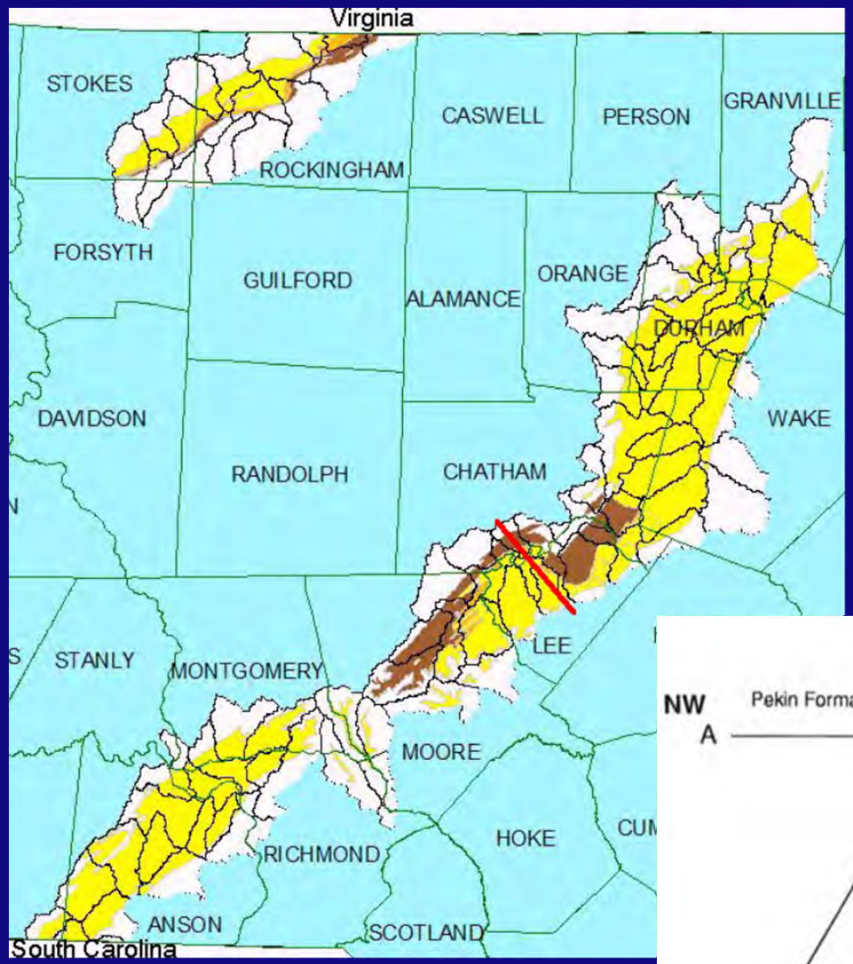
Triassic Basins in Central NC



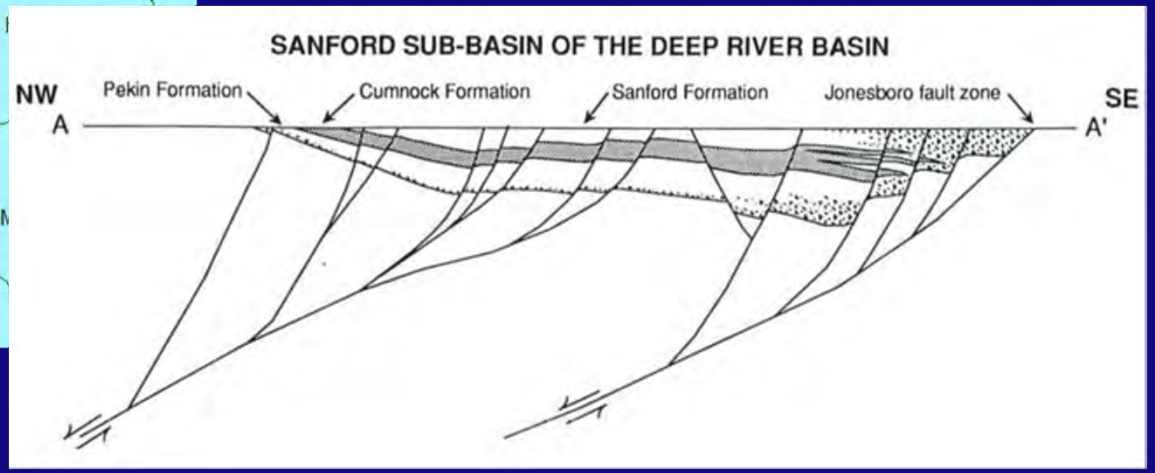
- Geologic basins in yellow, tan and brown
- Hydrologic drainage areas in white (HUC-8)
- Labeling confusion



Study Areas



- Counties
- USGS subwatersheds
- Cross-section of Sanford Sub-basin
  - Potential gas production from shaded formation



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Analysis Example

- **Sanford and Durham Triassic Sub-basins**

Sanford-Durham Sub-units of Deep River Triassic formations			
County Population	Population 2010	Population 2020	Population 2030
Chatham County	63,870	78,237	92,604
Durham County	268,925	323,474	378,024
Granville County	60,547	69,359	78,167
Lee County	58,059	65,857	73,658
Moore County	88,594	101,324	112,189
Orange County	134,325	155,442	176,559
Wake County	907,314	1,160,823	1,414,333
Total	1,581,634	1,954,516	2,325,534
(from OSBM website on January 6, 2012)			

Local Water Supply Plans

Sanford-Durham Sub-units of Deep River Triassic formations			
LWSP Service Population	Population 2010	Population 2020	Population 2030
Chatham County	30,853	32,886	35,266
Durham County	241,543	286,419	329,421
Granville County	31,262	36,046	44,822
Lee County	46,820	64,088	84,615
Moore County	51,101	60,112	69,474
Orange County	103,604	121,366	139,325
Wake County	688,004	964,088	1,224,617
Total	1,193,187	1,565,005	1,927,540

Sanford-Durham Sub-units of Deep River Triassic formations			
LWSP Service Area Demand	MGD 2010	MGD 2020	MGD 2030
Chatham County	5.1	6.3	7.6
Durham County	28.1	29.4	34.1
Granville County	5.7	7.8	9.7
Lee County	9.4	14.8	22.0
Moore County	8.0	9.1	10.5
Orange County	8.9	11.2	13.1
Wake County	84.5	108.1	133.7
Total	149.7	186.8	230.6

- How many people to be served by LWSP water systems?
- How much water will LWSP customers use?

Non-LWSP Users

Sanford-Durham Sub-units of Deep River Triassic formations			
Non-LWSP Population/Demand Estimated @ 75 gals/person/day	2010	2020	2030
Chatham County	33,017	45,351	57,338
Durham County	27,382	37,055	48,603
Granville County	29,285	33,313	33,345
Lee County	11,239	1,769	0
Moore County	37,493	41,212	42,715
Orange County	30,721	34,076	37,234
Wake County	219,310	196,735	189,716
Estimated water needs (mgd)	29.1	29.2	30.7
zero values indicate predicted service population exceeded predicted county population			

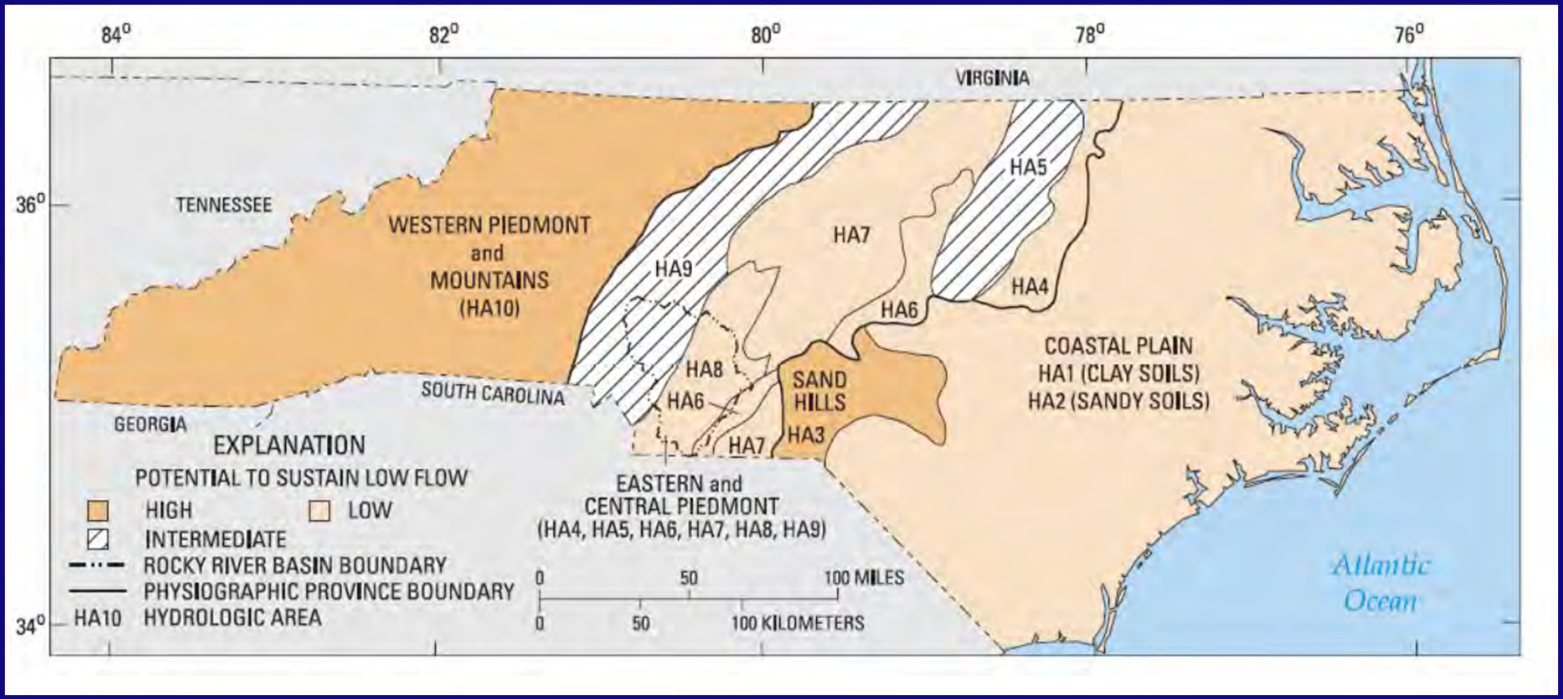
- County residents not served by a LWSP water system
- Estimated groundwater use

Agricultural Water Use

Sanford-Durham Sub-units of Deep River Triassic formations				
2010 Daily Agricultural Use Use in million gallons per day	Unique Operations	Ave. Daily Ground Water	Ave. Daily Surface Water	Daily Capacity
Chatham County	12	0.091	*	0.956
Durham County	6	*	0.040	0.938
Granville County	19	0.425	0.346	17.876
Lee County	20	0.062	0.216	13.539
Moore County	33	*	0.537	22.508
Orange County	10	*	0.074	5.424
Wake County	41	0.143	1.477	28.822
Total	141			90.1
Data from Dept. Agriculture & Consumer Services-Agricultural Statistics Division - Water Use Survey				
* data not released -one operation is greater than 60% of total or less than 3 operations				

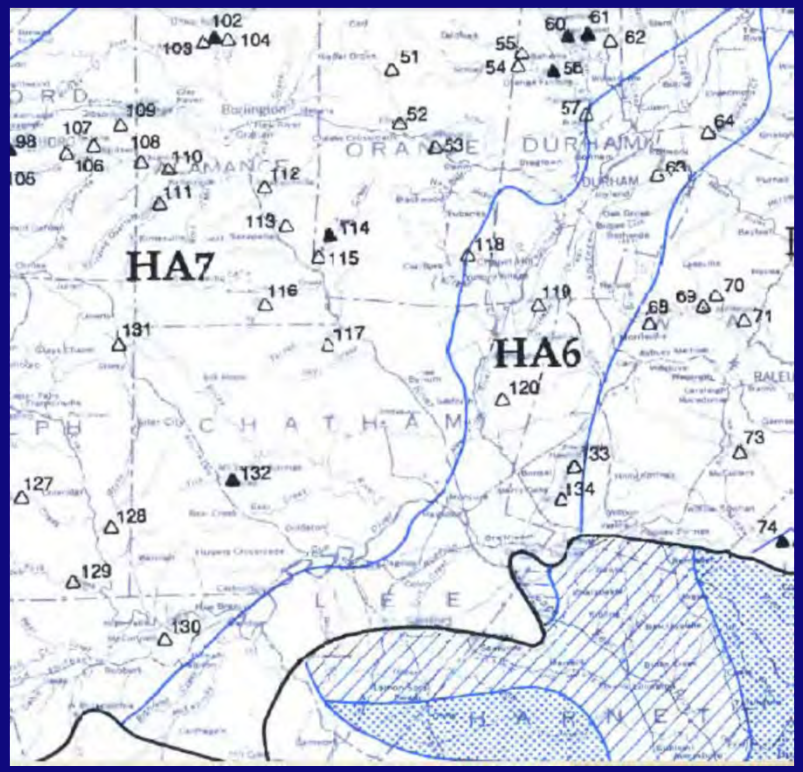
- **Agricultural operations using more than 10,000 gallons on any day during 2010**

Surface Water Availability



- USGS Low-Flow Characteristics of Streams in NC
- Geographic estimators of flow
- Primary concern = withdrawals during low-flow periods

Sanford Triassic Sub-basin



7Q10 Estimators

HA6

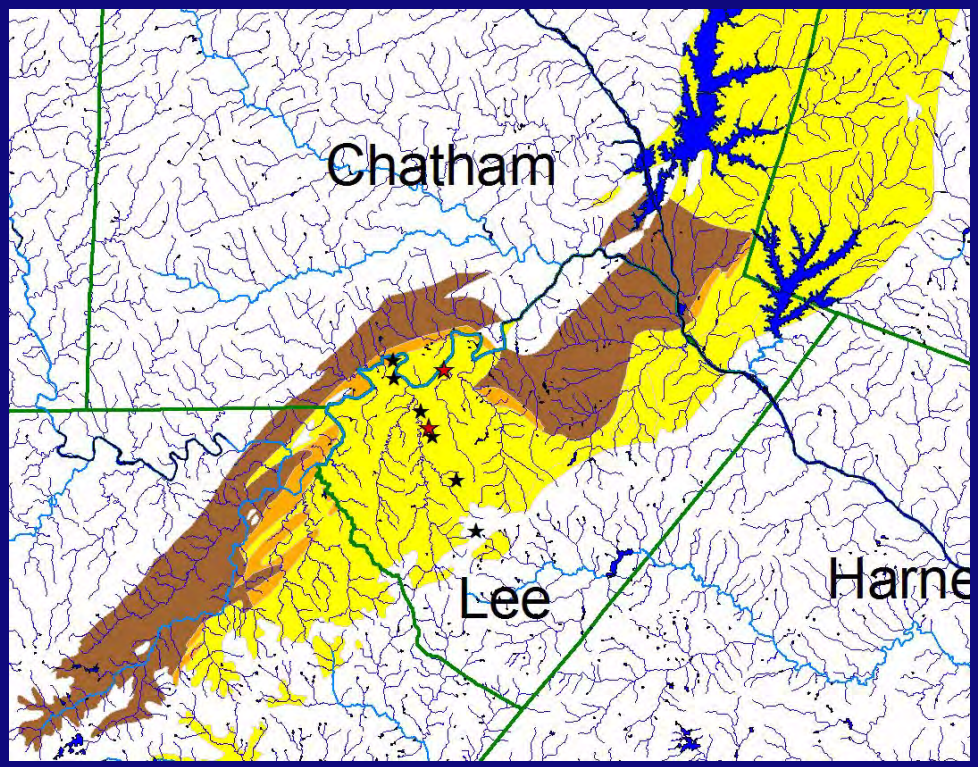
0.004(DA mi^2) = max 7Q10 cfs

If DA > 45 mi^2

HA7

0.131(DA mi^2) = max 7Q10 cfs

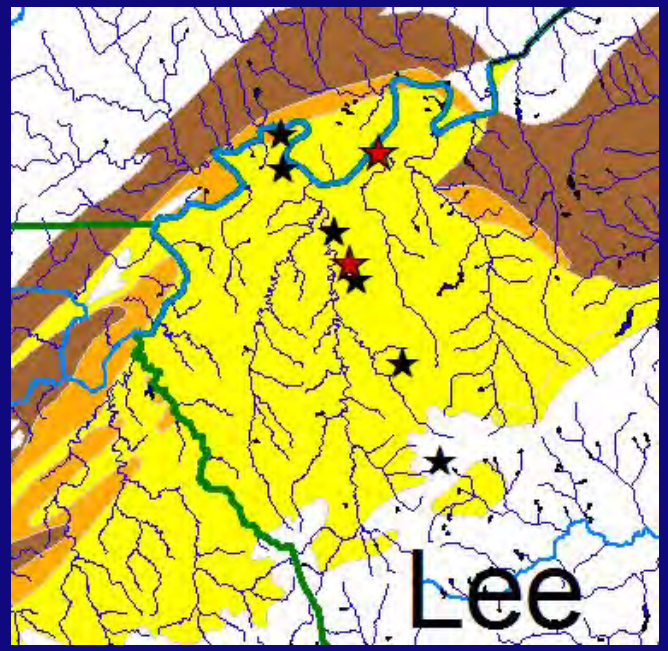
If DA > 3 mi^2



Surface Water Evaluation

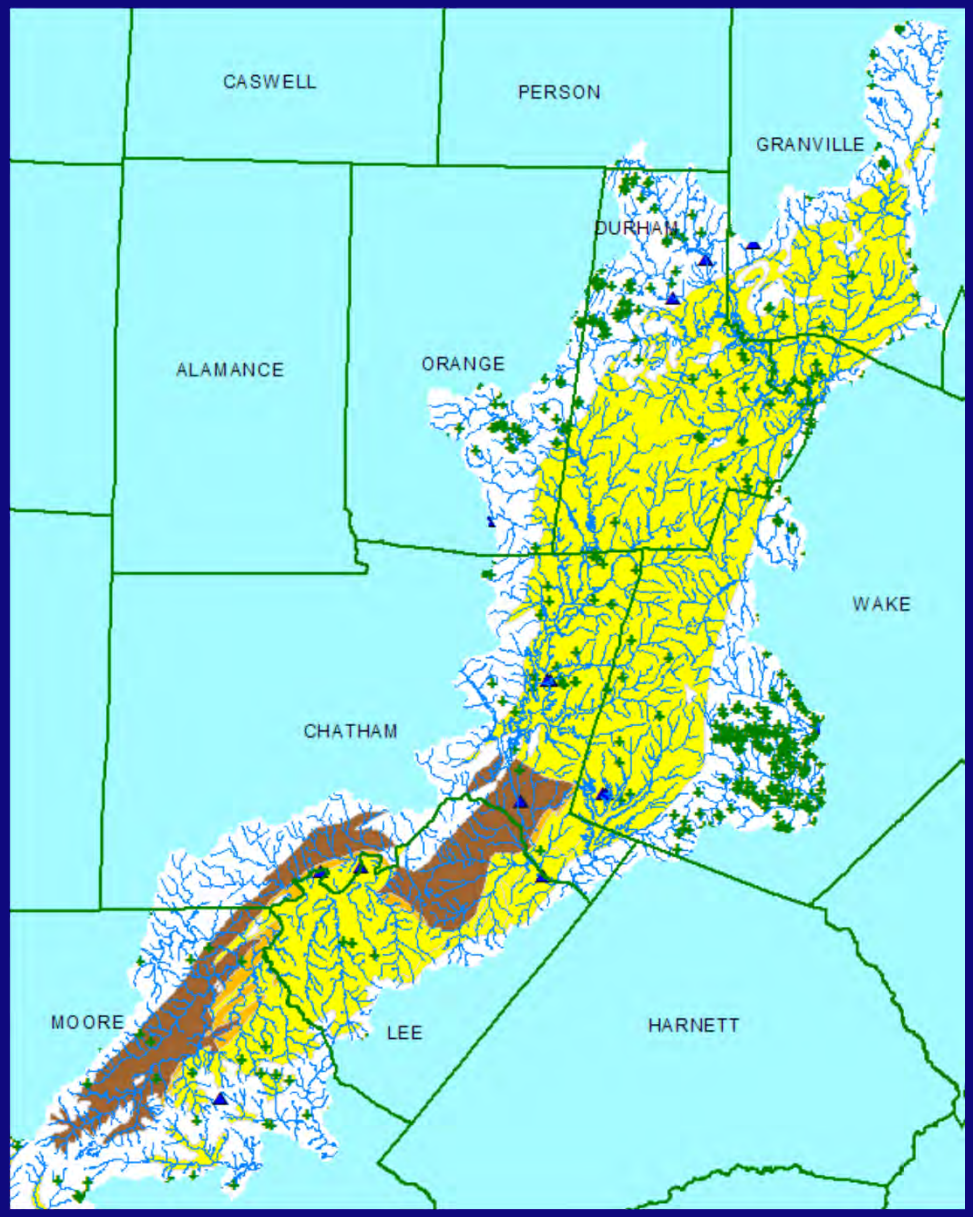
- Stars are exploratory wells in Lee County
- Red Stars gas producing

- Pocket Creek DA
- 37.6 mi^2 (< 45 mi^2)
- 7Q10 = 0.004 (37.6) = 0.15 cfs
- With DA < 45 mi^2 then 7Q10 more likely = 0 cfs



Public Water Supply Sources

- Triangles = Surface water intakes
- Crosses = wells
- Triassic wells typically not prolific
- Note proliferation of wells outside of Triassic Basin



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Groundwater in Triassic Formations

Subwatershed	Geologic Unit	Geologic Formation	Public Water Supply #	Source Name	Depth (feet)	Yield (gpm)	Yield (mgd)	Yield (cfs)
Chatham County								
030300020604	TRc	Chatham Group-Undivided	4019004	WELL#7	1000	39	0.056	0.087
030300020604	TRc	Chatham Group-Undivided	4019004	WELL#4	400	49	0.071	0.109
030300020604	TRc	Chatham Group-Undivided	4019004	WELL#2	400	41	0.059	0.091
030300020604	TRc	Chatham Group-Undivided	4019004	WELL#1A	400	14	0.020	0.031
030300020604	TRc	Chatham Group-Undivided	0319439	WELL#1	225	5	0.007	0.011
030300020605	TRc	Chatham Group-Undivided	4019015	WELL#2	500	98	0.141	0.219
030300020605	TRc	Chatham Group-Undivided	0319440	WELL#1	28	60	0.086	0.134
030300020608	TRc	Chatham Group-Undivided	0319456	WELL#1	Unk.	60	0.086	0.134
030300020608	TRc	Chatham Group-Undivided	0319424	WELL#1	Unk.	60	0.086	0.134
030300020608	TRc	Chatham Group-Undivided	0319471	WELL#2	305	7	0.010	0.016
030300020608	TRc	Chatham Group-Undivided	4019016	WELL#1	Unk.	10	0.014	0.022
030300020608	TRc	Chatham Group-Undivided	0319457	WELL#1	110	10	0.014	0.022
030300020608	TRc	Chatham Group-Undivided	0319124	WELL#2	120	15	0.022	0.033
030300020608	TRc	Chatham Group-Undivided	0319124	WELL#1	125	25	0.036	0.056
030300020610	TRc	Chatham Group-Undivided	4019020	WELL#1	365	10	0.014	0.022
030300020610	TRc	Chatham Group-Undivided	0319469	WELL#1	125	60	0.086	0.134
030300020610	TRc	Chatham Group-Undivided	0319425	WELL#6	411	20	0.029	0.045
030300020610	TRc	Chatham Group-Undivided	0319425	WELL#8	320	120	0.173	0.268

- **Public water supply wells in Triassic Basins**

How is water used?

- During initial drilling
- Hydraulic fracturing
  - Recycled water
  - Water to make up necessary volume
- Fresh water is NOT required
- Often stored onsite prior to use
- Fracturing fluid compatible with composition of geologic formations

How much water is needed for hydraulic fracturing?

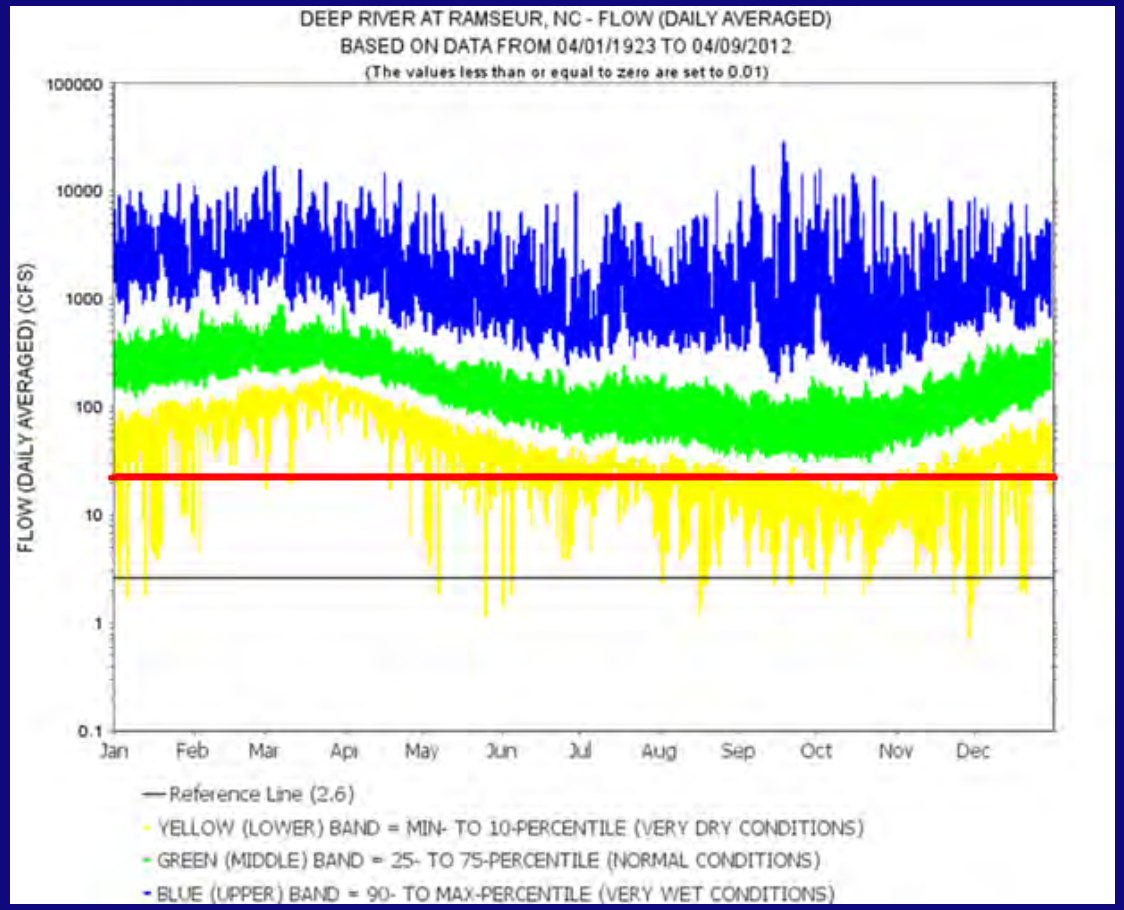
Table 3-17 Analysis Scenario Description					
Assumptions					
	Water per well (million gallons)	3	3	5	5
	Well Spacing (acres per well)	160	160	160	160
	Pumping Days	3	21	3	21
	Development cycles per year	4	4	4	4
	Years of development	30	30	30	30
	Triassic Basins' estimated acreage	785,000	785,000	785,000	785,000
Estimations					
	Maximum number of wells for spacing	4,906	4,906	4,906	4,906
	Wells per year if maximum number	164	164	164	164
	Wells per quarter if maximum number	41	41	41	41
	Total water per pumping day @ 100% development (mgd)	41	6	68	10
	Total water per pumping day @ 50% development (mgd)	20	3	34	5
	Total water per pumping day @ 25% development (mgd)	10	1	17	2
	Water per well per pumping day (mgd)	1.000	0.143	1.667	0.238
	Water per well per pumping day (cfs)	1.547	0.221	2.579	0.368

Regulatory Regime – Reasonable Use

- Water withdrawal permits are NOT required except in designated capacity use areas
  - Groundwater use on overlying land is "reasonable use"
    - Permits required in Central Coastal Plain CUA
  - Riparian landowners have equal right to "reasonable use" of surface water
  - Owners of "legally constructed" impoundments control access to stored water
- Review if other permits are required
  - Federal or State
  - < 20% of 7Q10 flow - assumed minor ecological impacts
  - > 20% of 7Q10 flow – site specific evaluation required
- Awaiting Ecological Flows Recommendations

Surface Water Flow Example

- Deep River @ Ramseur (89 years of data)
- Colored bands = range of daily average flows
- Yellow = flows exceeded 90% of the time
- Red line = 7Q10 (12.7 cfs)
- Black line = 20% of 7Q10 flow (2.5 cfs) (recommended withdrawal limit)



DWR
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Is there enough water available for hydraulic fracturing while maintaining sufficient water to support aquatic life, ensure good water quality and protect the rights of other users?

- **YES, if North Carolina:**
- **adopts adequate safeguards in the form of regulatory standards based on conditions in NC**
- **establishes specific conditions under which hydraulic fracturing can be done without putting the state's water resources at risk**

Recommendations

- Water Management Plan - Approved by DENR
  - Source, Magnitude, Timing, Disposal, etc.
- Disclosure of chemicals to be used
- Baseline data on groundwater levels
- Pump test if using groundwater
- Limit cumulative surface water withdrawals to 20% of 7Q10 flow in vicinity of intake
- Prohibit surface water withdrawals during droughts and periods of low flows
- Encourage use of reclaimed water
- Take advantage of unused capacity at existing intakes

DENR's
NC Oil and Gas Study under Session Law 2011-276
is available at

http://portal.ncdenr.org/web/guest/shale-gas