Ground Water Investigation Program

An overview of a new MBMG Hydrogeology Program

John Wheaton

Presented to the MBIA
October 5, 2012

Where do people get water?
In Montana

How many sources are there?

How much water do we use?

Do our actions impact the resources?

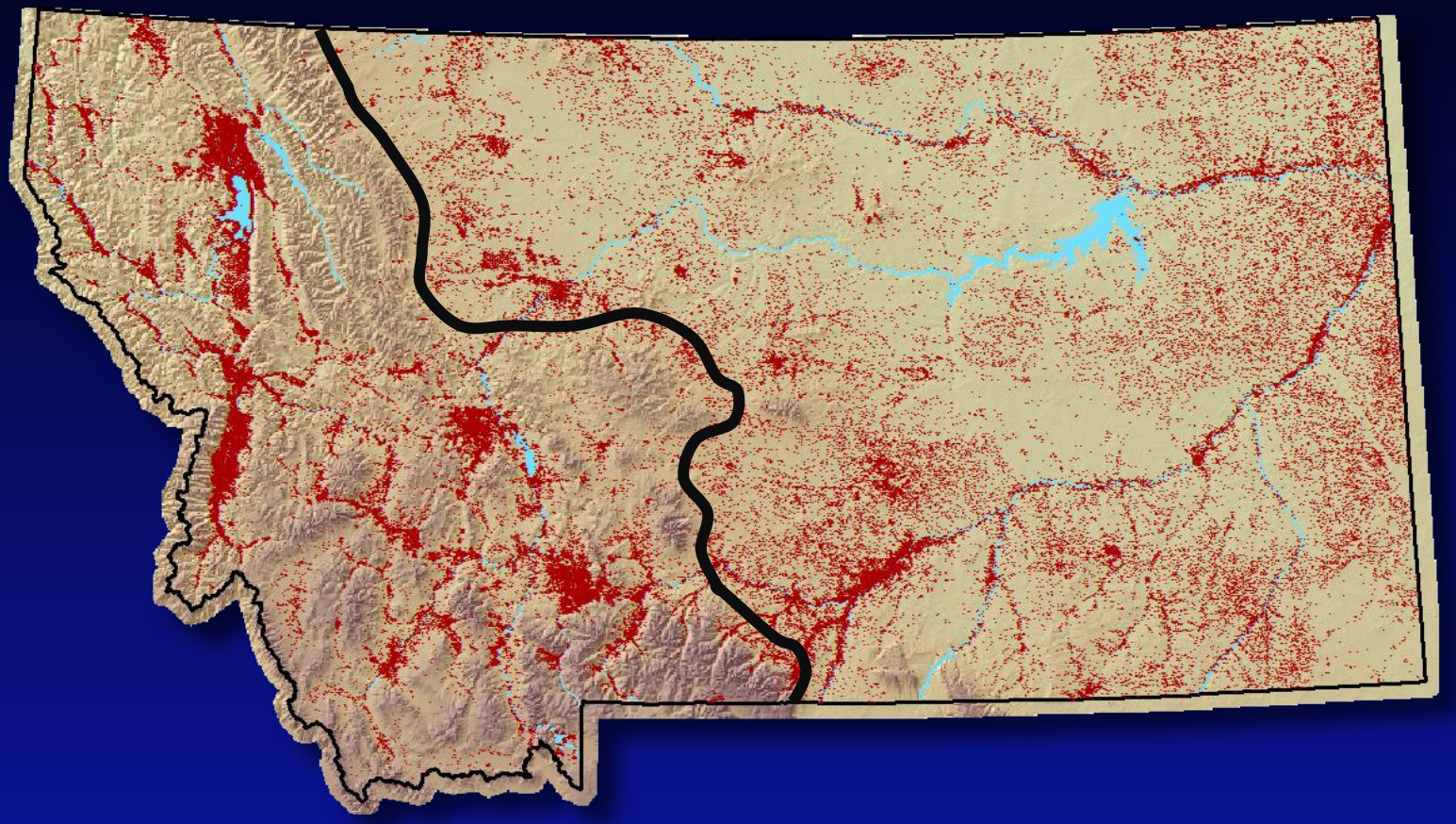
Where do people get water? In Montana (2005)

Total Population:	**936,000**	
PWS from Groundwater:	**275,000**	**61%**
Individual wells:	**300,500**	
Surface water (PWS):	**360,500**	**39%**

Dominant Aquifers

Western Montana
Basin – fill aquifers (gravel, etc)

Eastern Montana
Bedrock aquifers

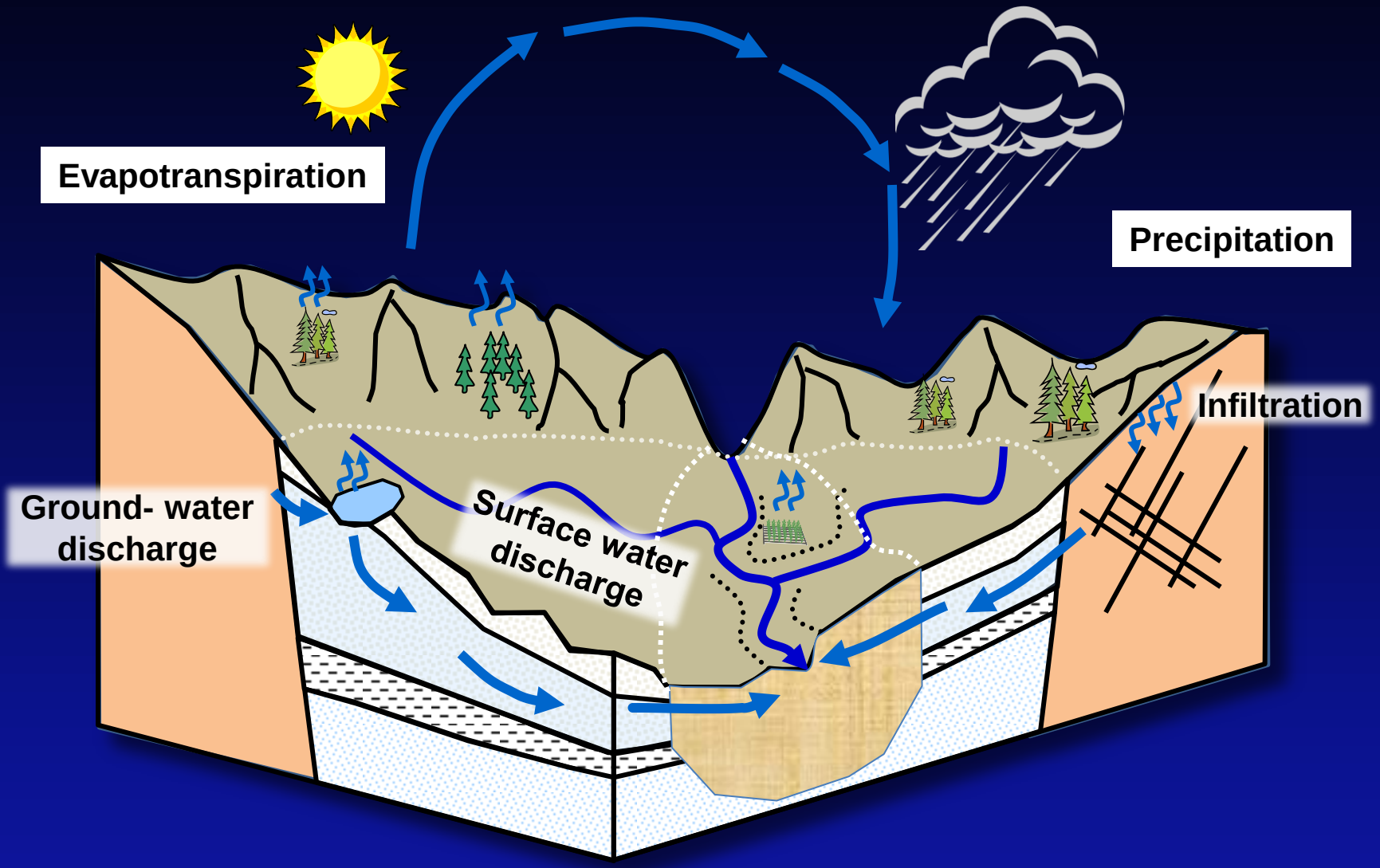


About 225,000 wells in the Ground-Water Information Center (GWIC) database.

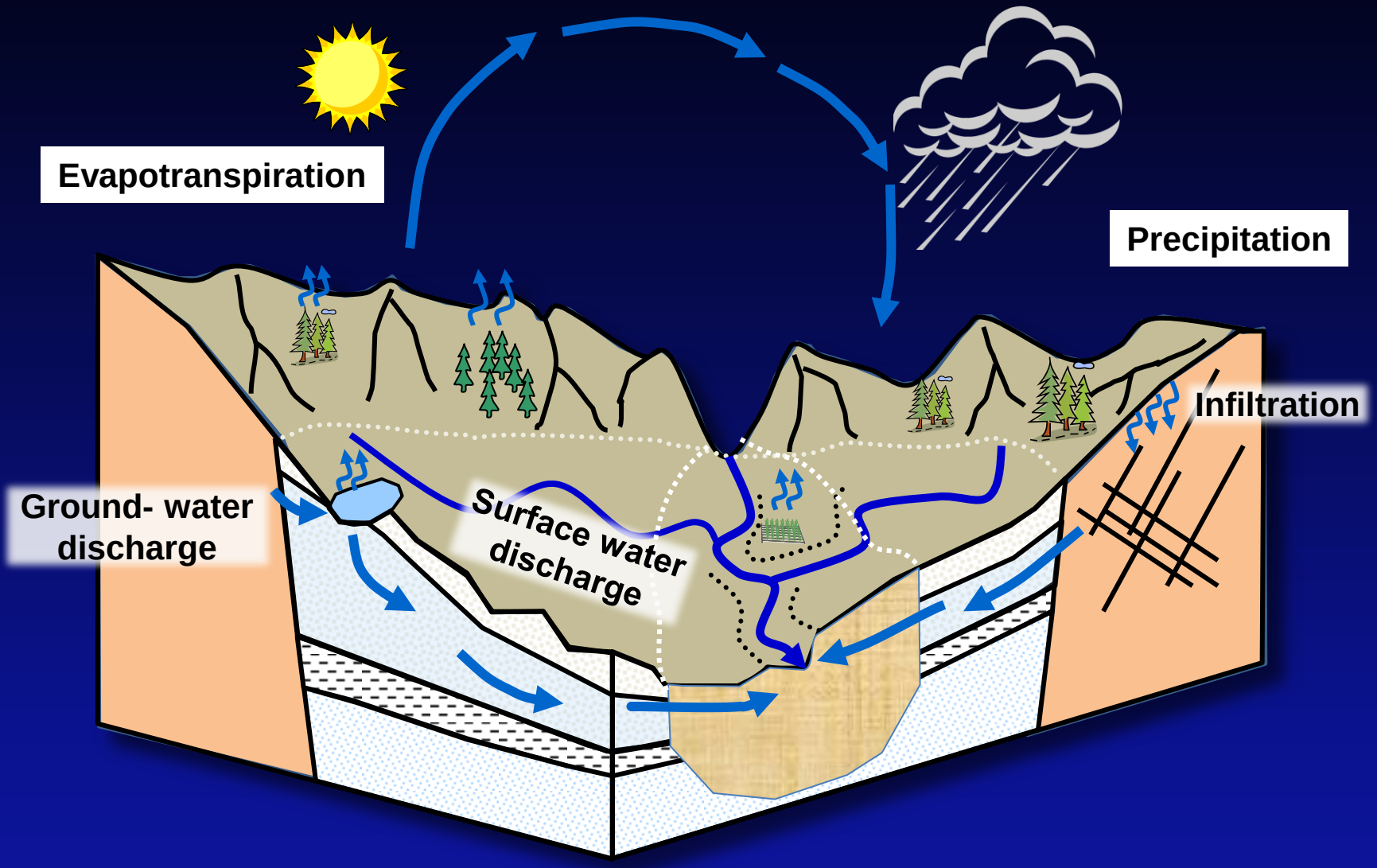
Hydrologic Cycles

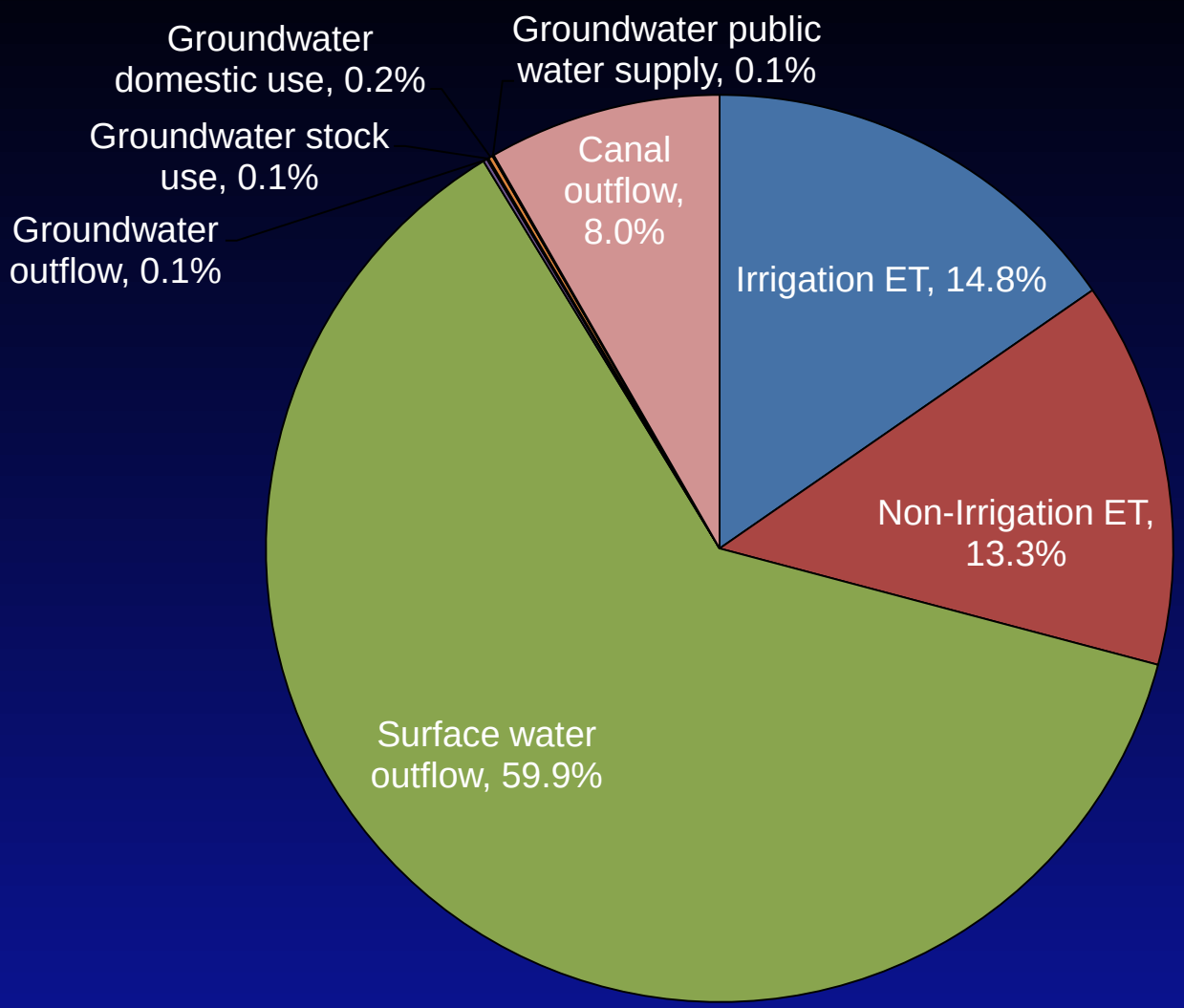
Understanding how specific ones work

And our role in them



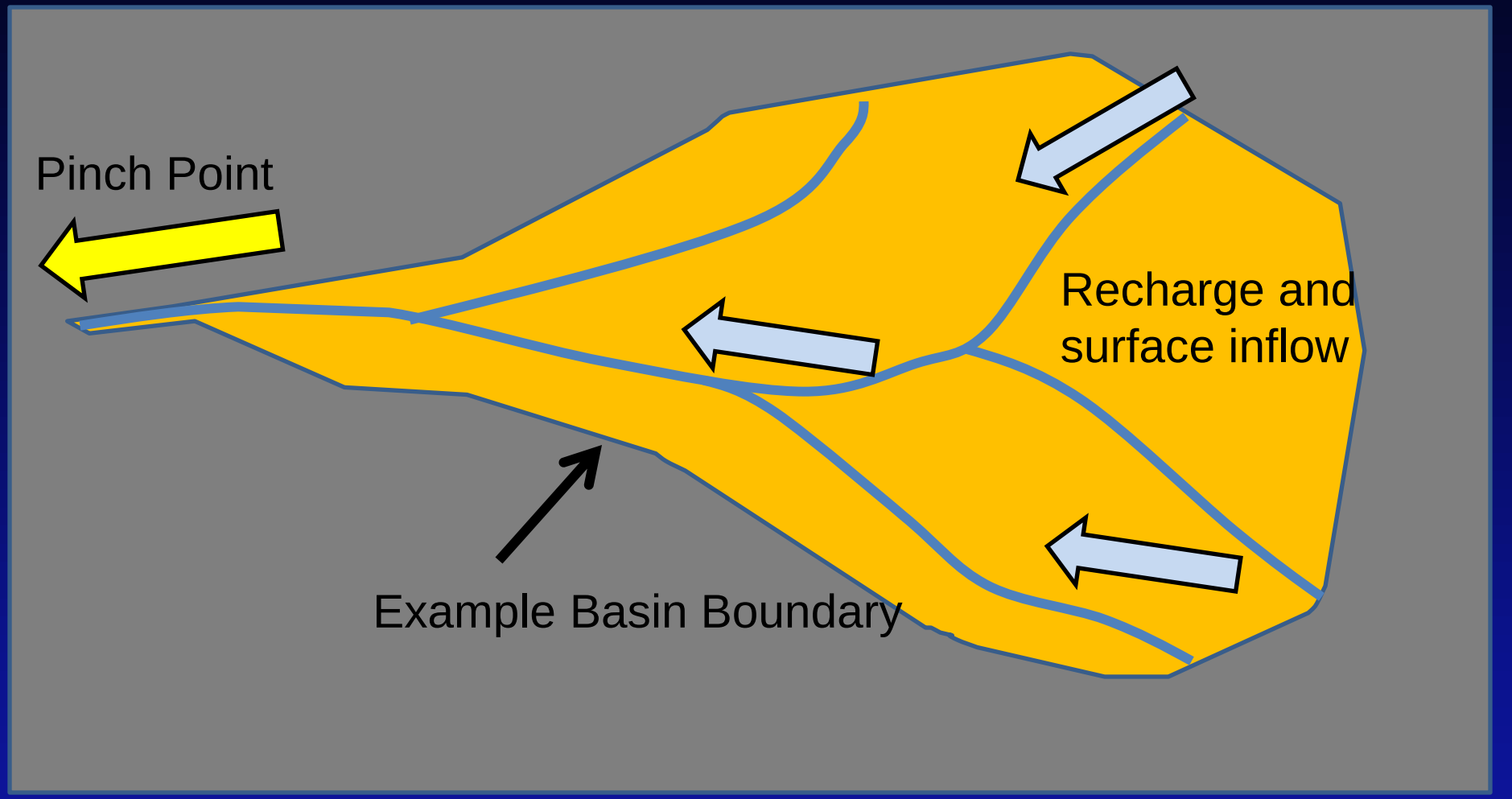
Water Budgets
Essential tools for management



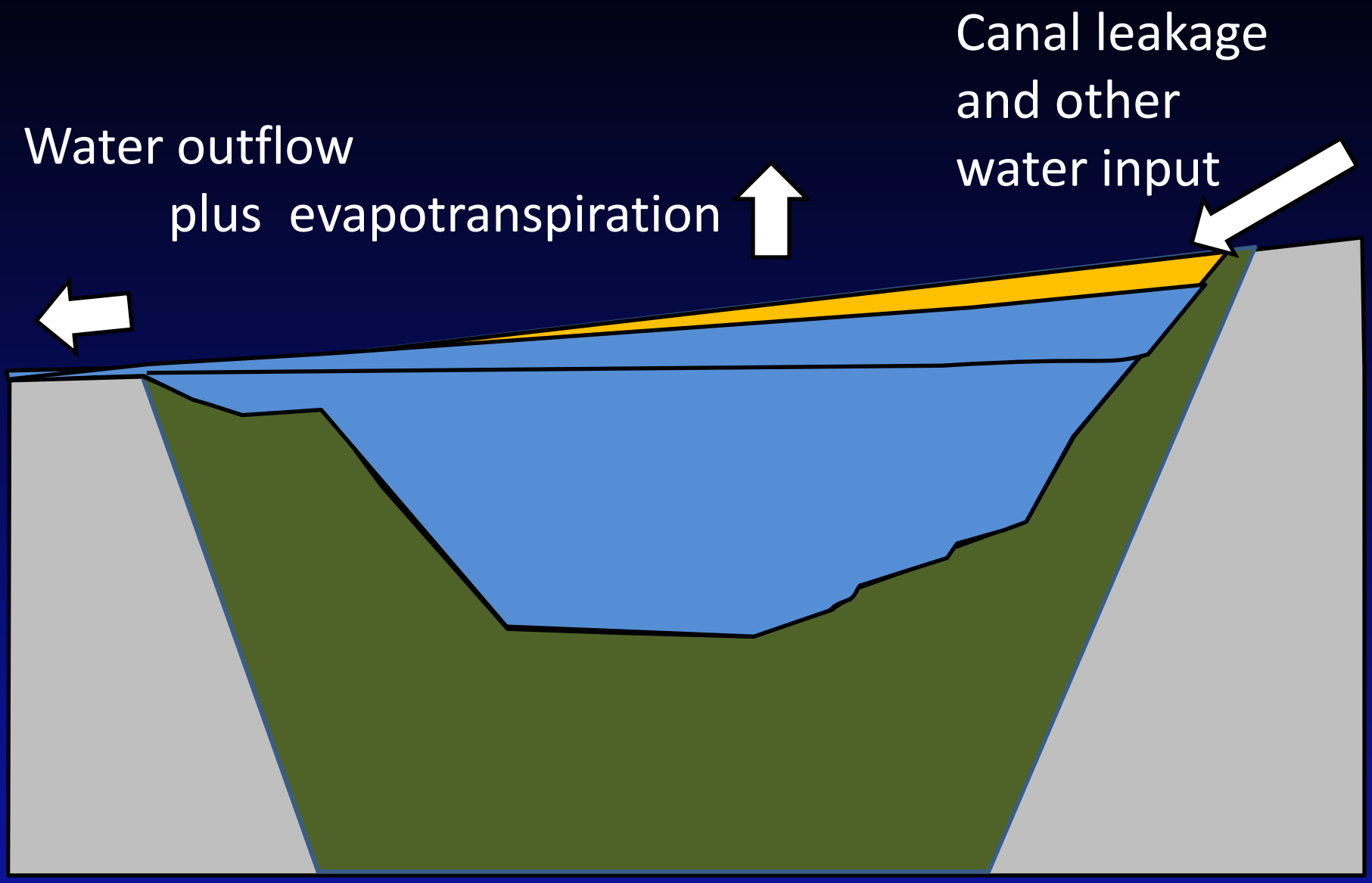

Groundwater domestic use, 0.2%
Groundwater public water supply, 0.1%
Groundwater stock use, 0.1%
Groundwater outflow, 0.1%
Canal outflow, 8.0%
Irrigation ET, 14.8%
Non-Irrigation ET, 13.3%
Surface water outflow, 59.9%

Some valley fill aquifers:

Large basin, both groundwater and surface are forced through a restricted pinch point.



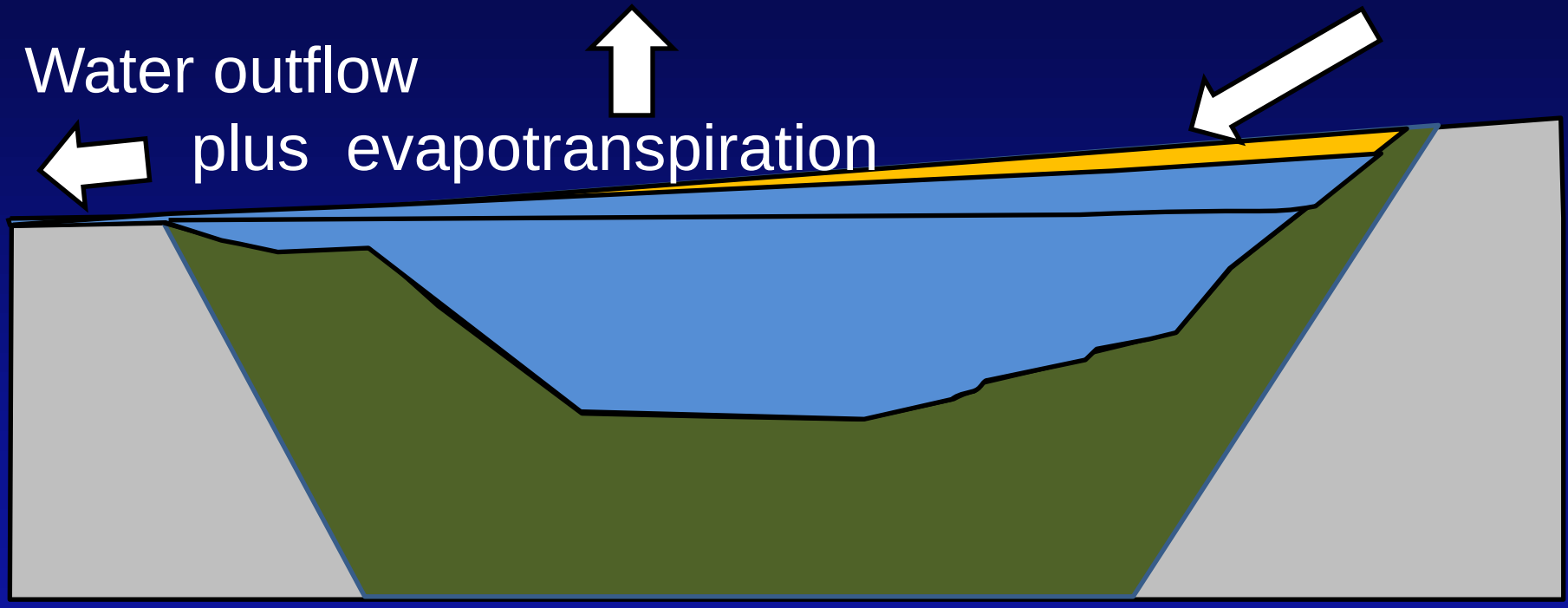
Valley fill aquifer - Annual basin recharge is enhanced by irrigation.



Groundwater level is the gradient (energy slope) moving water out of the basin.

It is a function of:

elevation of discharge point (controls outflow level)
amount of input
loss within the basin (ET)



WHY:

Ground-Water Investigation Program (G W I P)

Competition for groundwater resources;

Lack of groundwater / surface-water information;

Need to answer locally identified questions;

Focused, intensive studies

in a structured, widely accepted program;

What:

Ground-Water Investigation Program (G W I P)

- **State funded and guided research program**
- **Addressing specific groundwater questions across Montana**
- **All results and data are public, available on Internet**

http://www.mbmg.mtech.edu/gwip/gwip.asp

Additional Points:

Understanding impacts and **lack** of impacts,
both are equally important

Provide information so aquifers can be managed,
Not just used

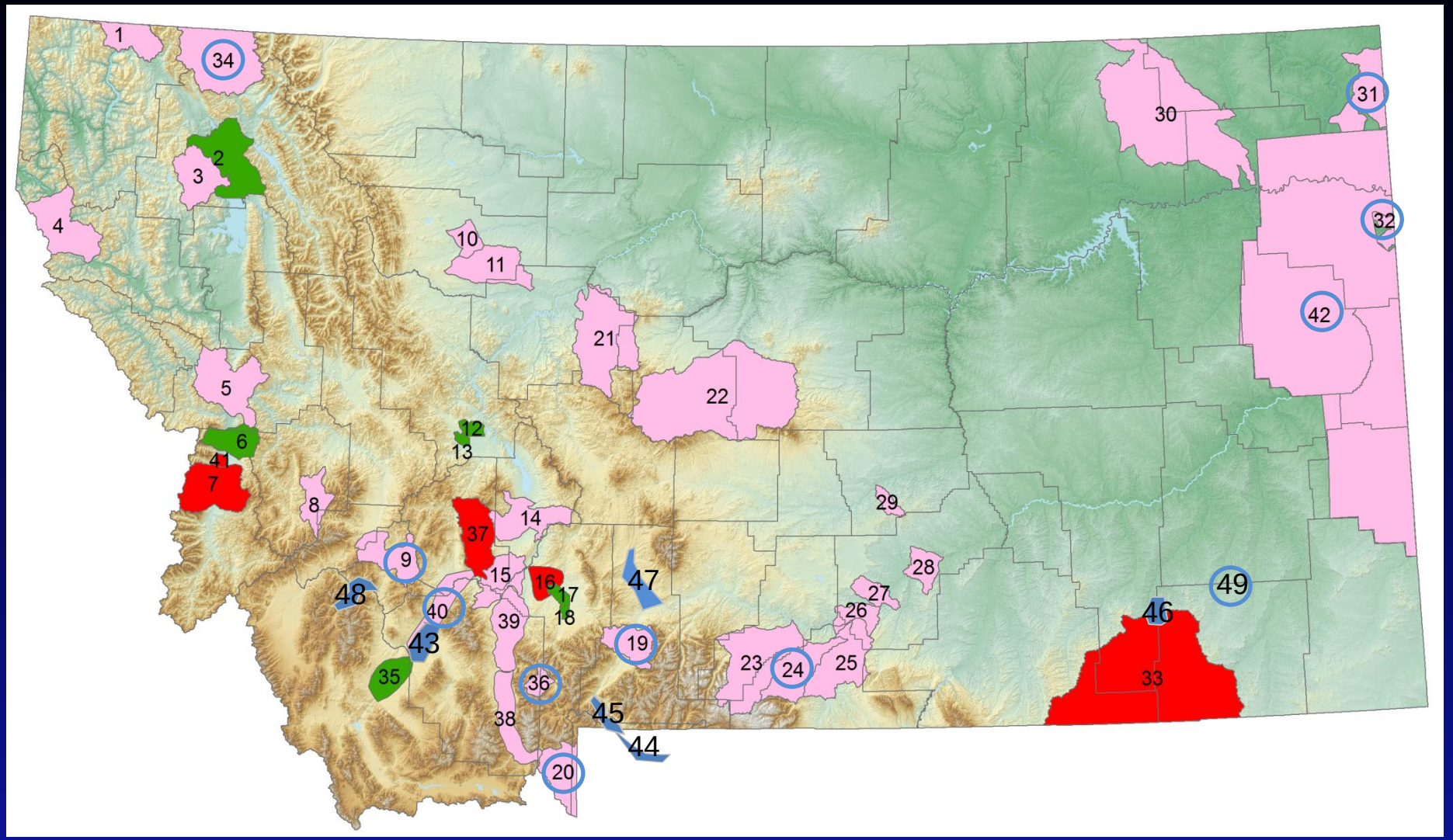
They are and can be utilized as reservoirs

How Projects are Chosen:

Submitted based on locally identified concerns

Anyone can submit a project

Ranked by the Ground Water Steering Committee


1
34
2
3
4
10
11
21
22
30
31
32
42
5
6
41
7
12
13
8
14
37
29
9
15
16
17
18
47
28
27
26
49
48
40
39
43
19
46
33
23
24
25
35
36
38
45
44
20

Specific issues have been identified that need a consistent Statewide approach

Stream depletion related to groundwater development

Impacts to aquifers: increasing demand ; changing land use

Protection of senior water rights (groundwater and surface water)

Water quality impacts such as septic effluent

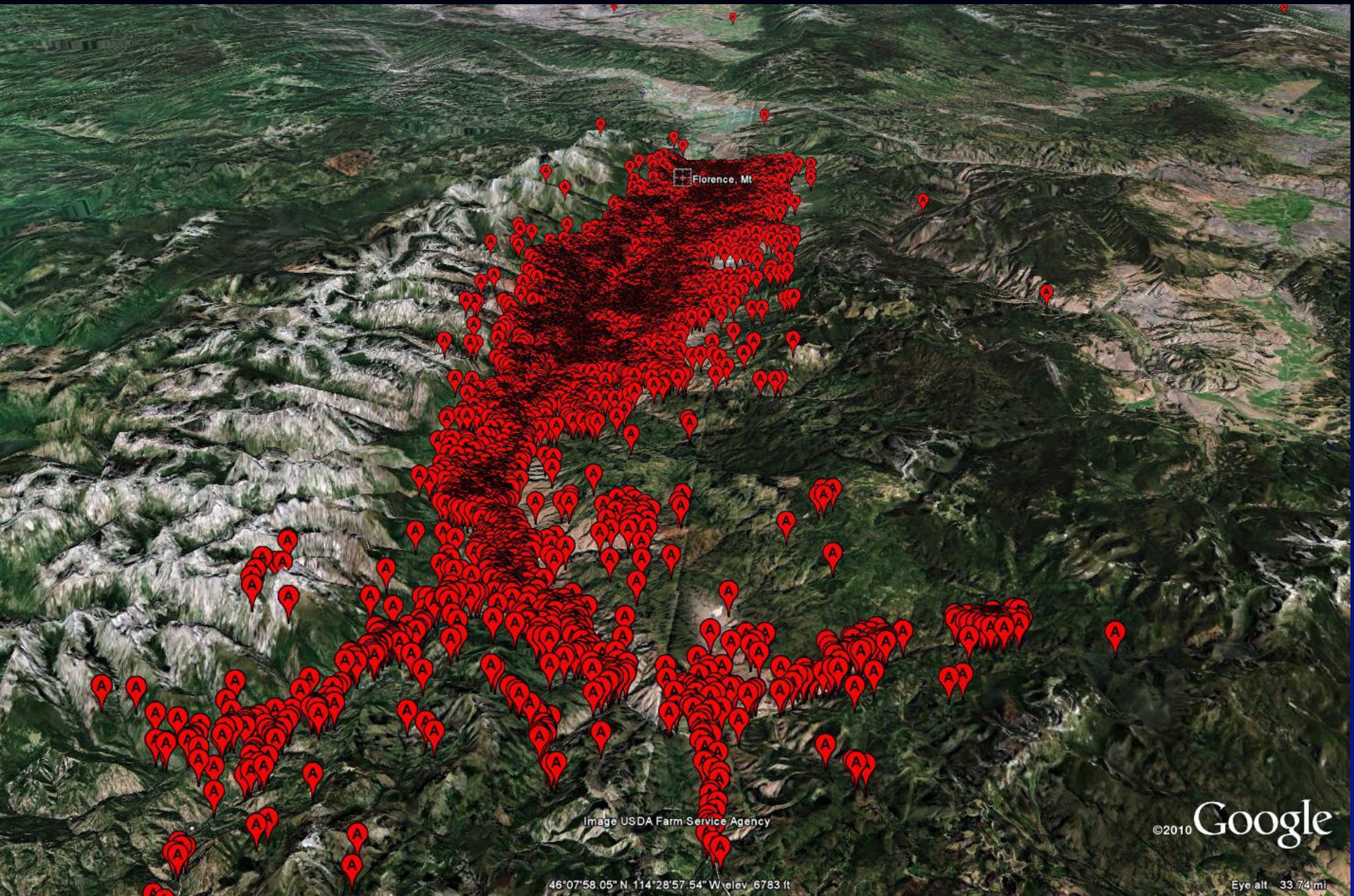
Cumulative effects of water development

Aquifer Storage and Recovery (ASR) in Montana

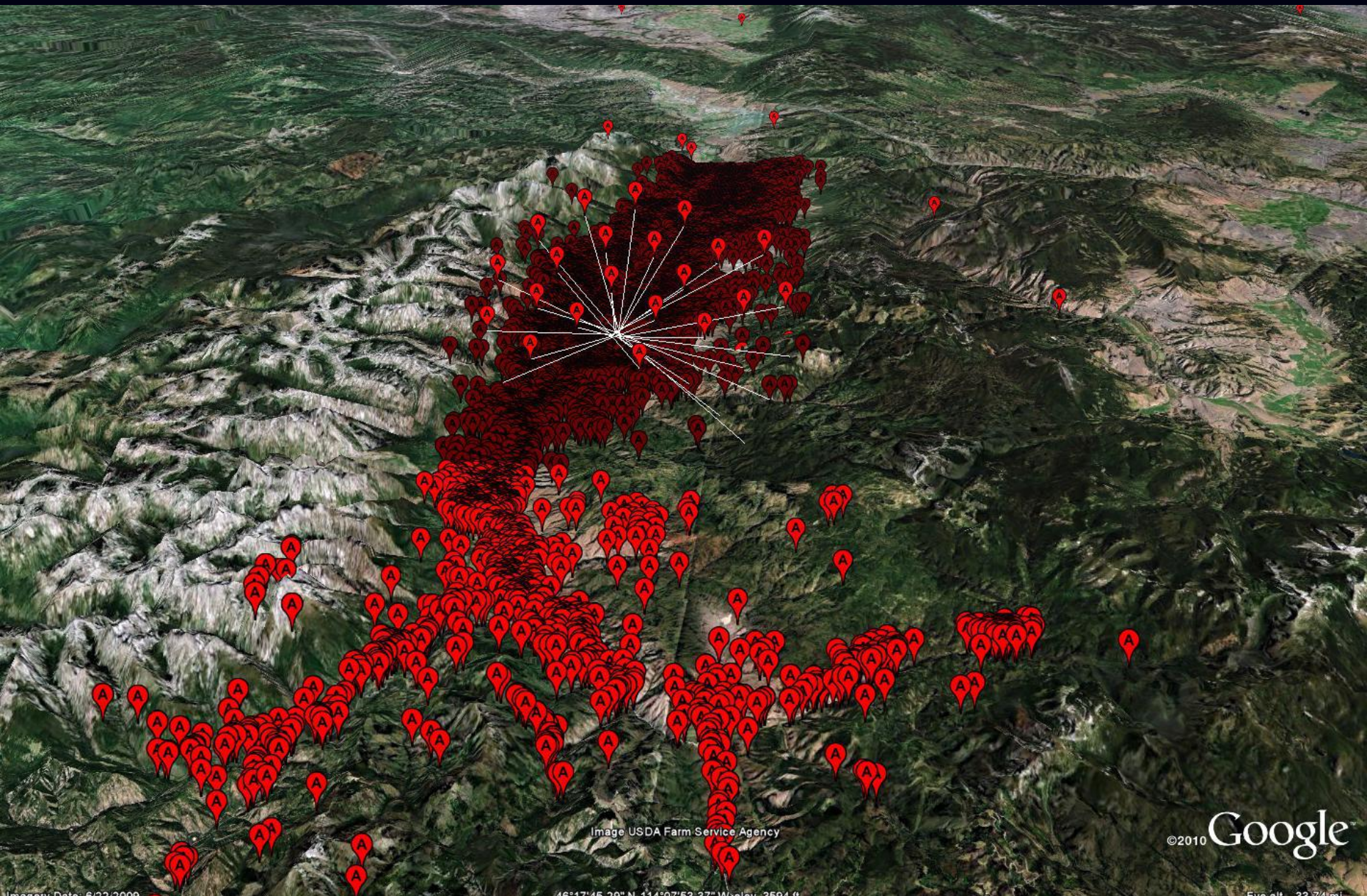
ANY OTHERS THAT MAY BE IDENTIFIED

If not one, then how many hoses ?

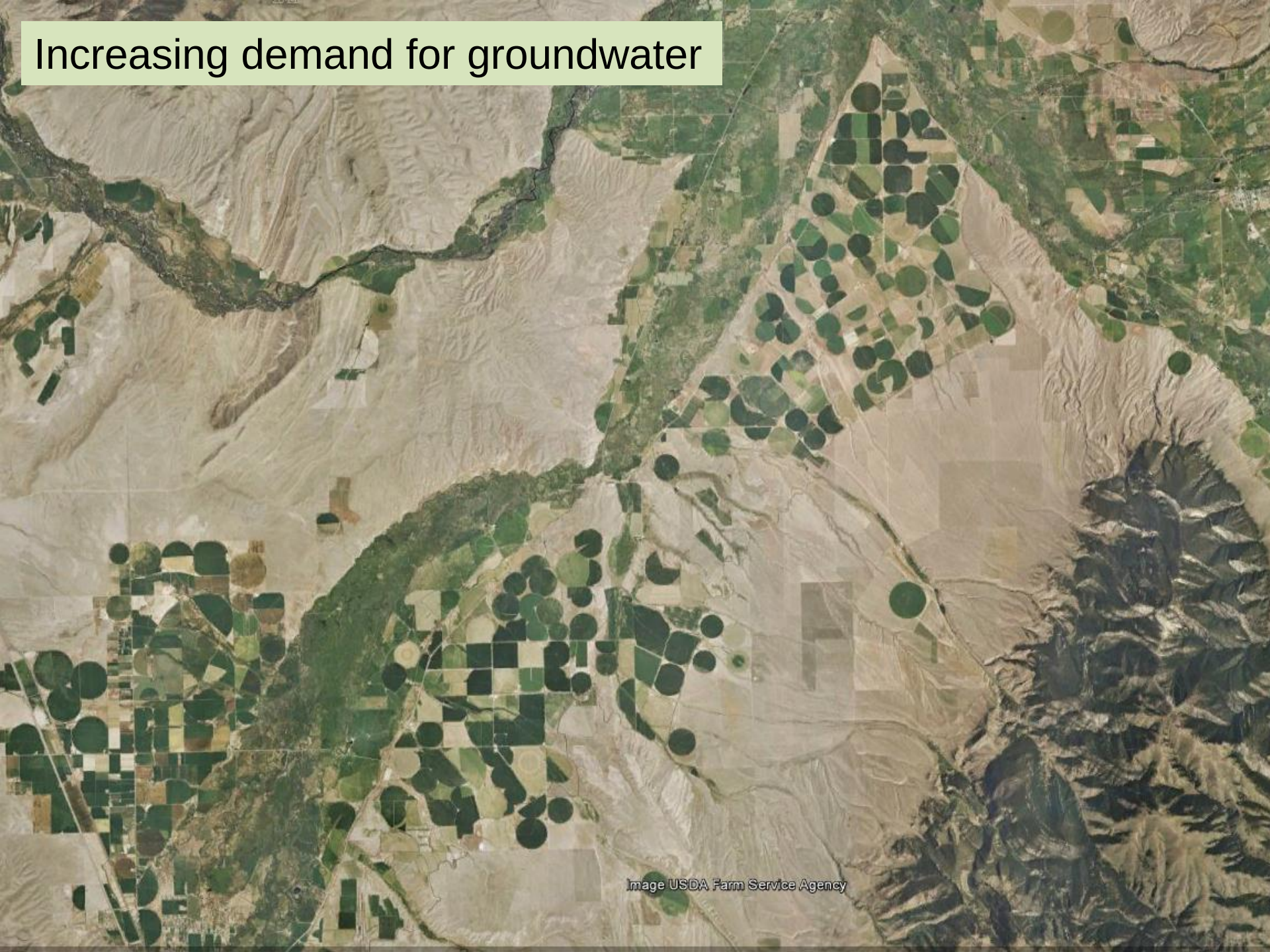
Exempt wells Bitterroot Valley (looking North)

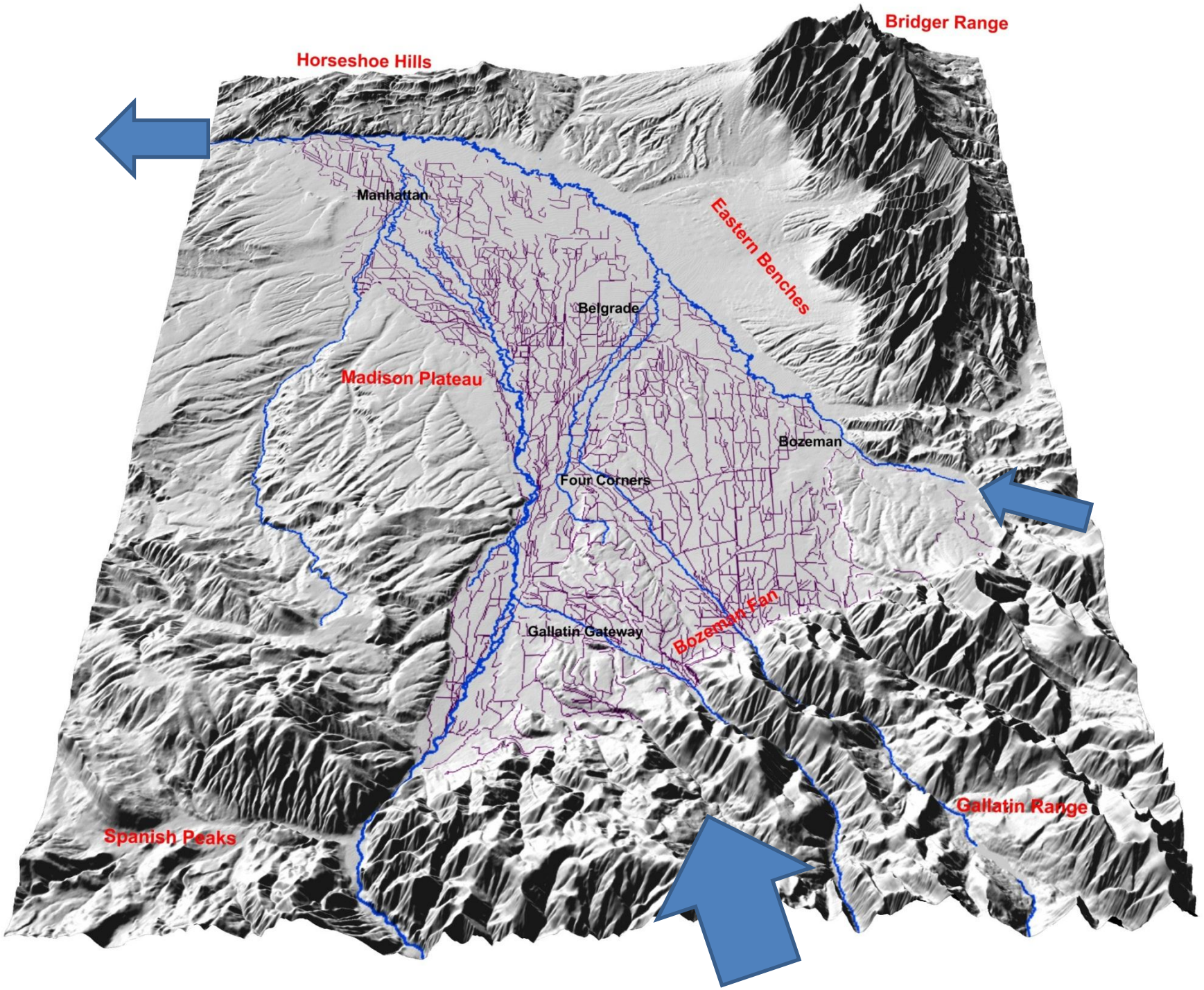

Florence, Mt
Image USDA Farm Service Agency
©2010 Google
46°07'58.05" N 114°28'57.54" W elev 6783 ft
Eye alt 33.74 mi

There are currently over 18,000 wells listed in GWIC in Ravalli County



Increasing demand for groundwater




Bridger Range
Horseshoe Hills
Manhattan
Eastern Benches
Belgrade
Madison Plateau
Bozeman
Four Corners
Gallatin Gateway
Bozeman Fan
Gallatin Range
Spanish Peaks

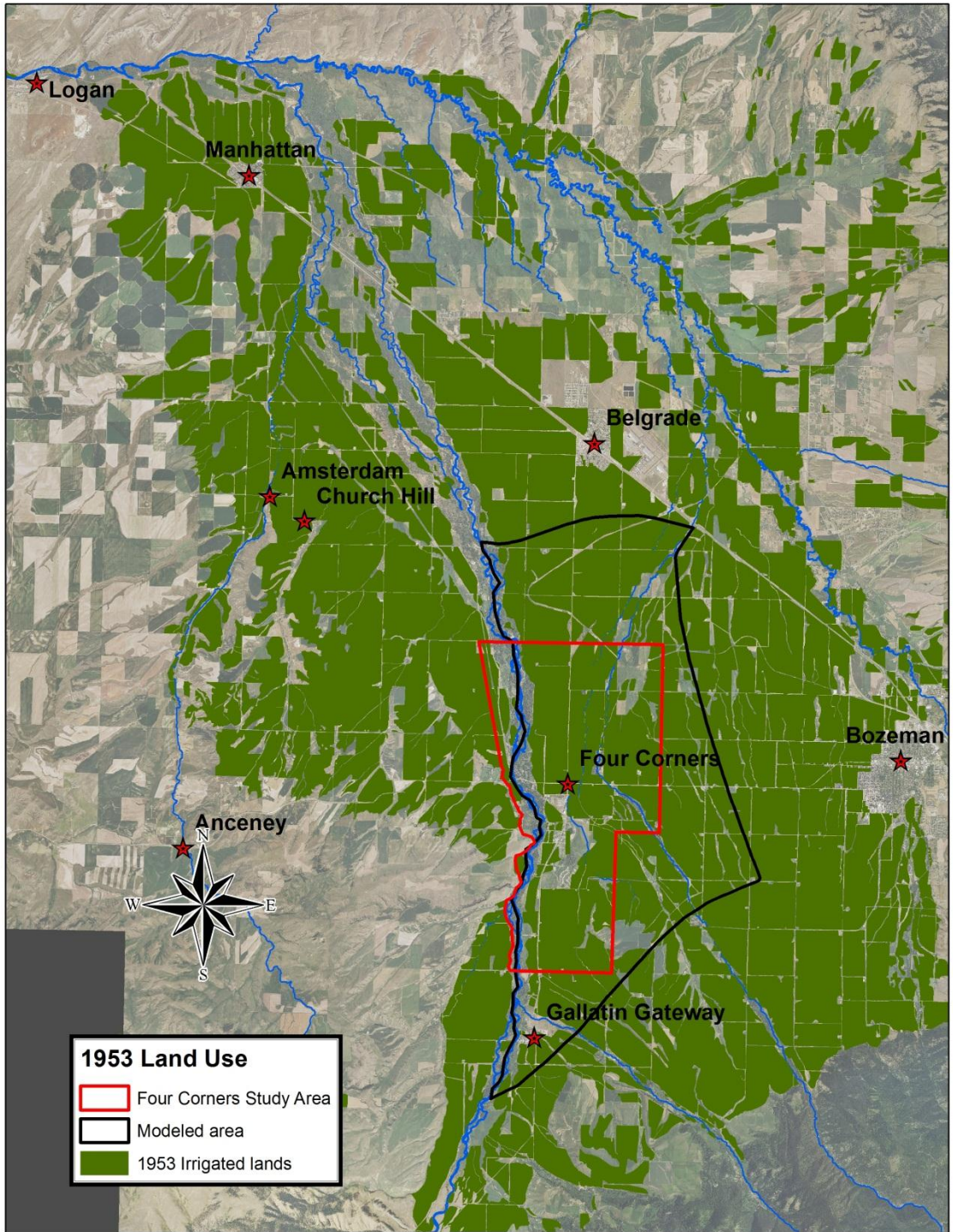
Examples of Seepage Loses

• East Bench Canal	2.2 cfs/mile
• West Side Canal	1.2 cfs/mile
• Bozeman area ditches	1.1 cfs/mile
• Upper Big Hole	0.15-1.5 cfs/mile
• Helena Valley	0.6 cfs/mile
• Billings area	0.05-0.5 cfs/mile
• Stillwater-Rosebud Watershed	1.1-1.8 cfs/mile
• Greenfields Bench	0.45-4.7 cfs/mile

Irrigated Land

(1953)

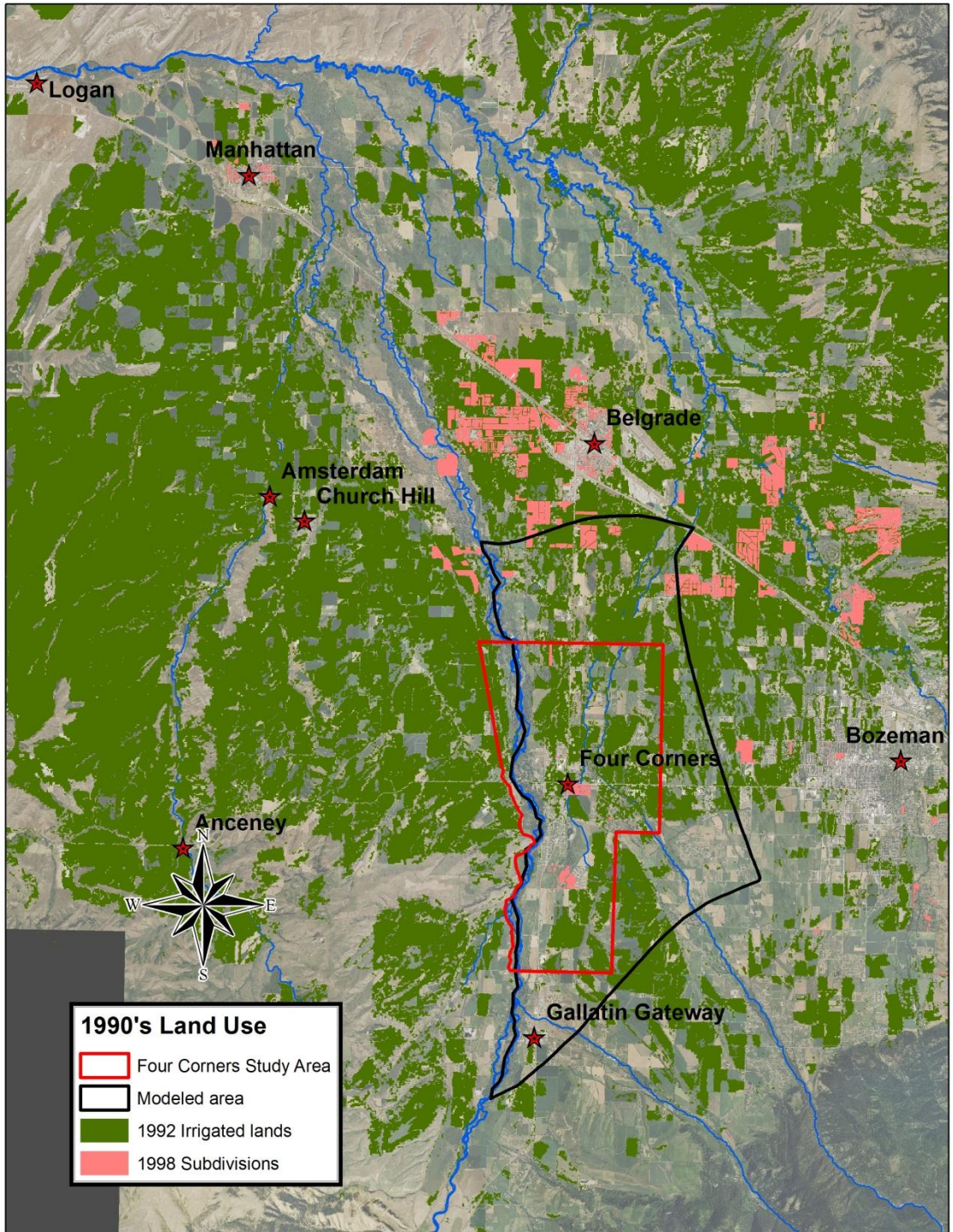
All flood irrigation



Irrigated Land
(1990's)

Irrigated lands decreased

Suburban development

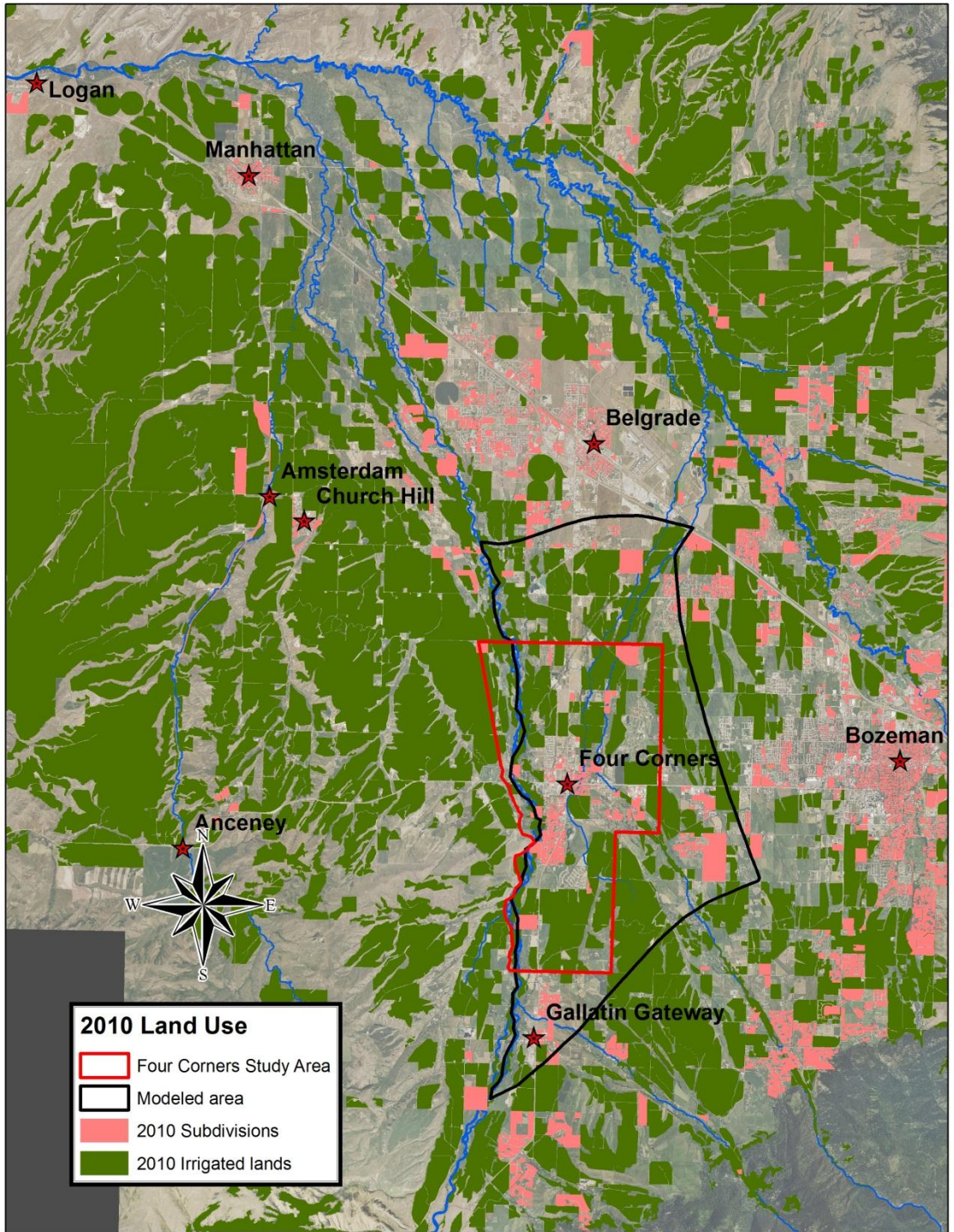


Irrigated Land

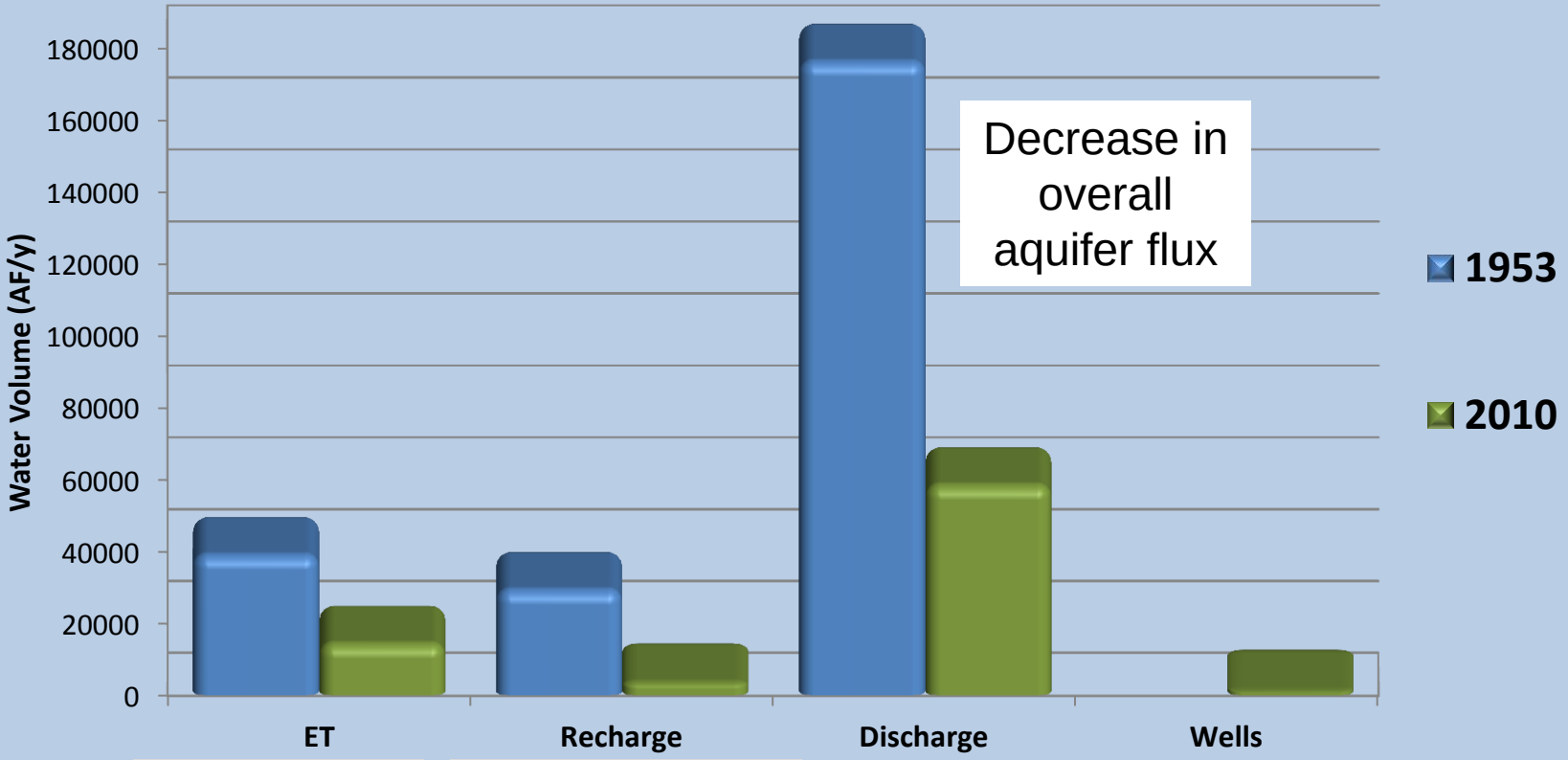
(2010)

Irrigated lands decreased at an average rate of 628 acres per year since 1992

Suburban development increasing at an average rate of 535 acres per year since 1998



Calculated and modeled changes to the aquifer



Decrease in ET due to fewer irrigated acres

Decrease in recharge to the aquifer due to less irrigation leakage

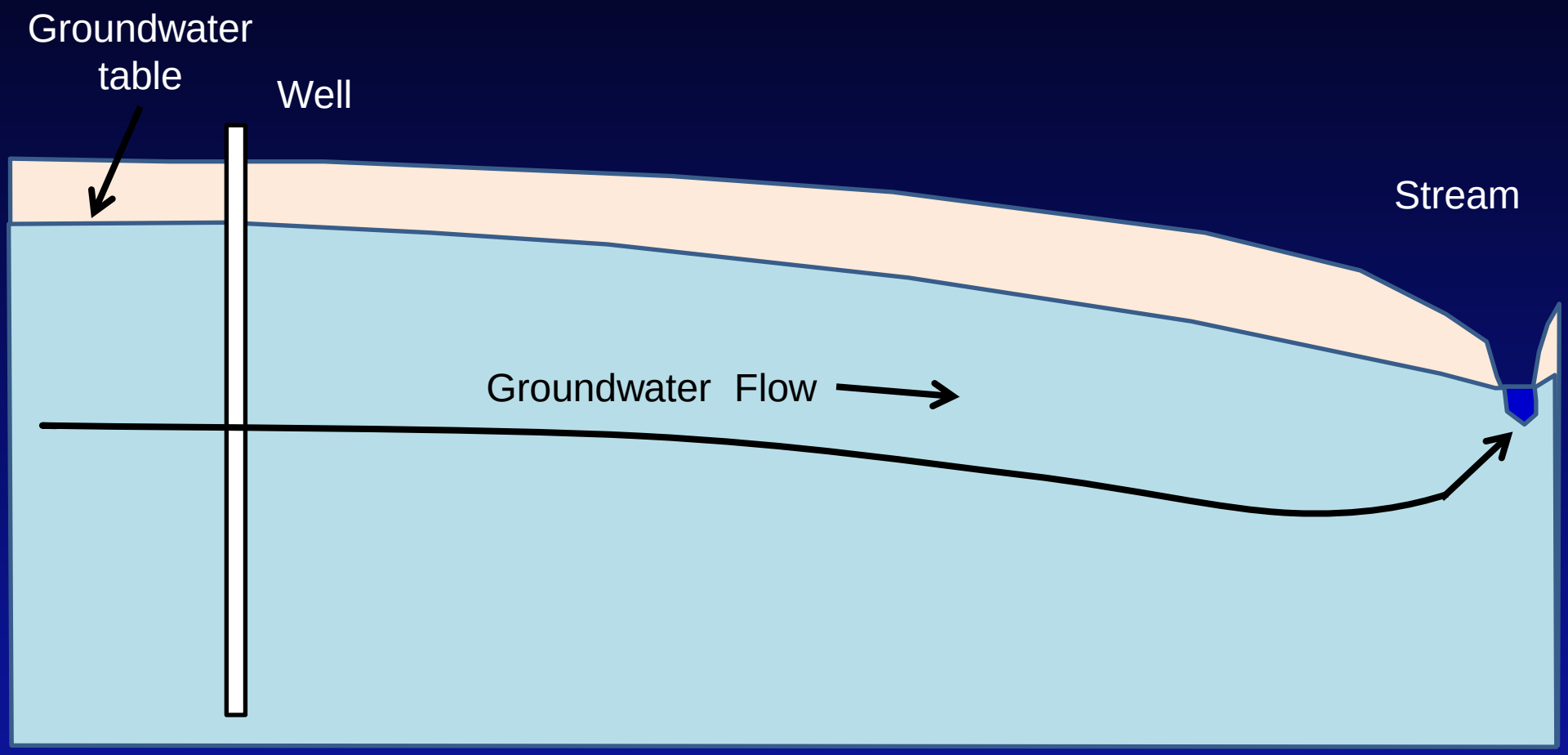
Urban well depletions minimal

Exempt domestic wells in several GWIP study areas:				
Lots in acreas				
Consumption in acre-feet per year				
Area	Irrigated size (acres)	Number of wells	Annual average Consumption per house (acre-feet)	Total Exempt Well Consumption (acre-feet)
Dillon	0.5	638	1.1	730
Scratchgravel	0.25	1608	0.5	804
North Hills	0.25	2150	0.5	1048
Belegrade	0.6	1738	0.8	1445
NOTE: excludes stock wells				

End of GWIP Introduction

A little discussion on stream depletion concepts

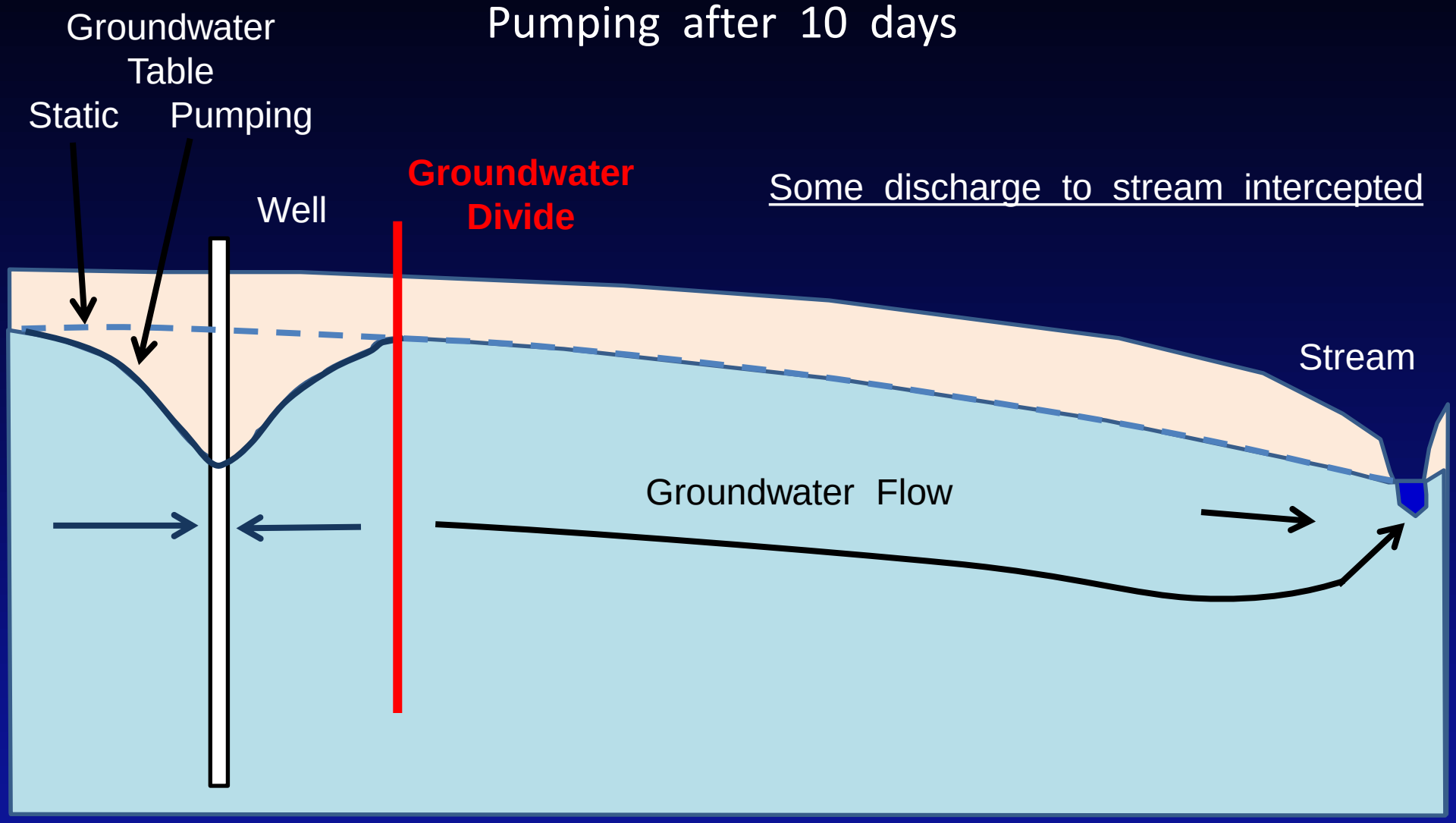
Potential Stream Depletion



Potential Stream Depletion

as an example

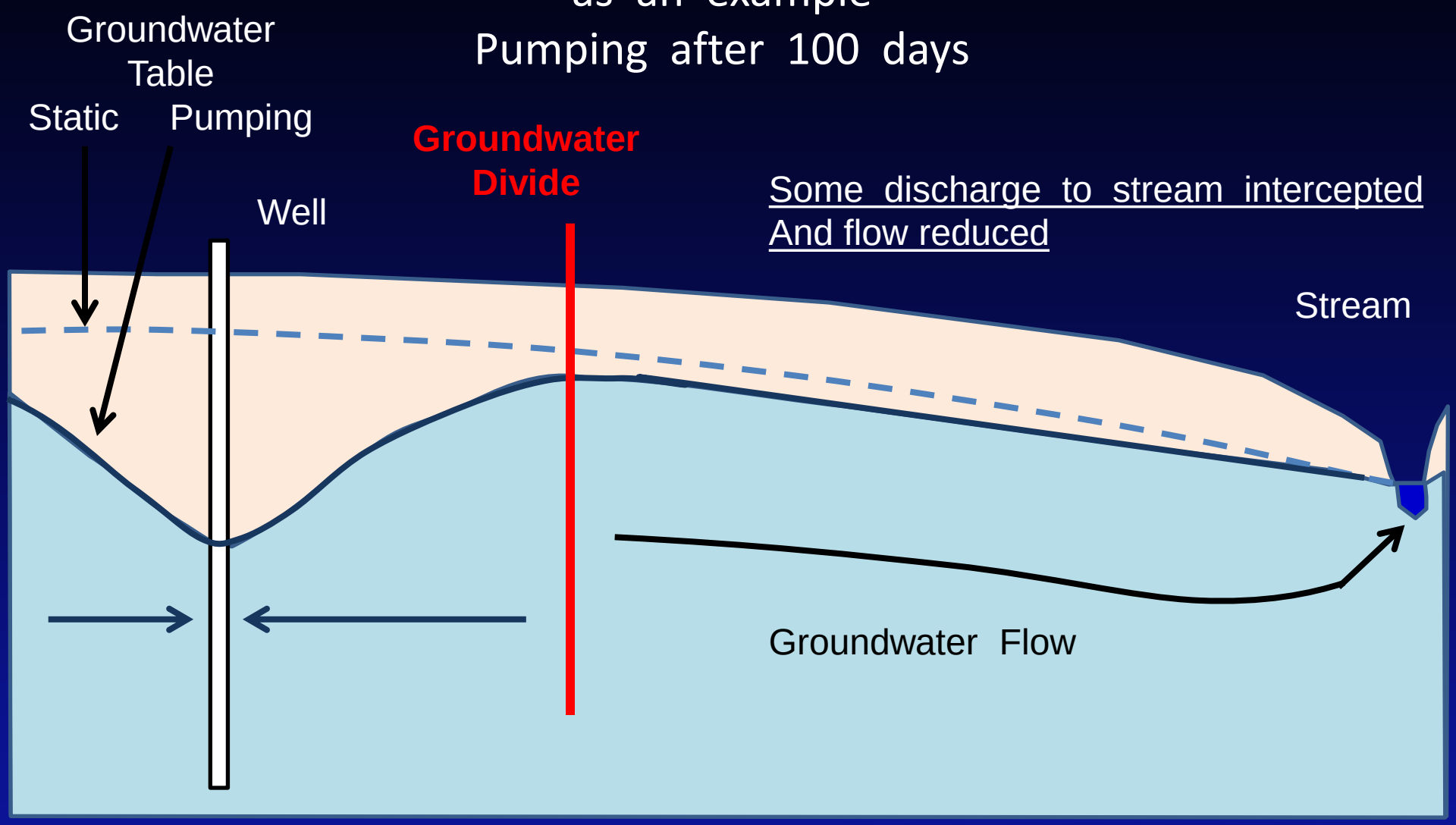
Pumping after 10 days



Potential Stream Depletion

as an example

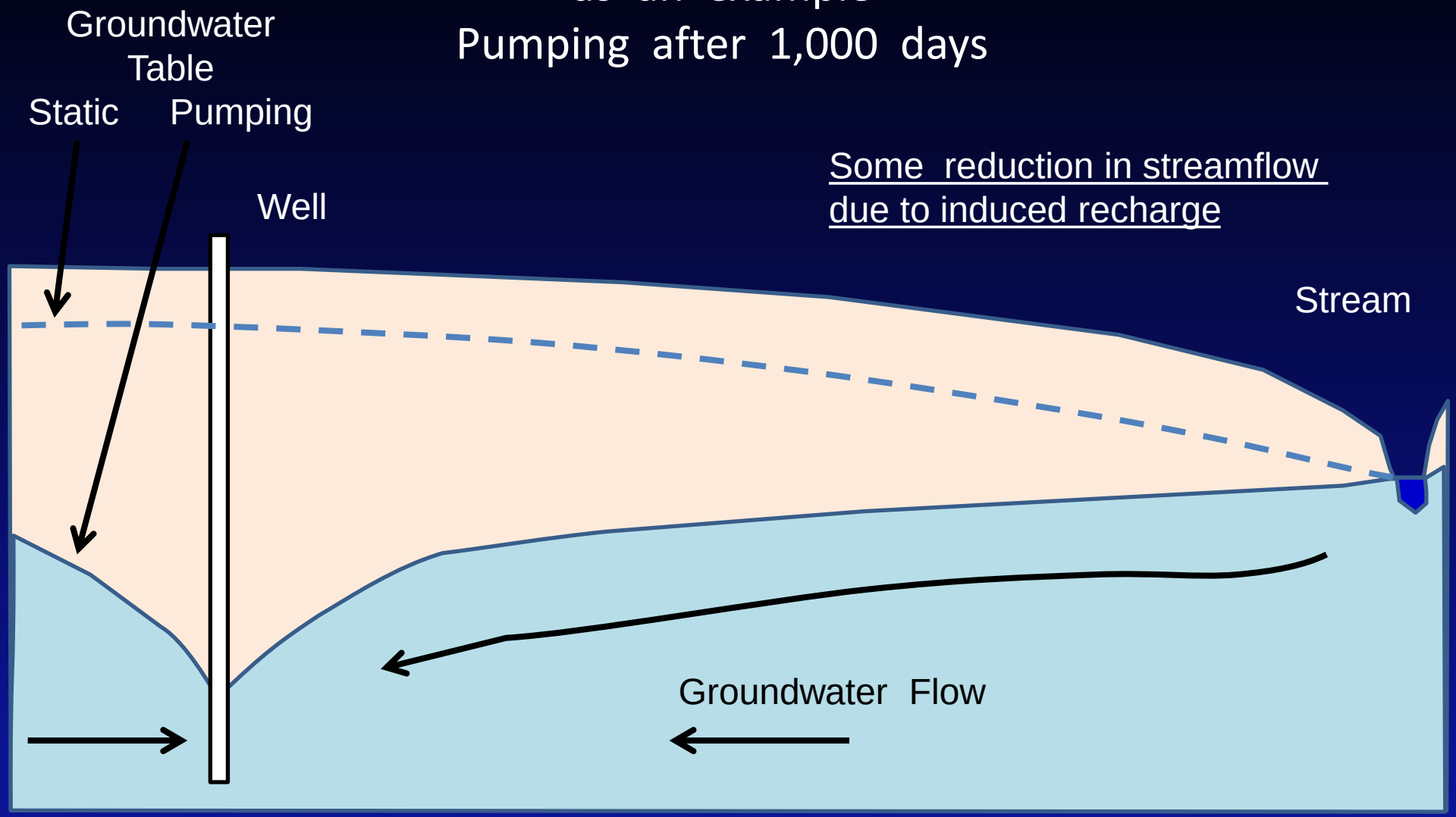
Pumping after 100 days

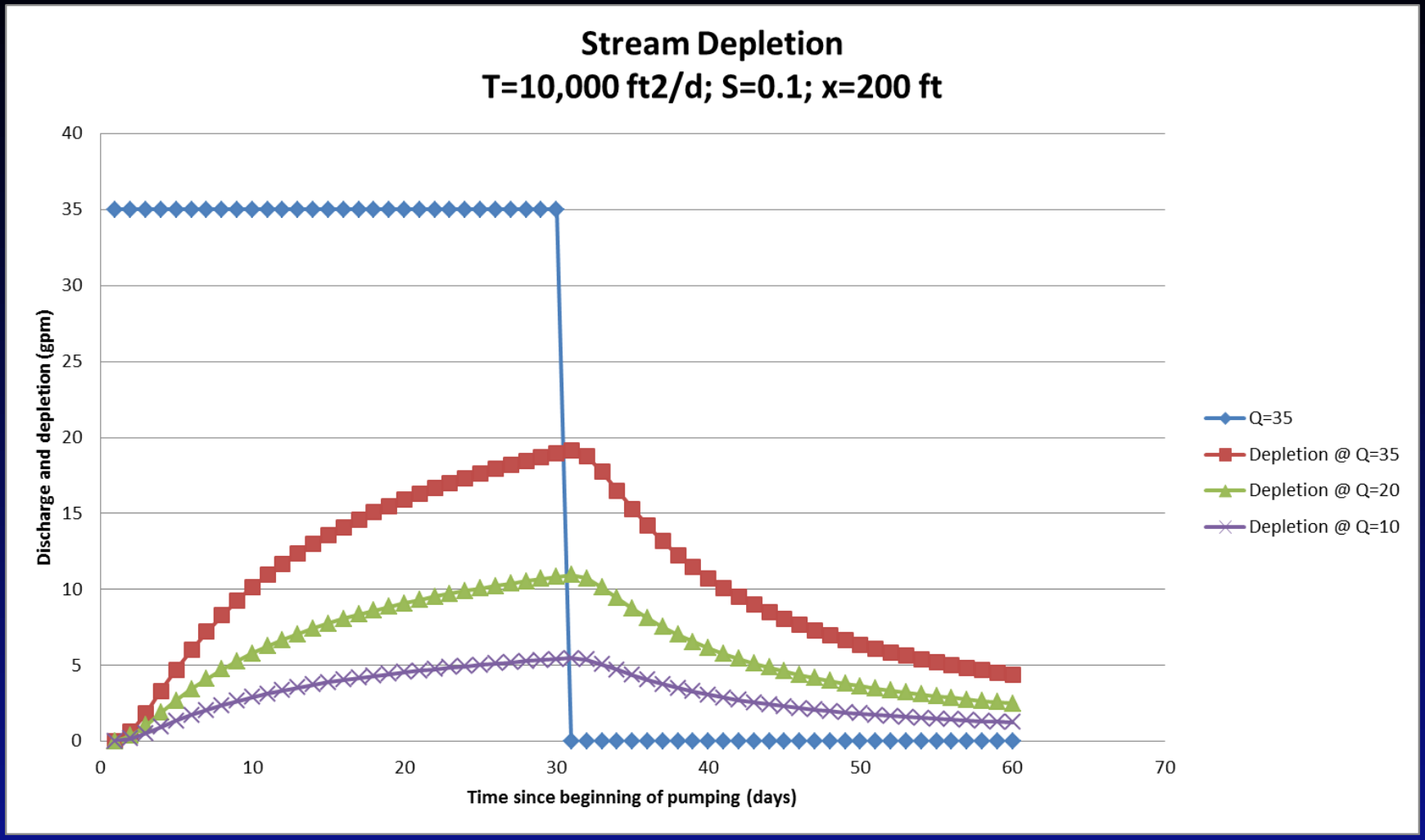


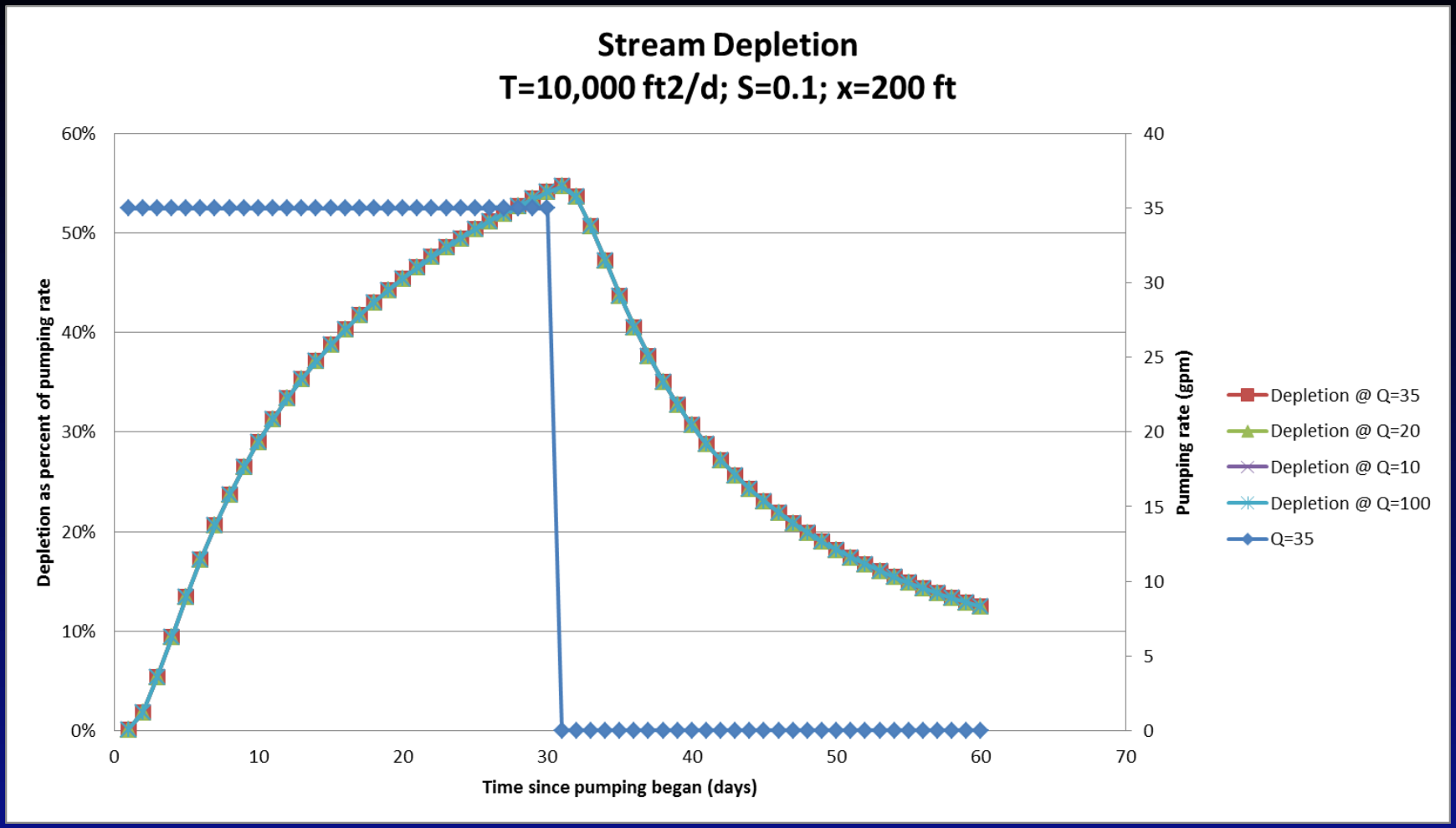
Potential Stream Depletion

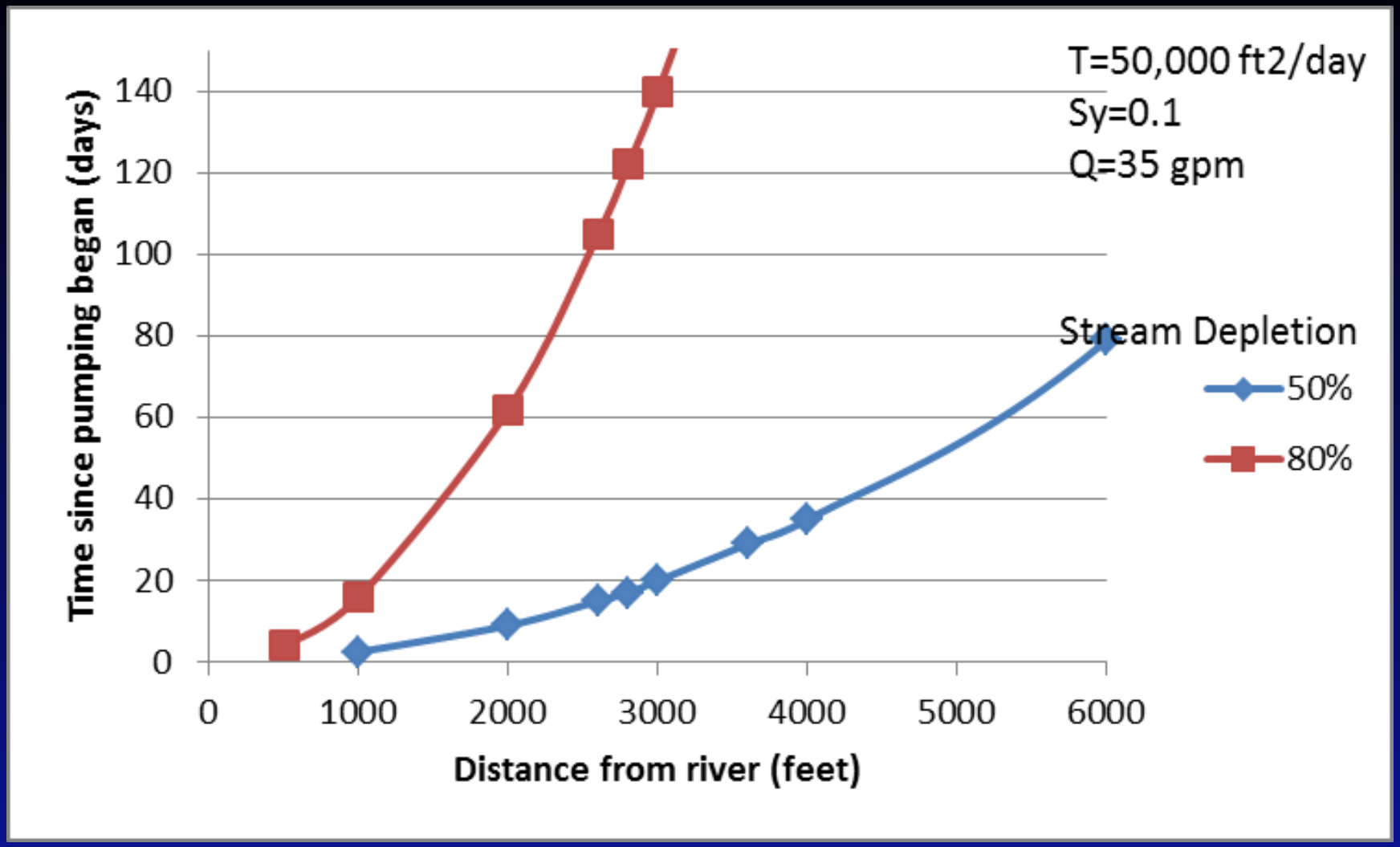
as an example

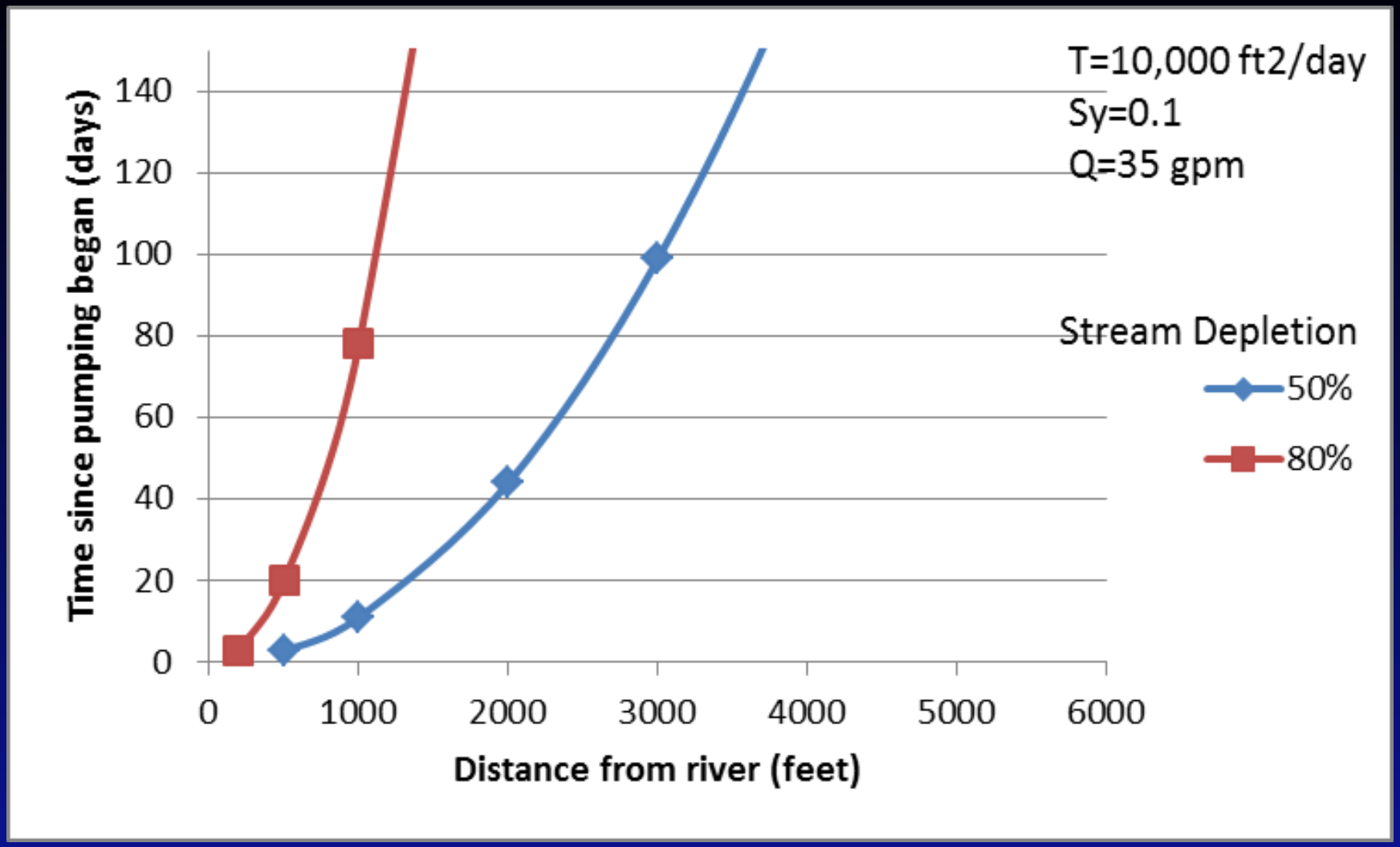
Pumping after 1,000 days



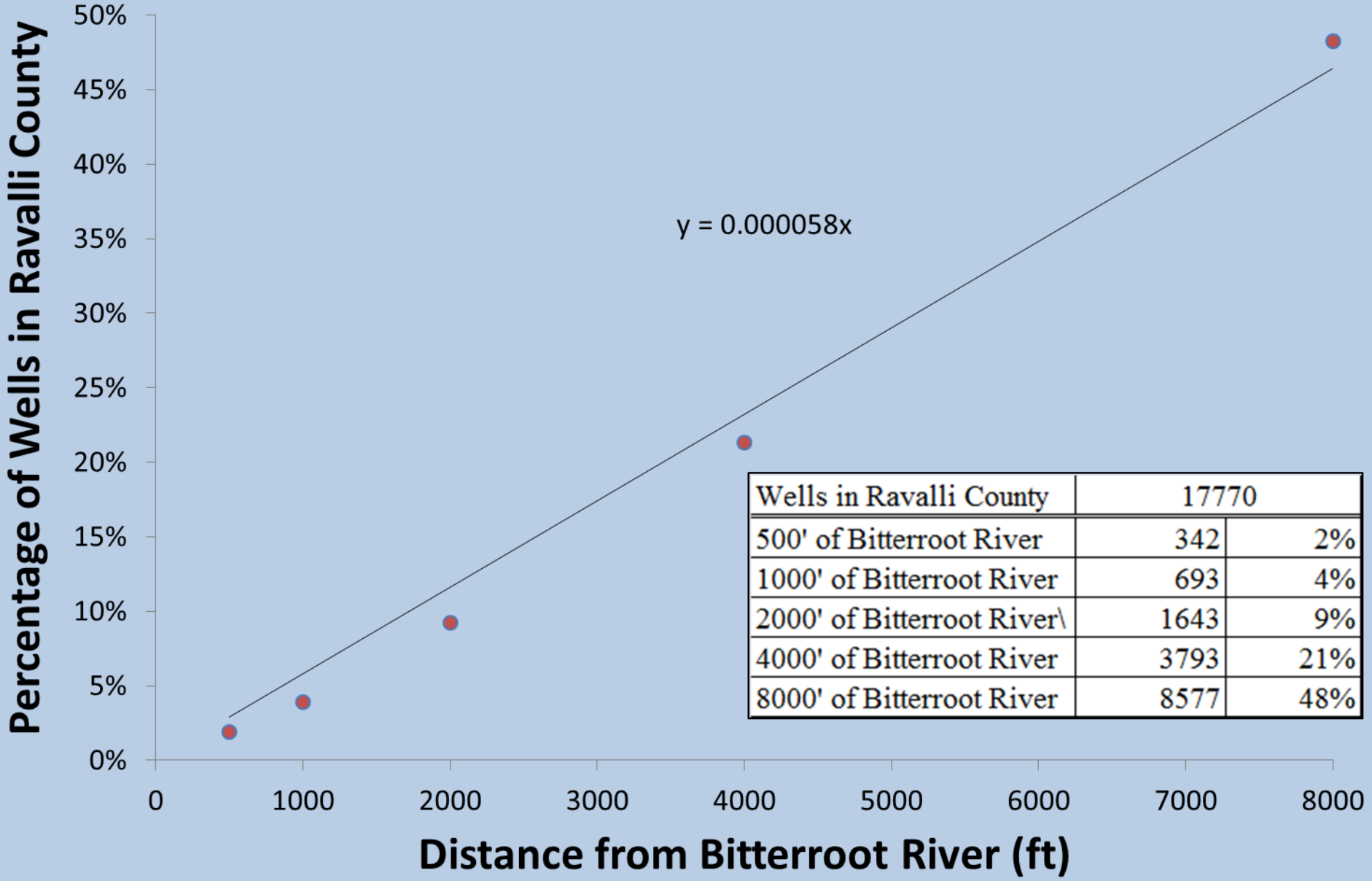

Stream Depletion
T=10,000 ft2/d; S=0.1; x=200 ft
Discharge and depletion (gpm)
Time since beginning of pumping (days)
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
Q=35
Depletion @ Q=35
Depletion @ Q=20
Depletion @ Q=10


Stream Depletion
T=10,000 ft2/d; S=0.1; x=200 ft
Depletion as percent of pumping rate
60%
50%
40%
30%
20%
10%
0%
Pumping rate (gpm)
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
Time since pumping began (days)
Depletion @ Q=35
Depletion @ Q=20
Depletion @ Q=10
Depletion @ Q=100
Q=35


T=50,000 ft2/day
Sy=0.1
Q=35 gpm
Stream Depletion
50%
80%
Time since pumping began (days)
0
20
40
60
80
100
120
140
0
1000
2000
3000
4000
5000
6000
Distance from river (feet)


T=10,000 ft2/day
Sy=0.1
Q=35 gpm
Stream Depletion
50%
80%
Time since pumping began (days)
0
20
40
60
80
100
120
140
0
1000
2000
3000
4000
5000
6000
Distance from river (feet)

An Evaluation of % Wells in Ravalli County Relative to Distance from the Bitterroot River



Wells in Ravalli County	17770	
500' of Bitterroot River	342	2%
1000' of Bitterroot River	693	4%
2000' of Bitterroot River\	1643	9%
4000' of Bitterroot River	3793	21%
8000' of Bitterroot River	8577	48%


09/07/2005
© 2012 Google
Image U.S. Geological Survey
44.71114, -111309743
Imagery Date: 6/26/1994
lat 44.711140° lon -111.097427° elev 0 ft


09/07/2005
© 2012 Google
Image © 2012 DigitalGlobe
Imagery Date: 9/7/2005
lat 44.711140° lon -111.097427° elev 0 ft


07/09/2010
© 2012 Google
Image © 2012 GeoEye
Imagery Date: 7/9/2010
lat 44.711140° lon -111.097427° elev 0 ft


11/20/2011
© 2012 Google
Image USDA Farm Service Agency
Imagery Date: 8/11/2011
lat 44.711140° lon -111.097427° elev 0 ft


Green Trailer House
Well
11/20/2011
© 2012 Google
Image USDA Farm Service Agency
Imagery Date: 8/11/2011
lat 44.711140° lon -111.097427° elev 0 ft