Groundwater Recharge
Spring Flow and Wetlands

- Spring discharges have been related to pressure head and volume of water in aquifers.
- Wetland preservation has been related to the volume of groundwater and its proximity to the wetland.
- Volume and head of groundwater is related to the recharge of water and withdrawals.

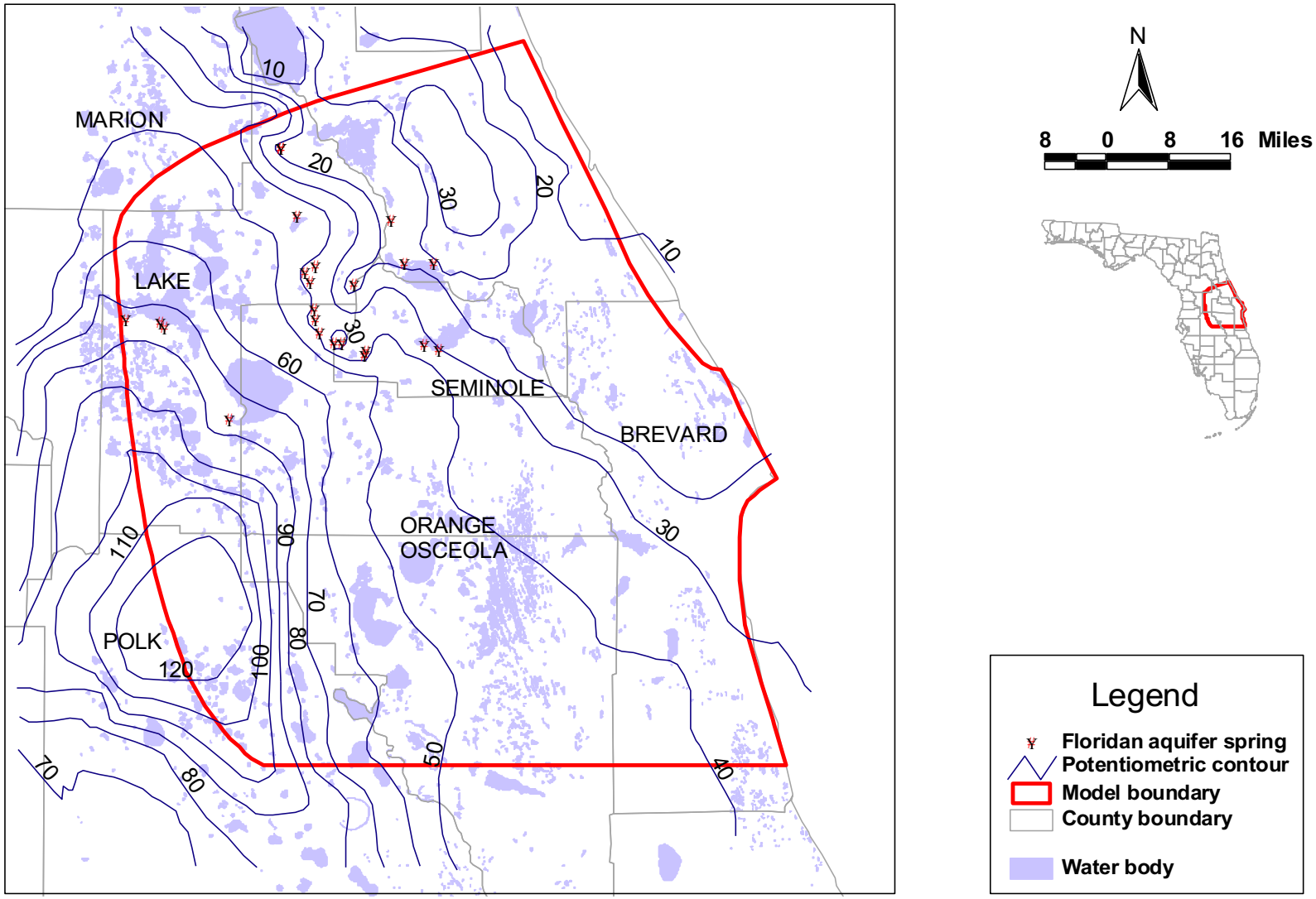


Figure 1: Estimated average 1995 potentiometric surface of the Upper Floridan aquifer (adapted from Knowles et al.1995 and O'Reilly et al.1996)

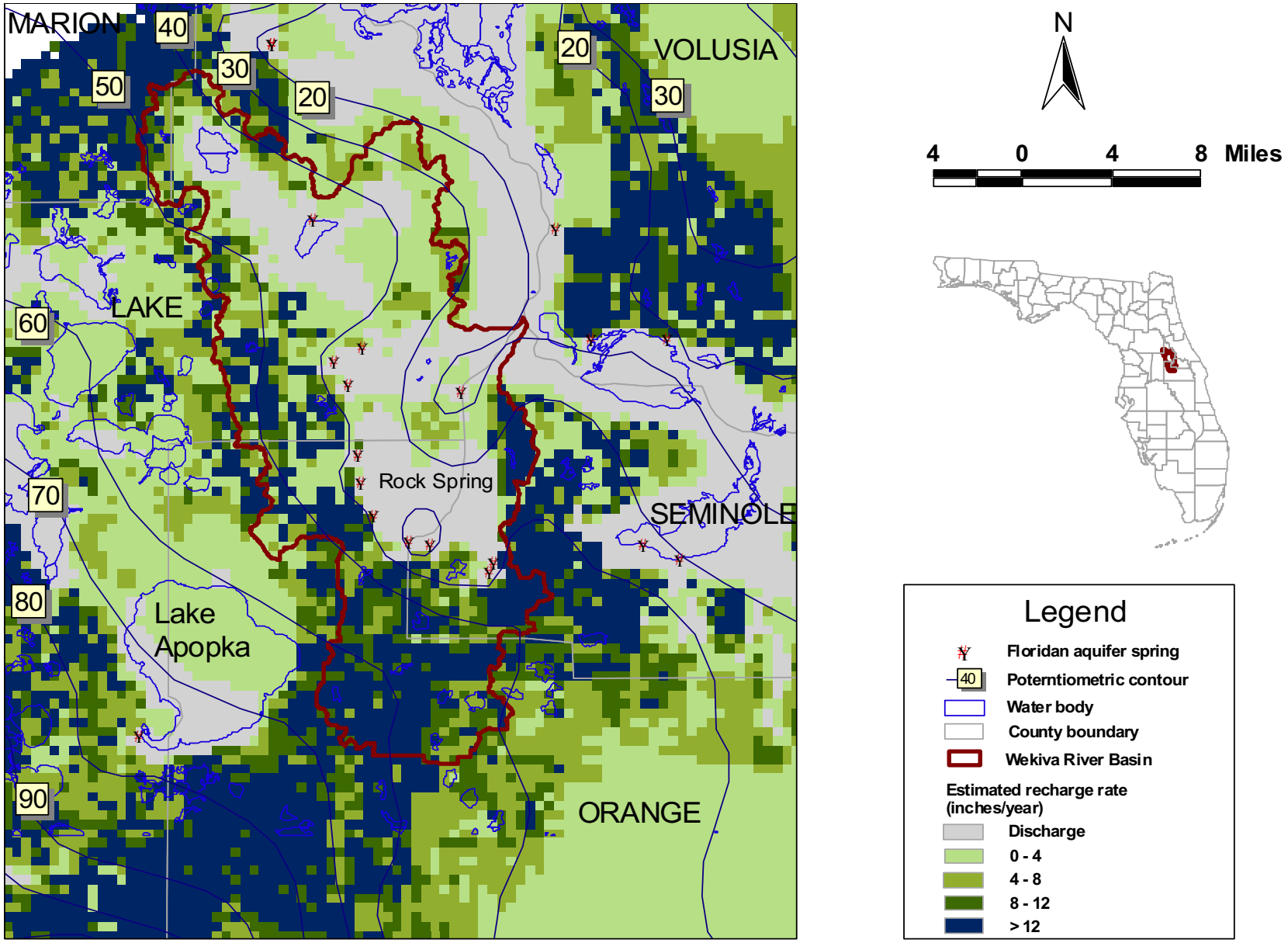


Figure 20: Areas of recharge to and discharge from the Floridan aquifer system

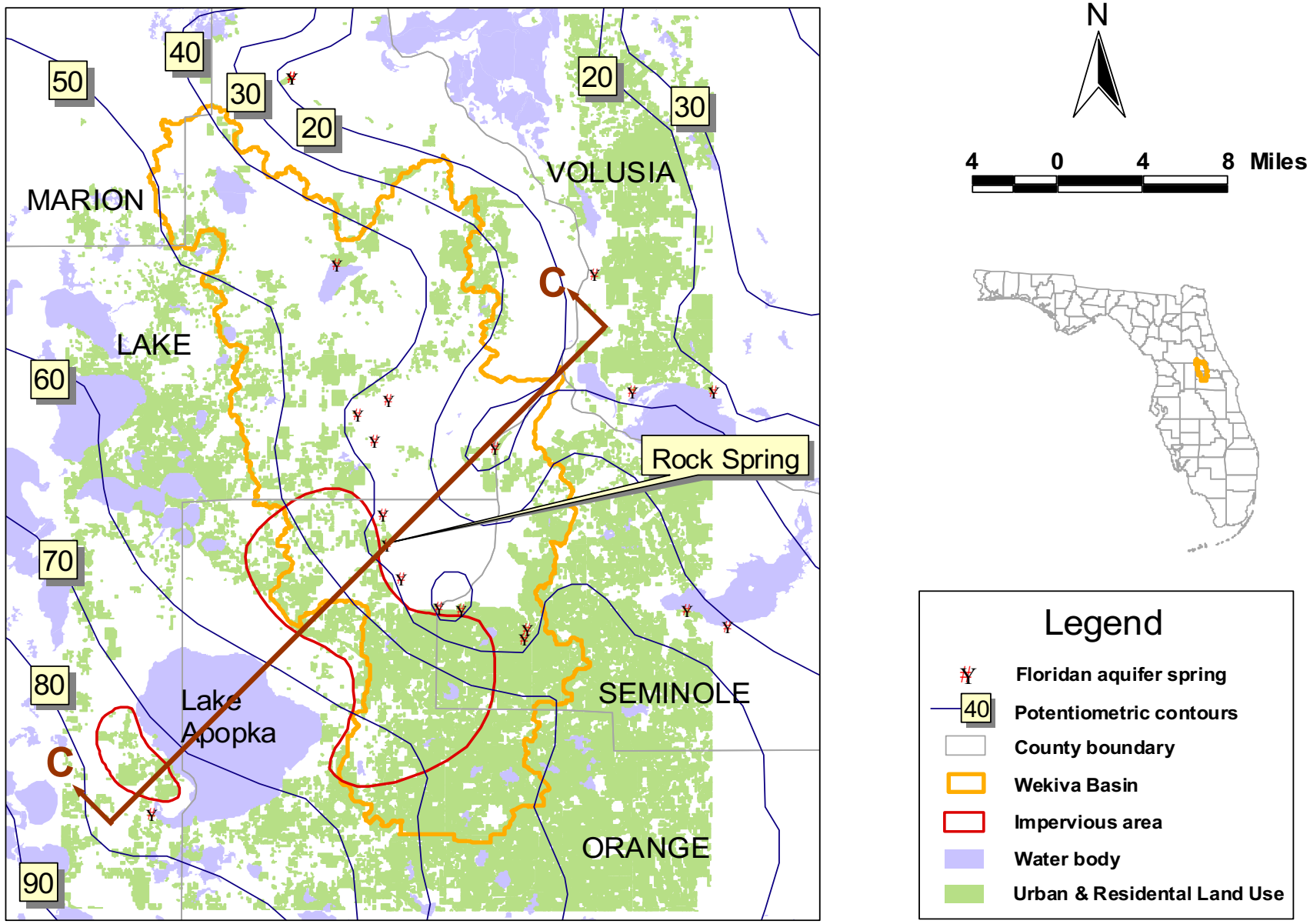


Figure 21: Wekiva River Basin and estimated impervious area

Example Impervious Area

20% coverage (about 60 square miles)
Result is a decrease in Rock Springs Discharge of about 10-15%

However, discharges at other springs are also decreased.

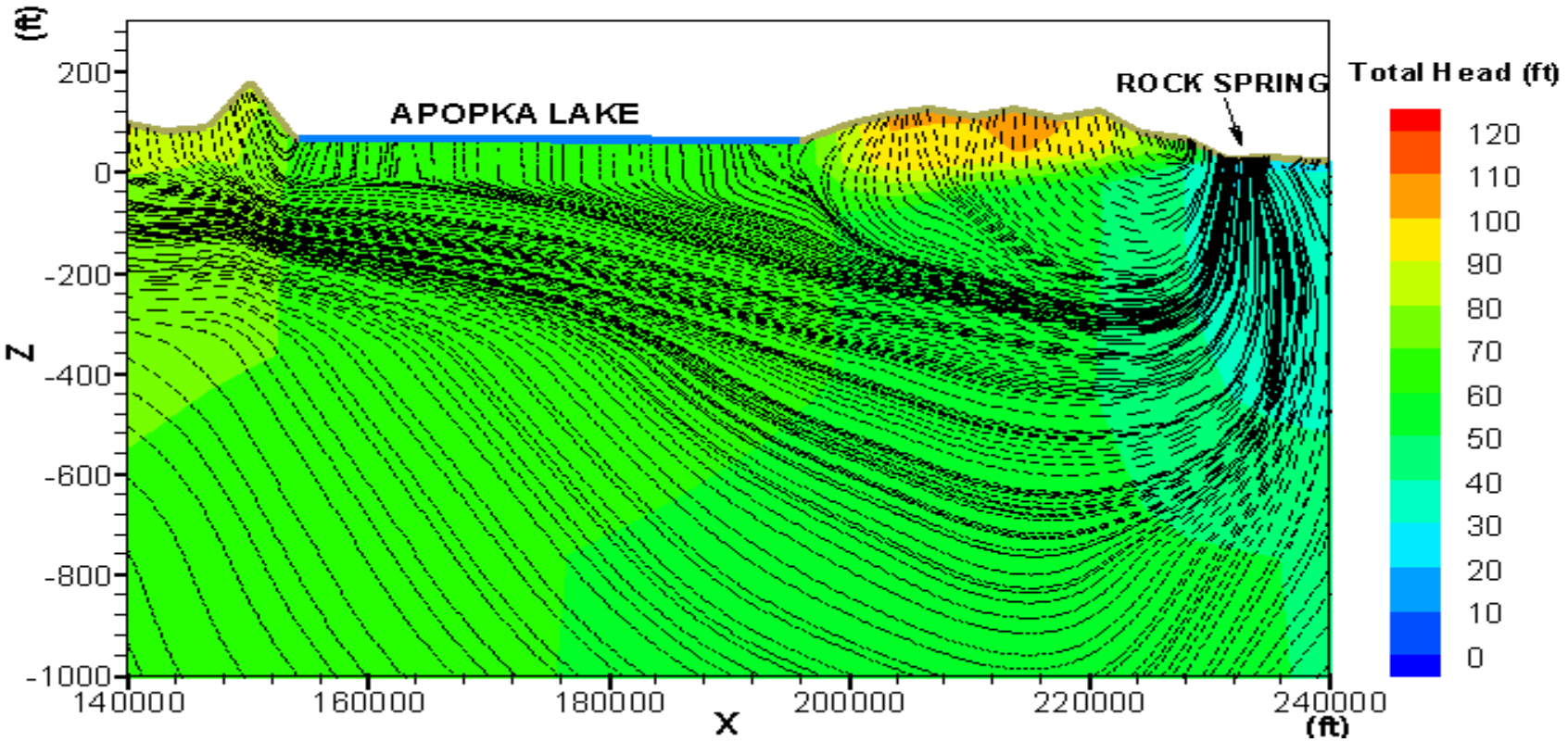
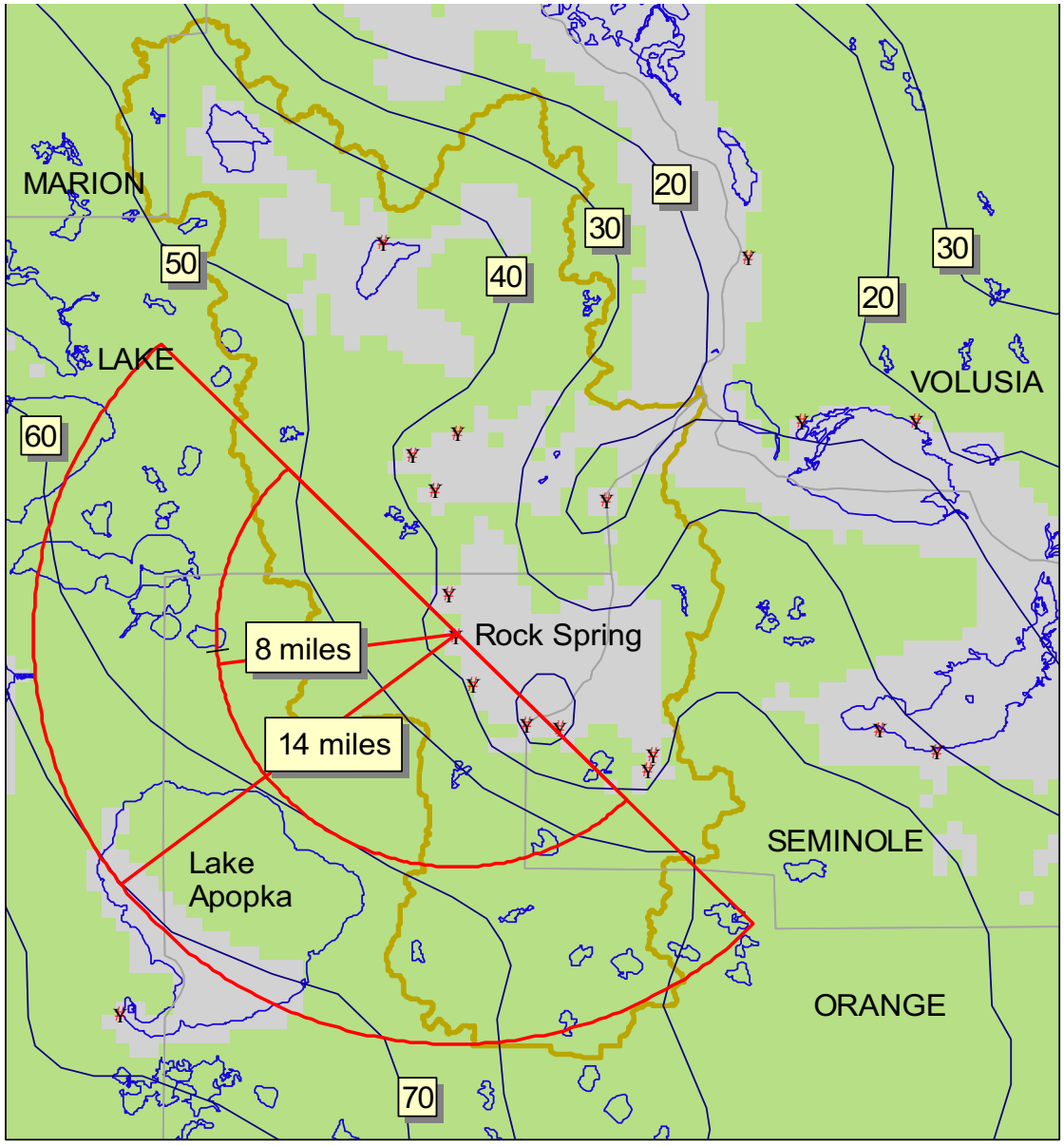
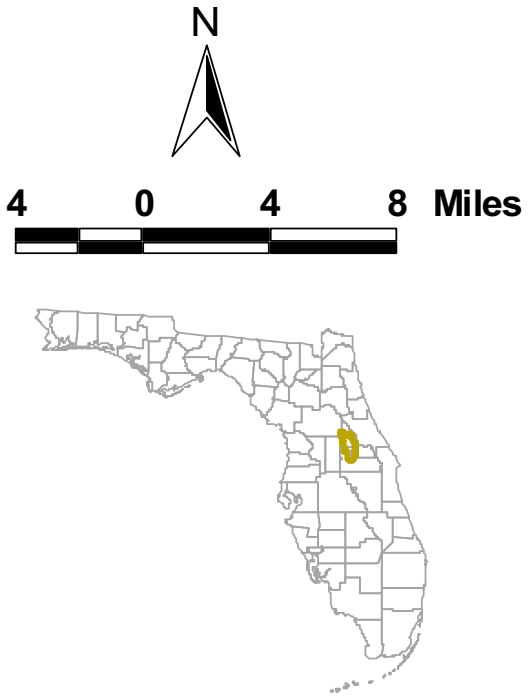


Figure 22-1: Groundwater flow along cross-section C-C before the increase of the impervious area

Flow versus distance

- 70% of Rock Springs springflow comes from an area within 8 miles of Rock Springs.
- Lake Apopka contributes to about another 5% of the flow at Rock Springs.
- All based on the assumptions of the modeling efforts. Not verified…..





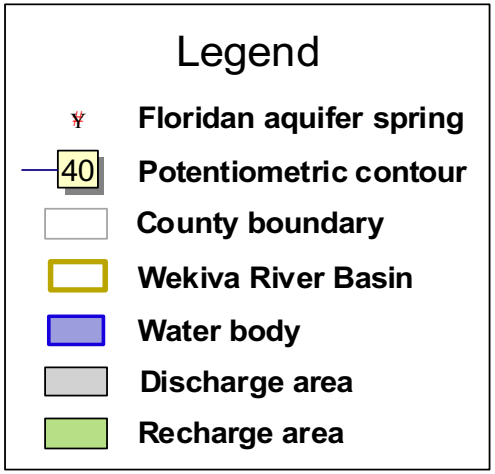
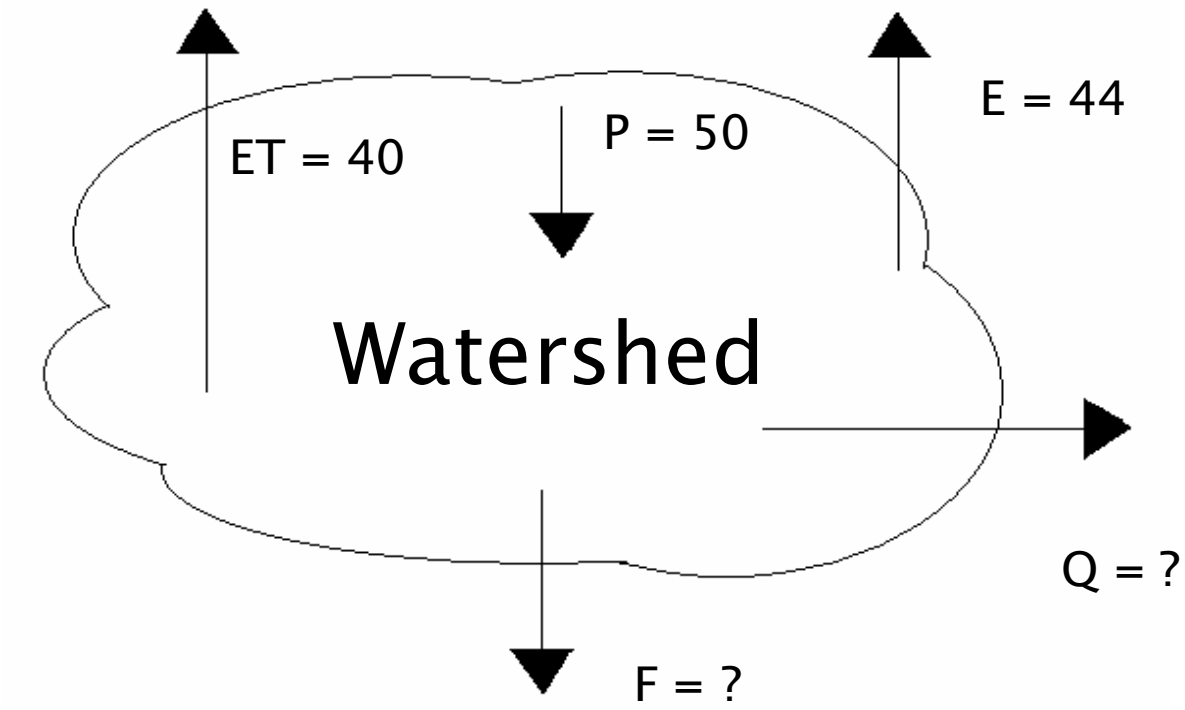


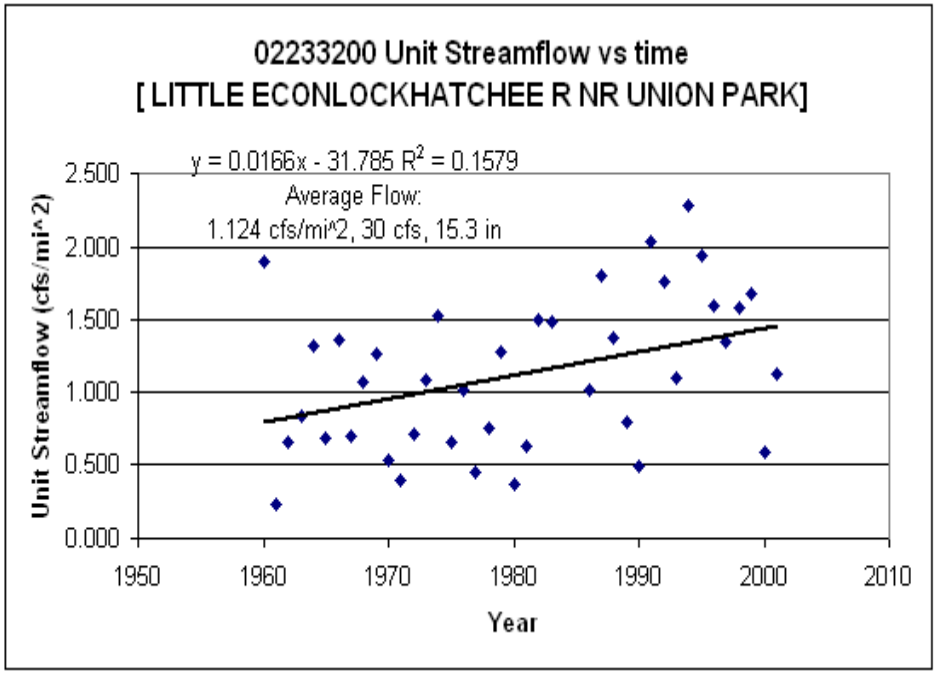
Figure 23: Distance and percentage of groundwater contribution for Rock Spring

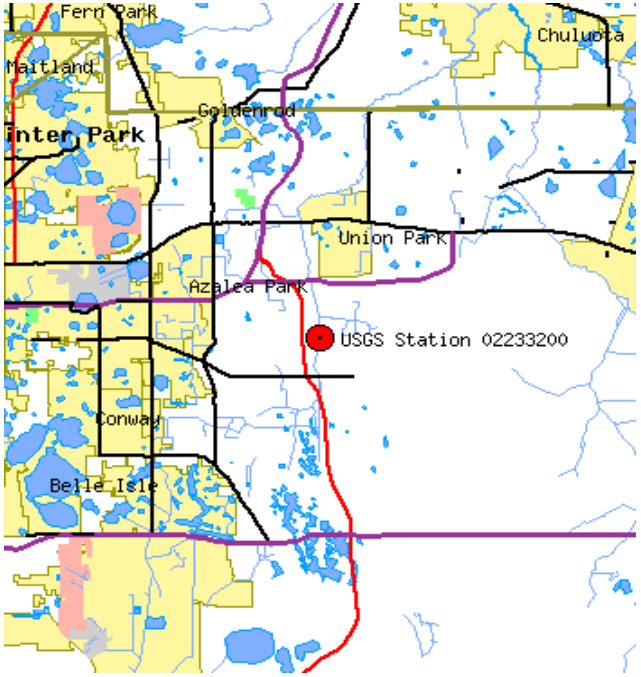
Estimation of yearly water budgets



Yearly Hydrologic Rates - inches

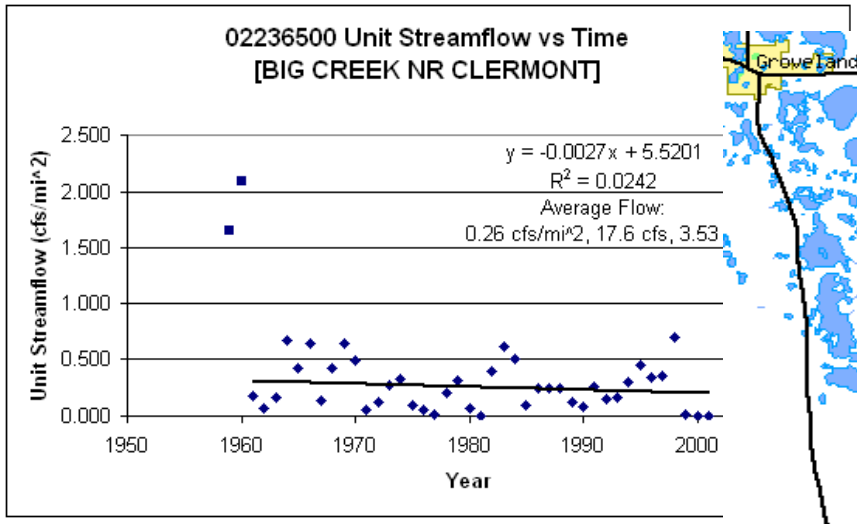
Unit Flow Summary for sites located in Orange County					
Site	Average Unit Flow (cfs/mi^2)	Flow Trend (Δcfs/mi^2/yr)	Inches/yr	Location	Classification
USGS 02232500	0.842	-0.001	11.45	St. John's R. NR Christmas	Rural
USGS 02233001	0.829	0.018	11.27	Econ. R. at Magnolia Ranch	Rural
USGS 02233200	**1.124**	**0.017**	**15.30**	**Litlle Econ. NR Union Park**	**Urban**
USGS 02262900	0.677	0.010	9.20	Boggy Creek NR Taft	Urban
USGS 02264000	0.064	-0.001	0.87	Cypress Creek at Vineland	Controlled
USGS 02264051	3.297	0.077	44.80	Black Lake Outlet at S-101A	Controlled
USGS 02264060	0.378	0.003	5.14	Lateral 101 at S-101 NR B. Vista	Controlled
USGS 02266025	0.114	0.016	1.55	Reedy Creek NR Vineland	Urban
USGS 02266200	0.365	0.013	4.97	Whittenhorse Creek NR Vineland	Urban
USGS 02266291	0.288	0.015	3.92	Doctor Phillips	Urban
USGS 02266295	0.620	-0.060	8.43	Vineland	Controlled

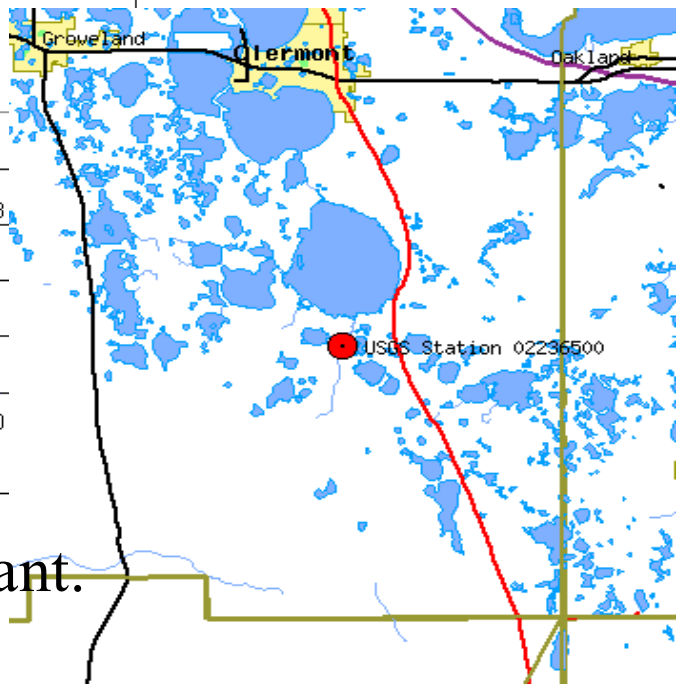




98 % confident Unit Discharge is increasing.

Unit Flow Summary for sites located in Lake County					
Site	Average Unit Flow (cfs/mi^2)	Flow Trend (Δcfs/mi^2/yr)	Inches/yr	Location	Classification
USGS 02235200	0.447	-0.010	6.10	Blackwater Creek NR Cassia	Rural
USGS 02236000	0.996	-0.002	13.54	St. John's R. NR Deland	Rural
USGS 02236500	**0.259**	**-0.003**	**3.53**	**Big Creek NR Clermont**	**Rural**
USGS 02236700	0.785	0.001	10.70	Little Creek NR Clermont	Rural
USGS 02236900	0.140	-0.009	1.85	Cherry LK Out NR Groveland	Rural
USGS 02237293	0.129	-0.001	1.75	Palatlakaha NR Okahumpka	Rural
USGS 02237700	0.400	-0.007	4.90	Apopka Beauclair Canal	Rural
USGS 02238000	0.324	-0.005	4.40	Haines Creek at Lisbon	Urban





Unit Discharge is constant.

Low Unit Discharge – more water is infiltrated.

Unit Flow Summary for sites located in Lake County					
Site	Average Unit Flow (cfs/mi^2)	Flow Trend (Δcfs/mi^2/yr)	Inches/yr	Location	Classification
USGS 02235200	0.447	-0.010	6.10	Blackwater Creek NR Cassia	Rural
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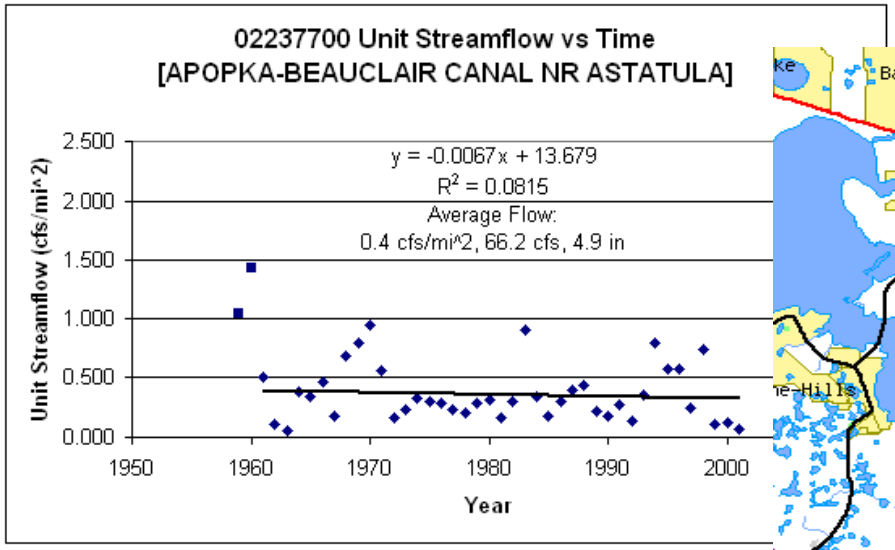
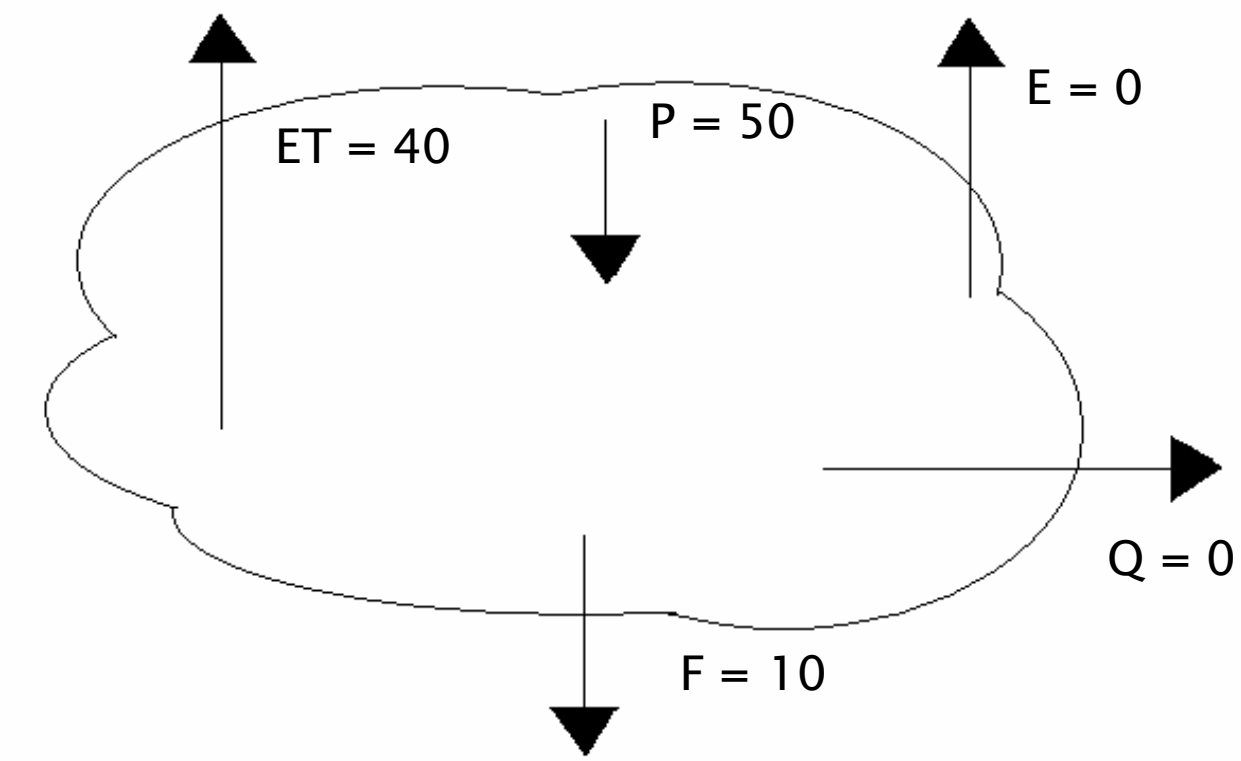
USGS 02238000	0.324	-0.005	4.40	Haines Creek at Lisbon	Urban



Unit Discharge is constant.

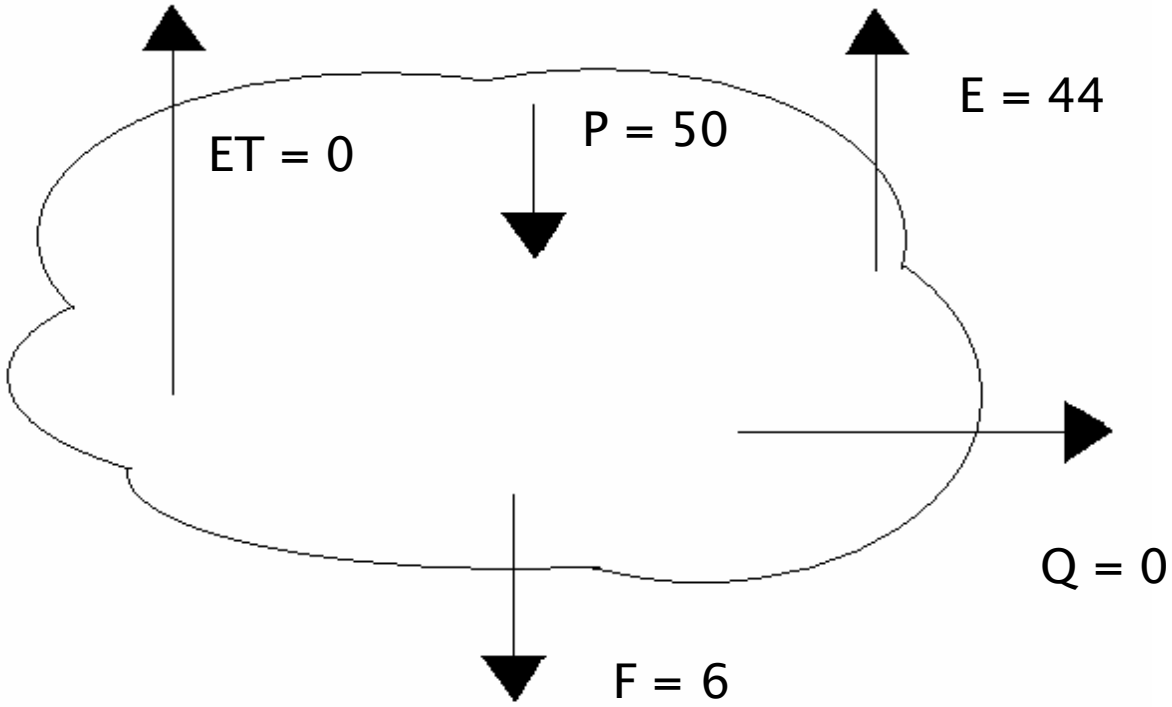
Low Unit Discharge – more water is infiltrated.

Land Locked
100% Vegetation
Watershed



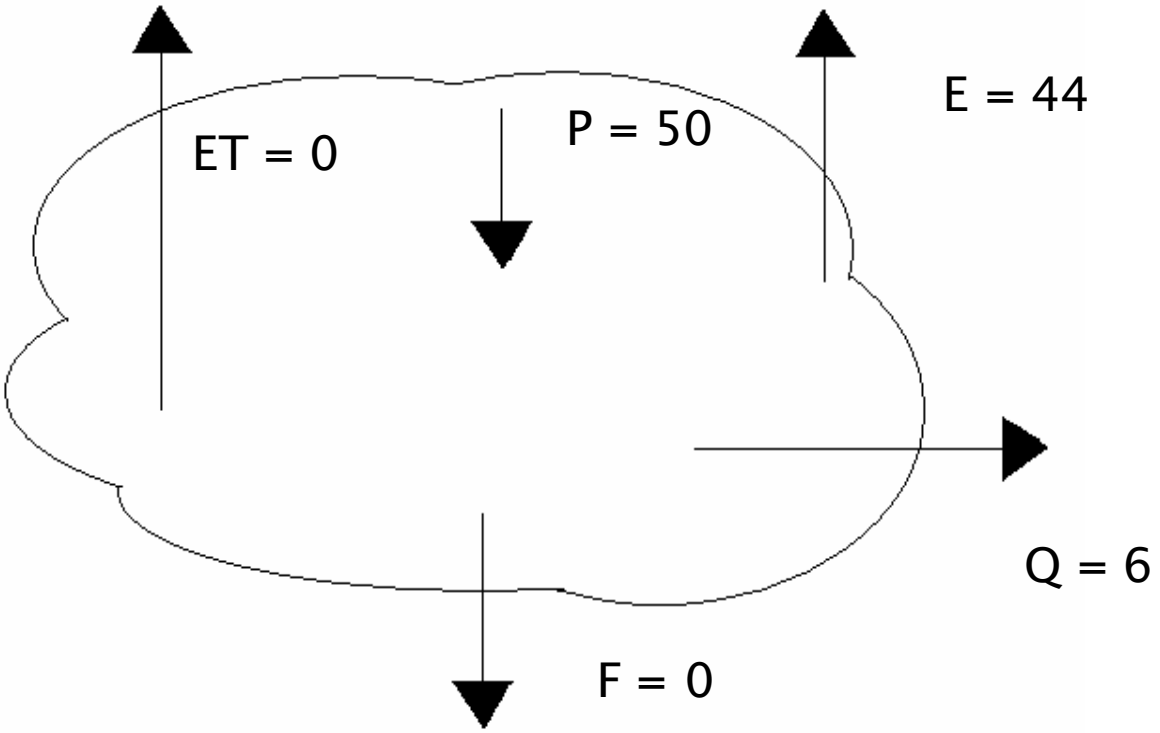
Yearly Water Budget - inches

Land Locked Lake



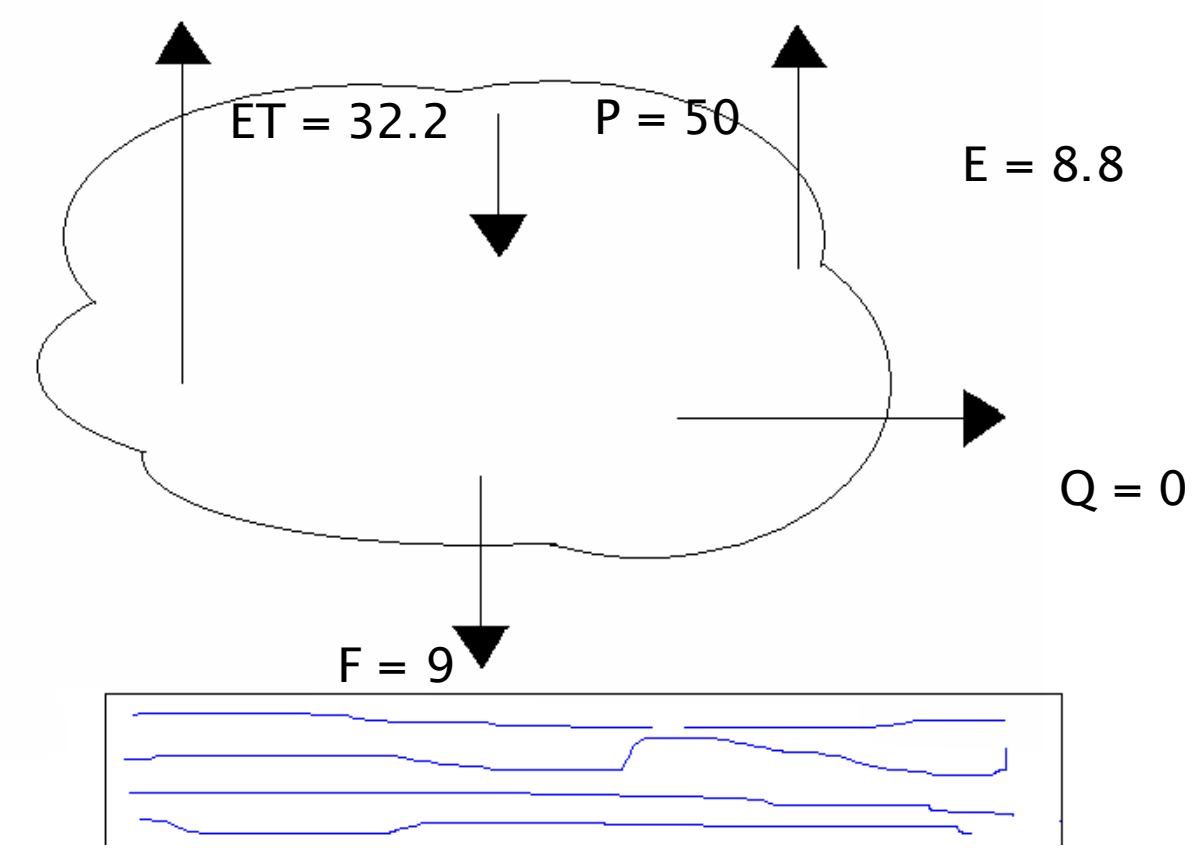
Yearly Water Budget (inches per year)

Discharge Lake



Yearly Water Budget (inches per year) Remember Lake Apopka Canal? 4.9 in/yr Most lakes both recharge and discharge during a year. The net yearly effect can be either discharge or recharge

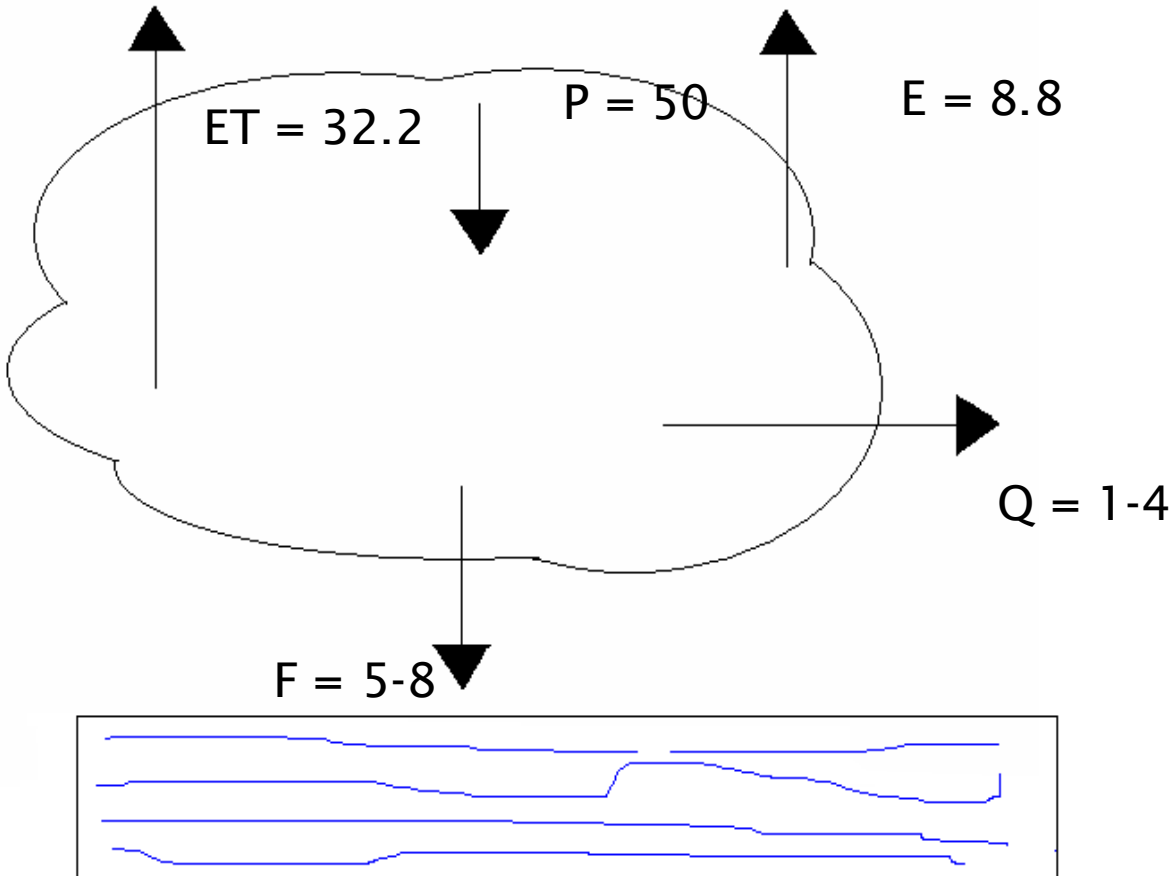
Typical Watershed
no DCIA, ~80% vegetation
~20% water surfaces



Recharge or Closed Watershed

Water Budget inches per year

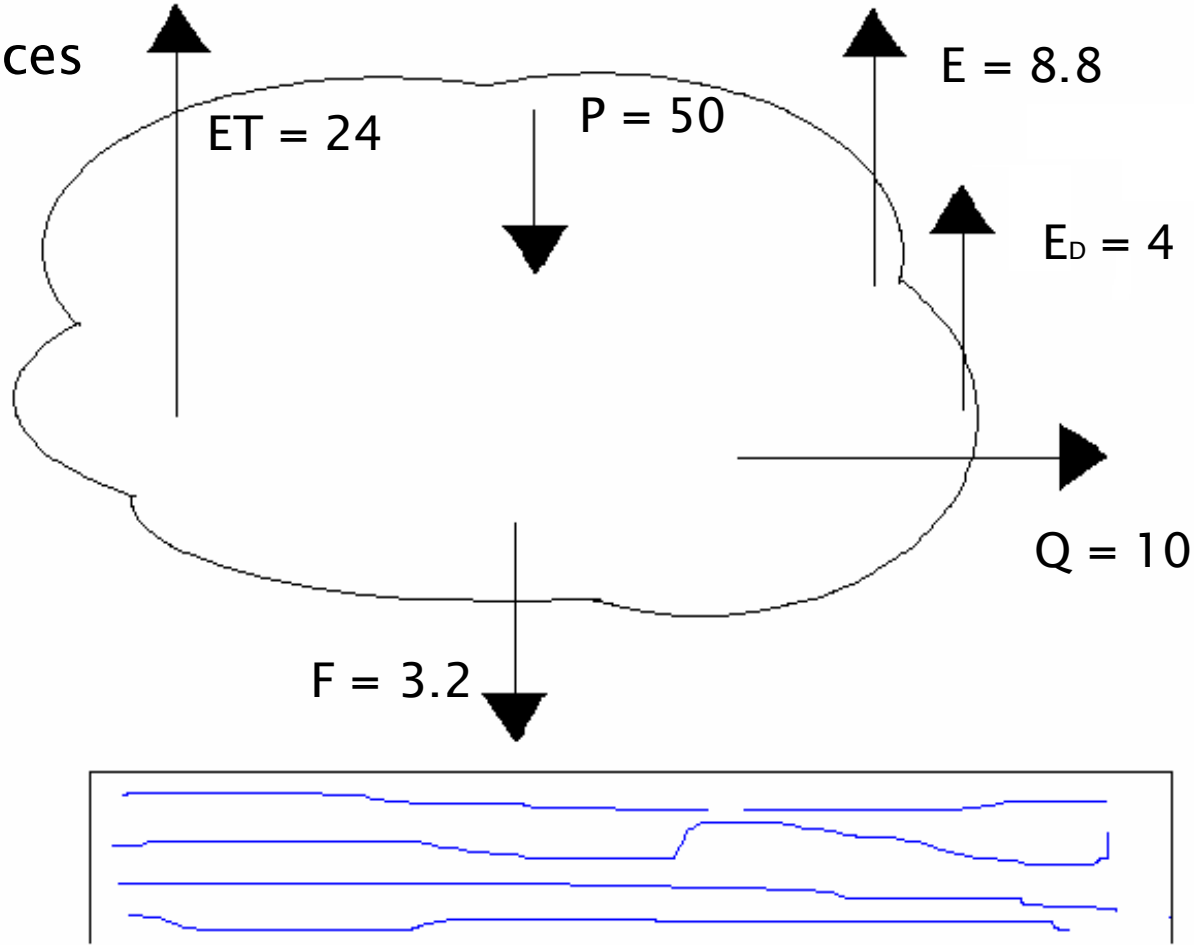
Typical Watershed
no DCIA, ~80% vegetation
~20% water surfaces



Discharge/Recharge Watershed

Water Budget inches per year

Typical Watershed
20% DCIA, ~60% vegetation
~20% water surfaces



Discharge/Recharge Watershed

Water Budget inches per year

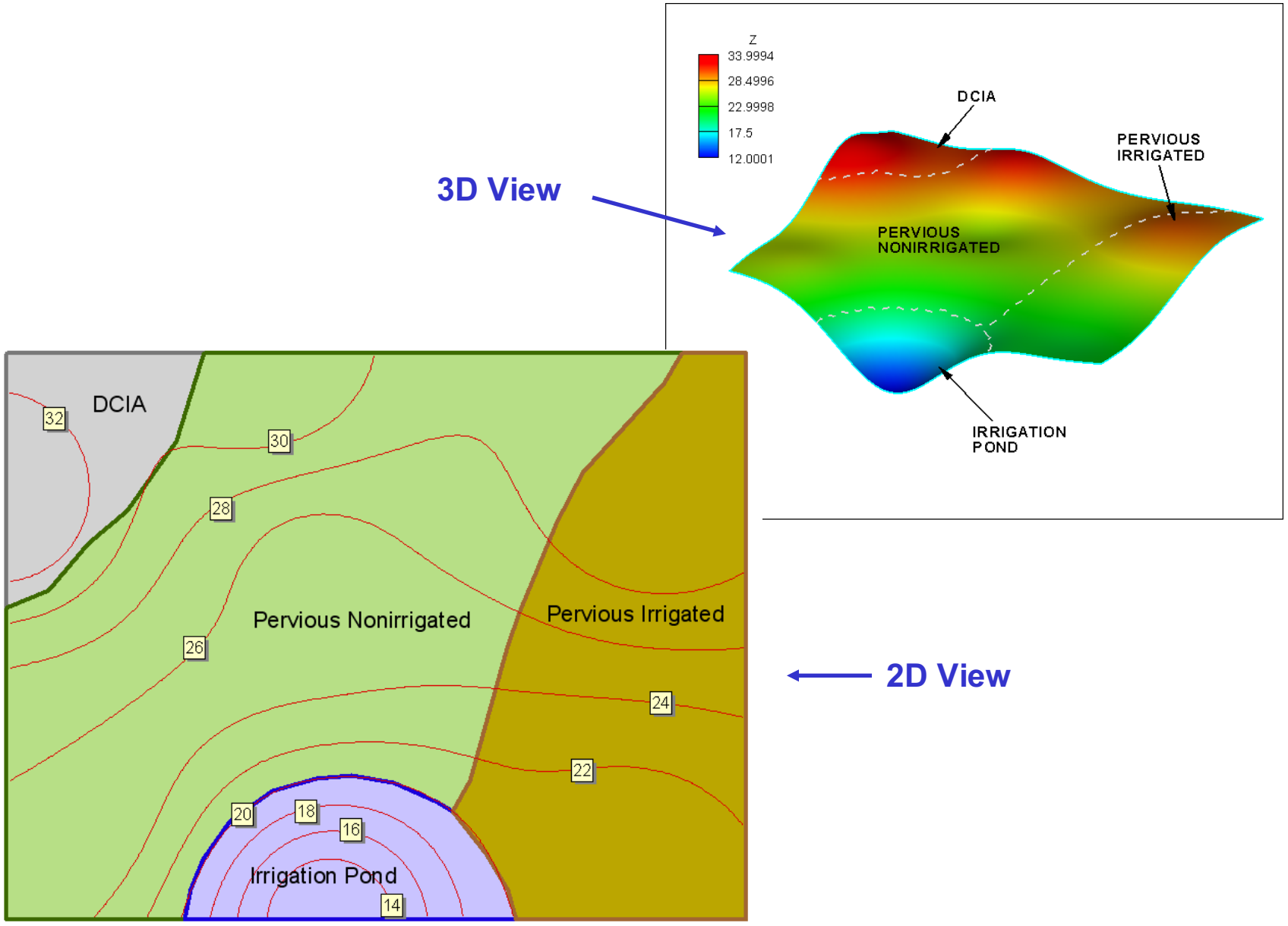
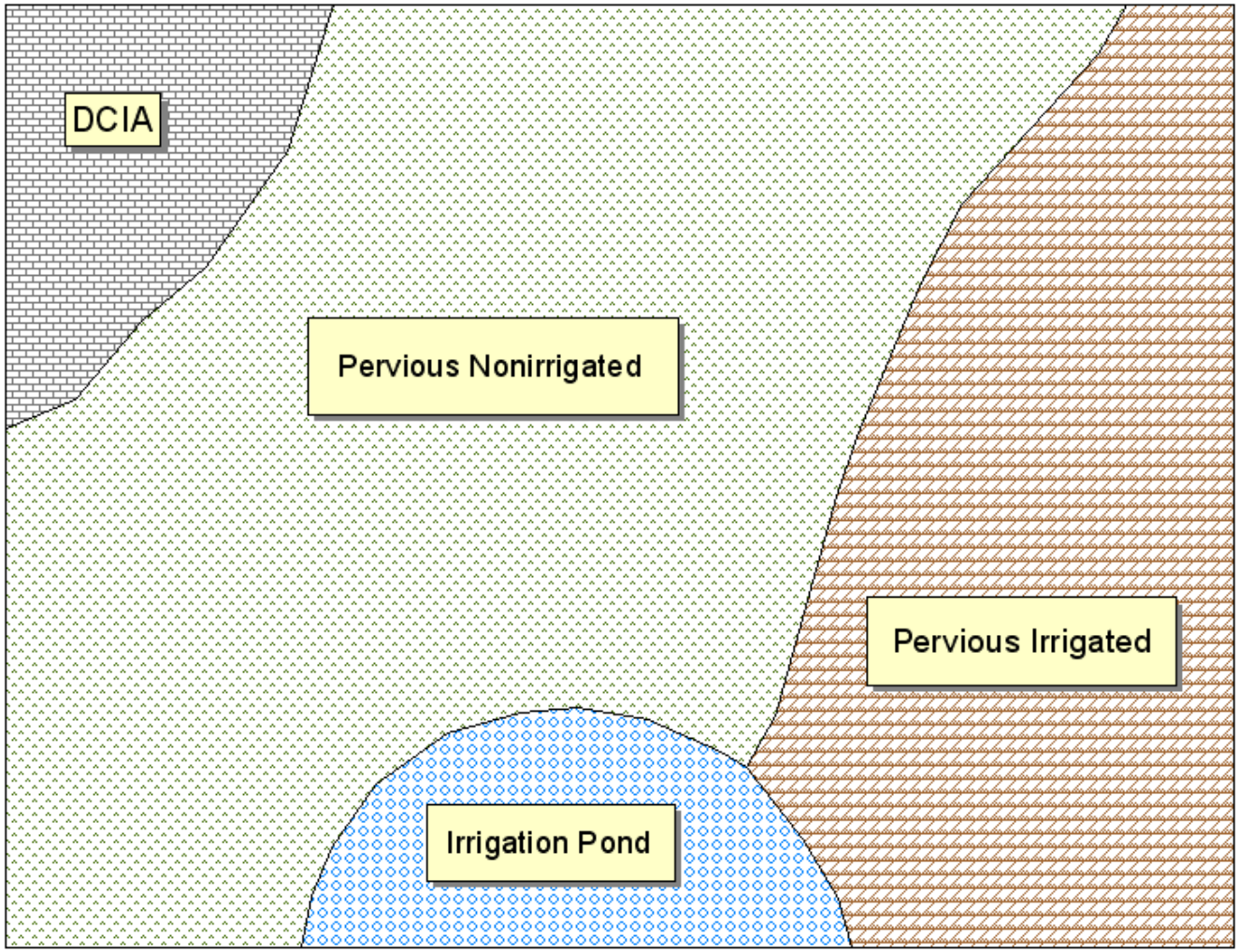


Figure 1: Land surface elevations for a closed basin (unit: feet NGVD)



Total Watershed:

9.97 acres

DCIA:

0.78 acre

Pervious Nonirrigated:

5.49 acres

Pervious Irrigated:

2.84 acres

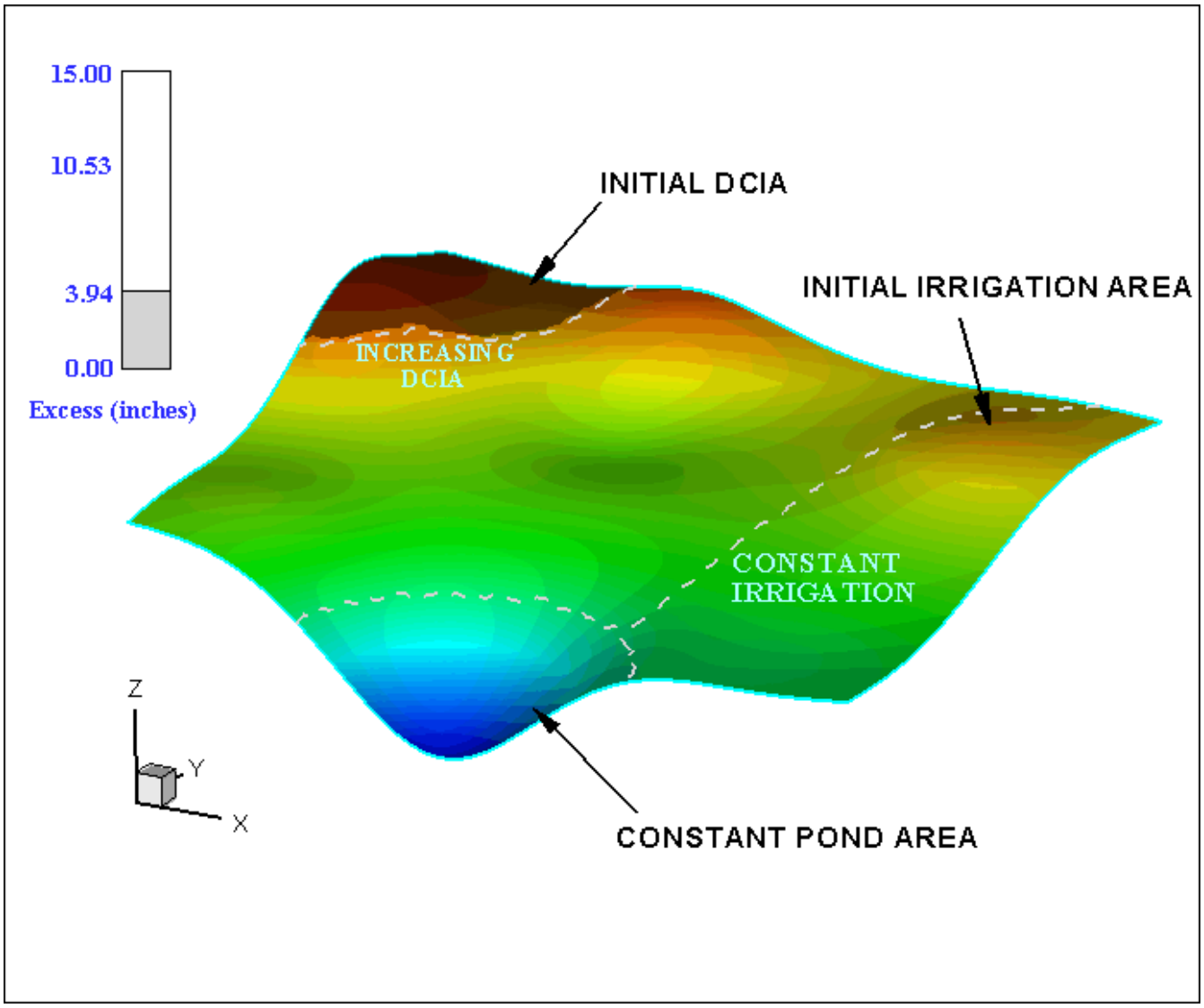
Irrigation Ponds:

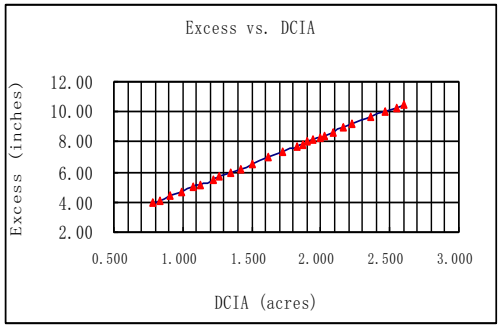
0.86 acre

Pervious + Irrigation Excess:

3.94 inches

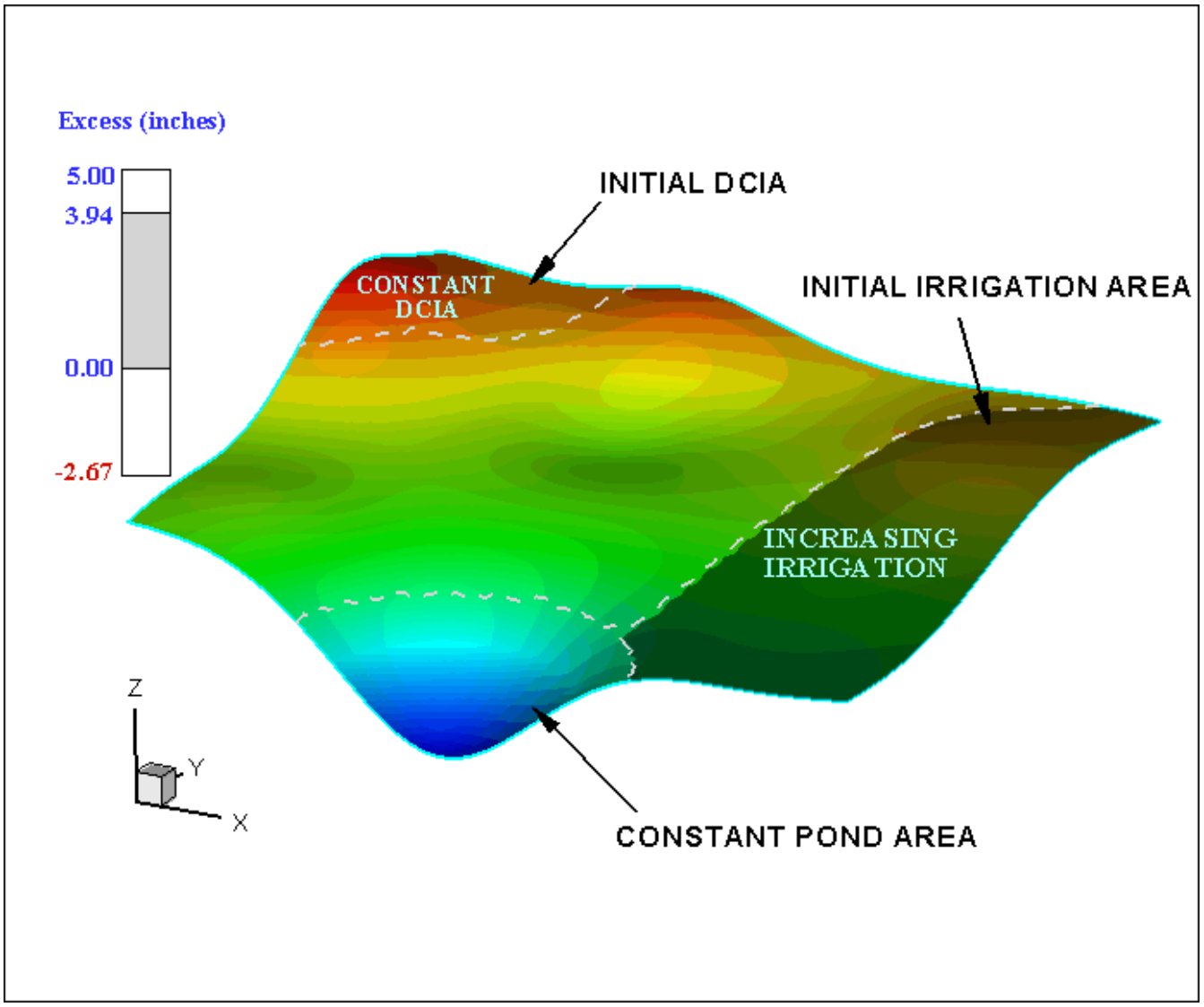
Figure 2: Land Use before tremendous urbanization for a closed basin (P = 50.0, E = 44.0, ET = 40.0, IET = 30.0, IA = 4.0, unit: inches/year)

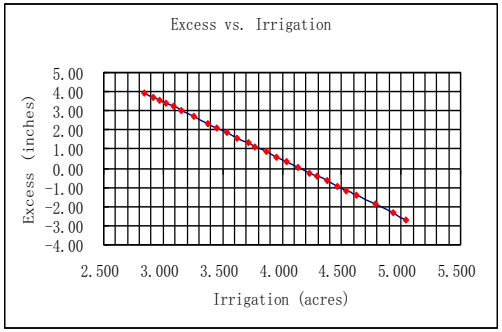




DCIA (acres)	Excess (inches)
0.784	3.94
0.838	4.14
0.912	4.40
0.990	4.69
1.079	5.01
1.129	5.19
1.218	5.51
1.262	5.67
1.343	5.96
1.420	6.24
1.505	6.55
1.619	6.96
1.722	7.33
1.826	7.71
1.873	7.87
1.905	7.99
1.948	8.15
2.000	8.33
2.031	8.45
2.088	8.65
2.168	8.94
2.228	9.16
2.359	9.63
2.462	10.00
2.547	10.31
2.607	10.53

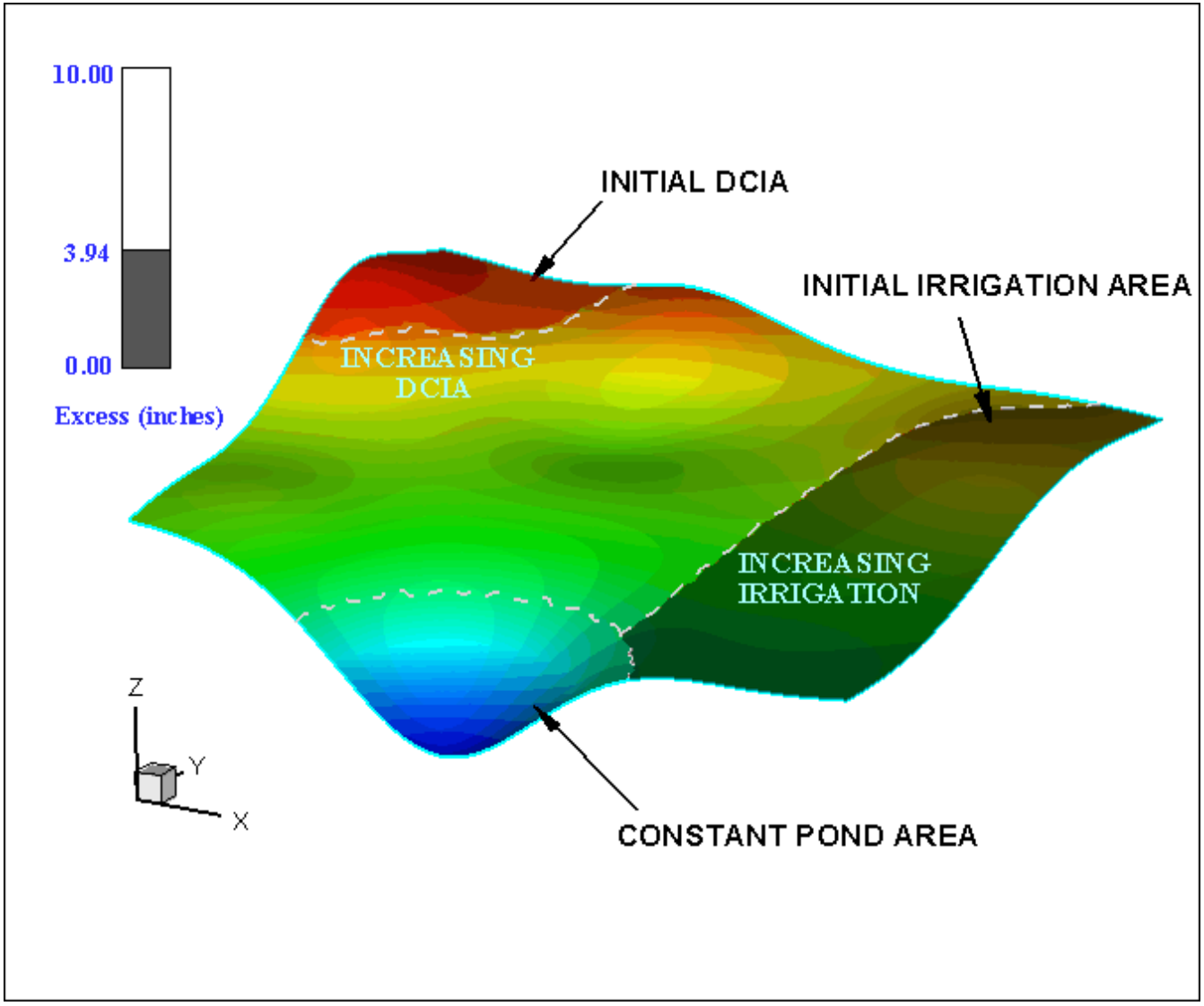
Figure 3: Excess vs. increasing DCIA and constant Irrigation for the closed basin

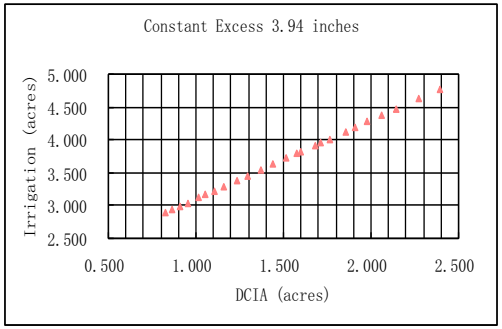




Irrigation (acres)	Excess (inches)
2.840	3.94
2.916	3.71
2.967	3.56
3.021	3.40
3.085	3.21
3.156	2.99
3.260	2.68
3.376	2.33
3.452	2.10
3.531	1.86
3.620	1.60
3.715	1.31
3.772	1.14
3.869	0.85
3.955	0.59
4.033	0.35
4.130	0.06
4.229	-0.24
4.298	-0.44
4.375	-0.68
4.463	-0.94
4.536	-1.16
4.626	-1.43
4.783	-1.90
4.932	-2.35
5.036	-2.67

Figure 4: Excess vs. increasing Irrigation and constant DCIA for the closed basin
(Note: negative excess means water needs to be introduced into the basin)





DCIA (acres)	Irrigation (acres)
0.829	2.895
0.865	2.936
0.912	2.995
0.952	3.043
1.016	3.120
1.055	3.164
1.103	3.222
1.162	3.293
1.235	3.382
1.296	3.454
1.372	3.546
1.437	3.625
1.517	3.720
1.577	3.790
1.599	3.818
1.682	3.920
1.714	3.958
1.762	4.015
1.859	4.130
1.906	4.188
1.980	4.275
2.057	4.370
2.147	4.475
2.275	4.630
2.392	4.770

Figure 5: Excess vs. increasing both DCIA and Irrigation for the closed basin

Conclusions

1. Springflow is affected by the groundwater levels.
2. Recharge can be shown by modeling to affect spring flow and Wetland conservation.
3. Mass balances on a yearly basis can assist in estimating unknowns such as runoff or recharge.
4. Irrigation of detained stormwater can be built into a stormwater management plan and cluster development is an option to provide undisturbed land for irrigation.