USGS
science for a changing world

Prepared in cooperation with the U.S. Air Force

Groundwater Level and Nitrate Concentration Trends on Mountain Home Air Force Base, Southwestern Idaho

Open File-Report 2014-1022

U.S. Department of the Interior
U.S. Geological Survey

Overview

- The Problem
- Study Area in Context
- Background and Past Studies
- Analysis Method and Criteria
- Monitoring Period
- Key Findings
- Summary

USGS

The Problem

- The regional aquifer is primary drinking-water resource for Mountain Home Air Force Base (MHAFB)
  - MHAFB is located in Mountain Home Groundwater Management Area
  - MHAFB is adjacent to the Cinder Cone Butte Critical Groundwater Area
  - Federal and State studies show that regional groundwater levels are declining

USGS

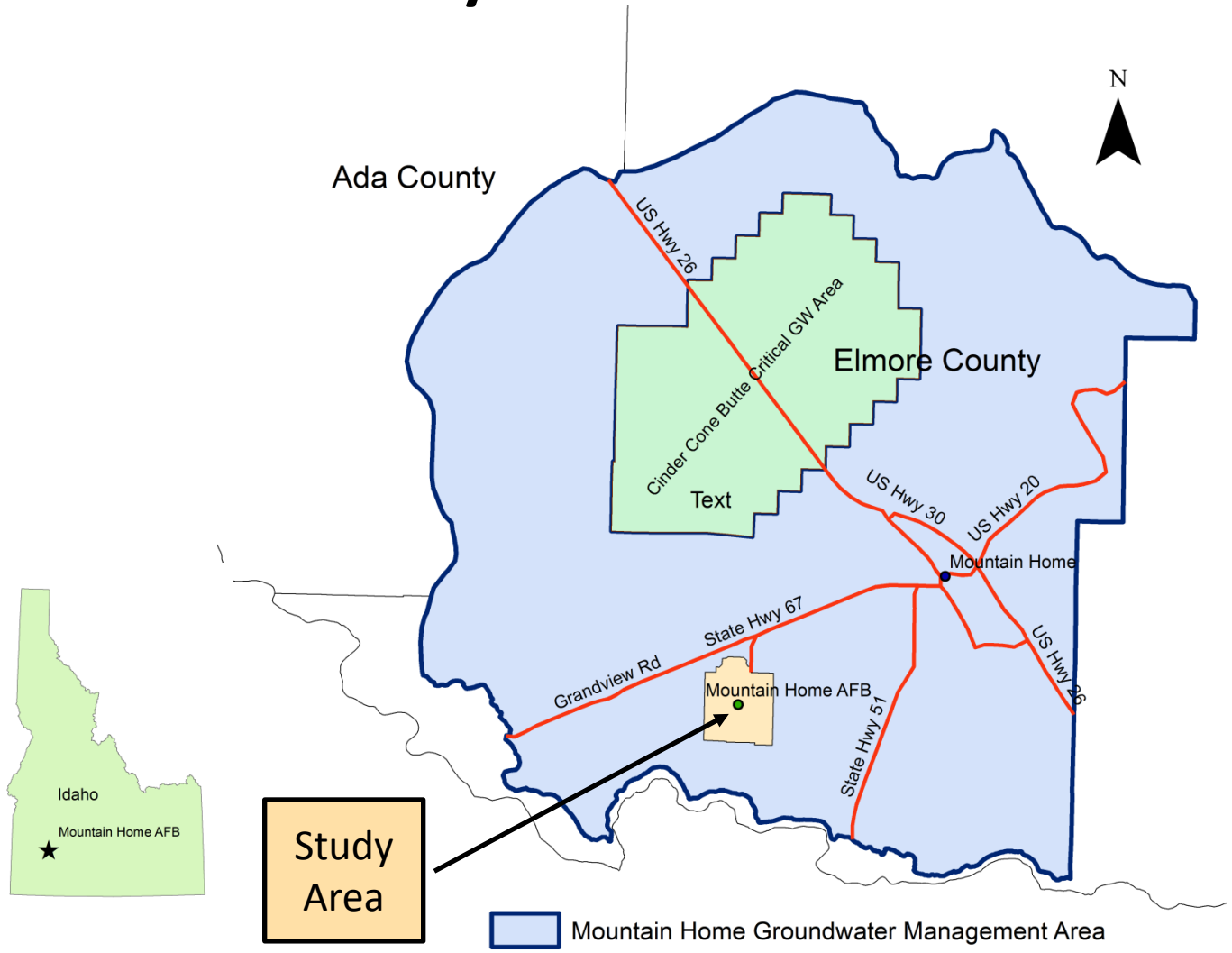
The Problem

- Nitrate (measured as nitrogen) in excess of 10 milligrams per liter (mg/L) is a health risk for infants <6 months of age and for the elderly
- MHAFB is #14 on Idaho Department of Environmental Quality's nitrate priority area list
  - Two production wells are blended for base drinking water because of high nitrate concentration
  - Another production well recently exceeded the U.S. Environmental Protection Agency's Maximum Contaminant Level (MCL) of 10 mg/L


Kevin Dennehy

USGS

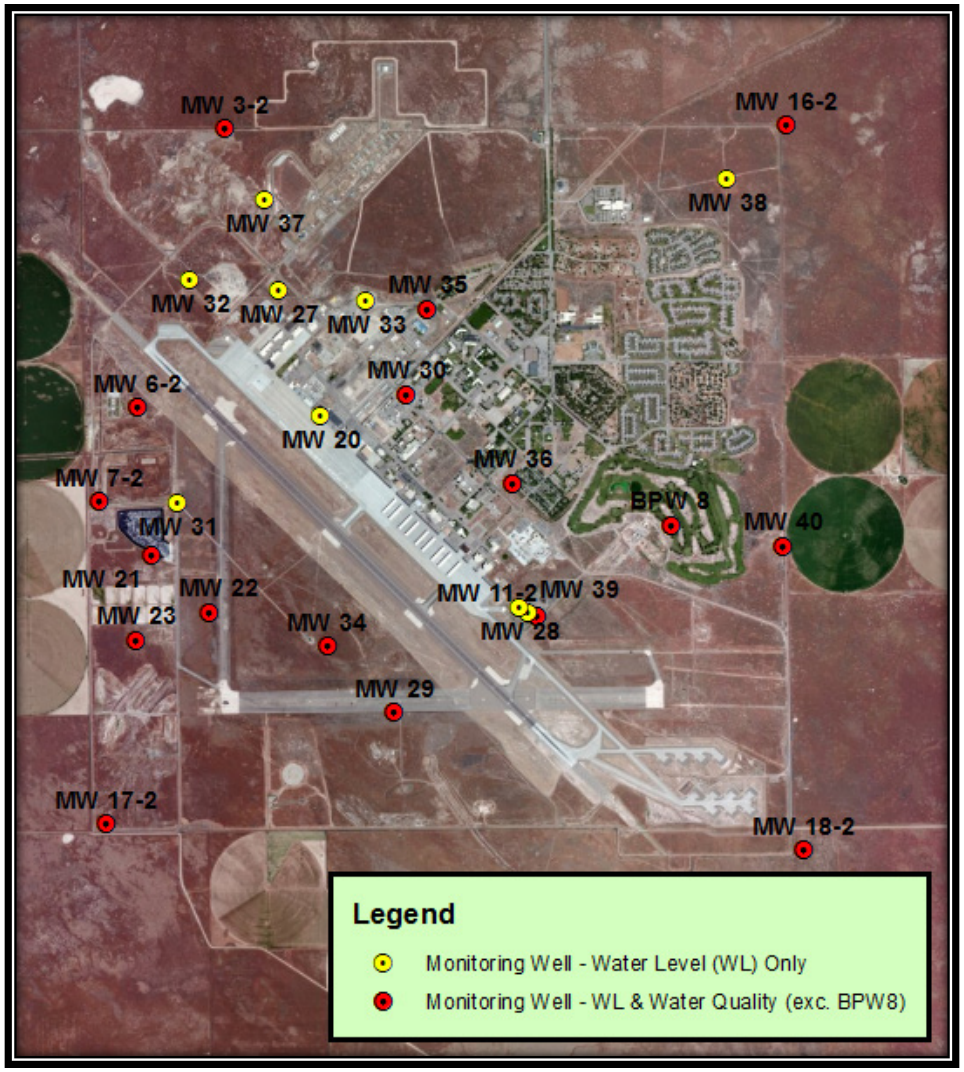
Study Area in Context



Source: IDWR, ESRI

USGS

Monitoring Well Locations



USGS

Source: ESRI, USGS

Purpose of the Study

- The 366 CES Environmental Flight requested the USGS to perform water level and nitrate trend analysis to help USAF leadership make drinking-water resource decisions

366th Gunfighters -- A six-ship formation of F-15C Eagle and F-15E Strike Eagle fighters fly over the Sawtooth Mountains of Idaho, Oct. 13, 2009 (USAF photo by MSgt. K.J. Gruenwald)

USGS

Background

- USGS and MHAFB have a long-standing relationship that began in late 1980s
- USGS monitors the following groundwater wells:
  - 25 wells for water levels
  - 17 wells for water quality, primarily nutrients

USGS

Past Analysis and Studies

HYDROLOGIC AND CHEMICAL DATA FROM SELECTED WELLS AND SPRINGS IN SOUTHERN ELMORE COUNTY, INCLUDING MOUNTAIN HOME AIR FORCE BASE, SOUTHWESTERN IDAHO, FALL 1989

By D.J. Parliman and H.W. Young

U.S. GEOLOGICAL SURVEY

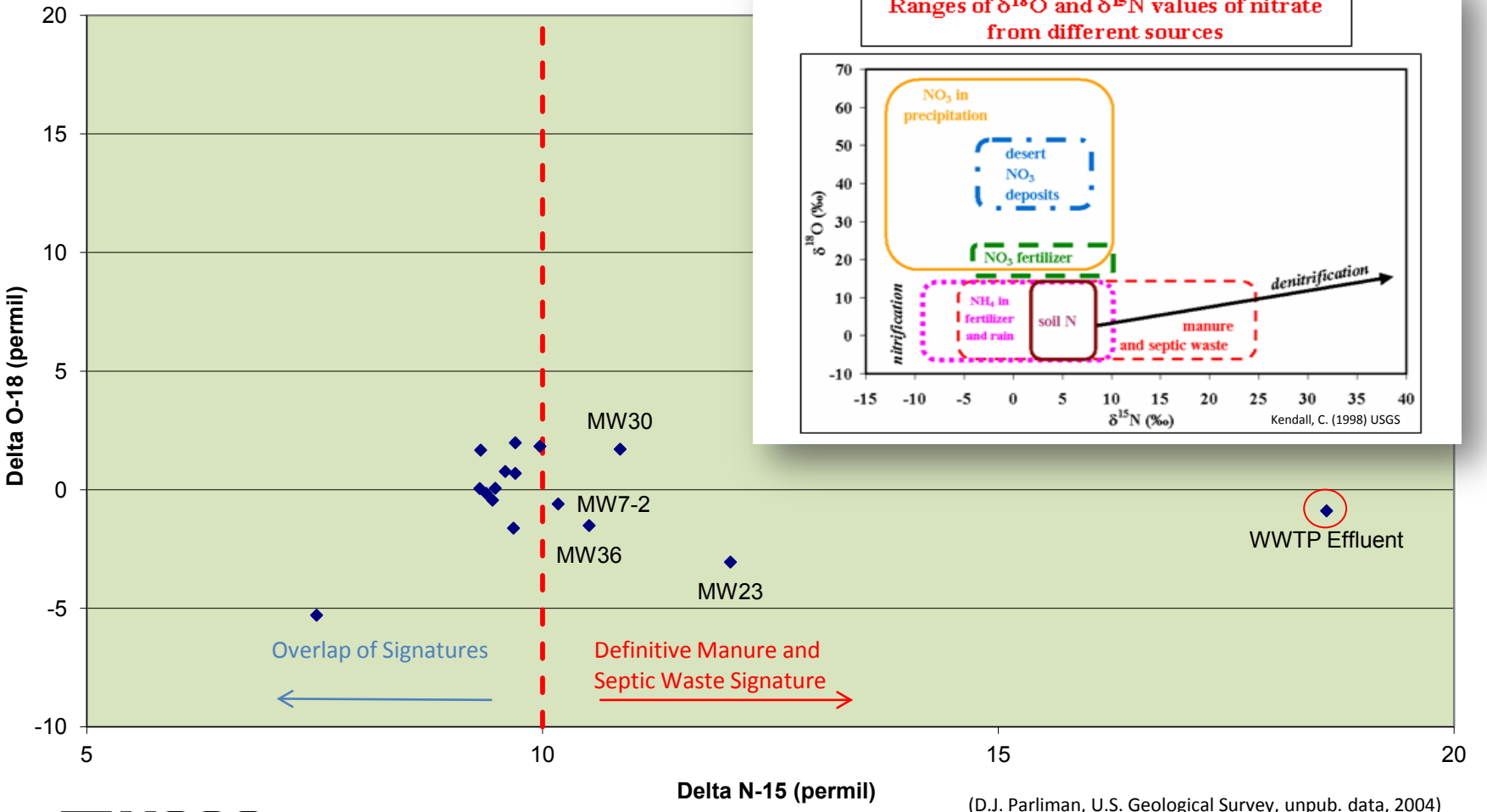
Open-File Report 90-112

Report found high levels of nitrate, fecal bacteria, and some VOCs in some MWs

USGS

Past Analysis and Studies

Stable Isotope Analysis, October 2004, Mountain Home AFB, Idaho



(D.J. Parliman, U.S. Geological Survey, unpub. data, 2004)

USGS

Past Analysis and Studies

Use of Human Pharmaceuticals to Determine a Sewer Water Nitrate Source to the Regional Aquifer, Mountain Home Air Force Base, Idaho

by D.L.Schwarz[1] and D. J. Parliman[2] October 29, 2010

[1] URS GROUP, INC.
720 Park Boulevard
Boise, ID 83712

URS IDAHO

[2] US DEPARTMENT OF THE INTERIOR
US GEOLOGICAL SURVEY
230 Collins Road
Boise, ID 83702

USGS science for a changing world

"…clean, unambiguous indication that sewer wastewater is a source of some, if not all of the nitrate."

USGS

Trend Analysis

- USGS developed a program for Mann-Kendall Family of trend tests
  - Long-term datasets are analyzed to determine trends
  - Objectives of the analysis:
    - Whether or not there is a trend
    - Direction of the trend (increasing or decreasing)
    - Level of confidence in the findings (probability value)
    - And a trend slope indicating the magnitude of change

USGS

Criteria

- Mann-Kendall Test
  - Run on nitrogen data unless plot indicated a seasonal variance
- Seasonal Kendall Test
  - Run on water levels and nitrogen data with seasonal variance
- Regional Kendall Test
  - Combined results from all wells to determine overall regional trend in water level
- Linear relationship between X (time) and Y (measured value) were considered statistically significant if the Kendall's *Tau* was >0.6, and had a p-value of <0.05

USGS

Years of Water-Level Monitoring

Measurement month	Years of record	Number of wells
March	12	25
June	12	25
September	13	25
December	13	25

USGS

Years of Water-Quality Monitoring

Local well No.	Years monitored*		Local well No.	Years monitored*
MW 3-2	12		MW 22	11
MW 6-2	11		MW 23	11
MW 7-2	13		MW 29	9
BPW 8	10		MW 30	9
MW 11-2	9		MW 34	9
MW 16-2	11		MW 35	9
MW 17-2	12		MW 36	9
MW 18-2	11		MW 40	3
MW 21	11			

USGS

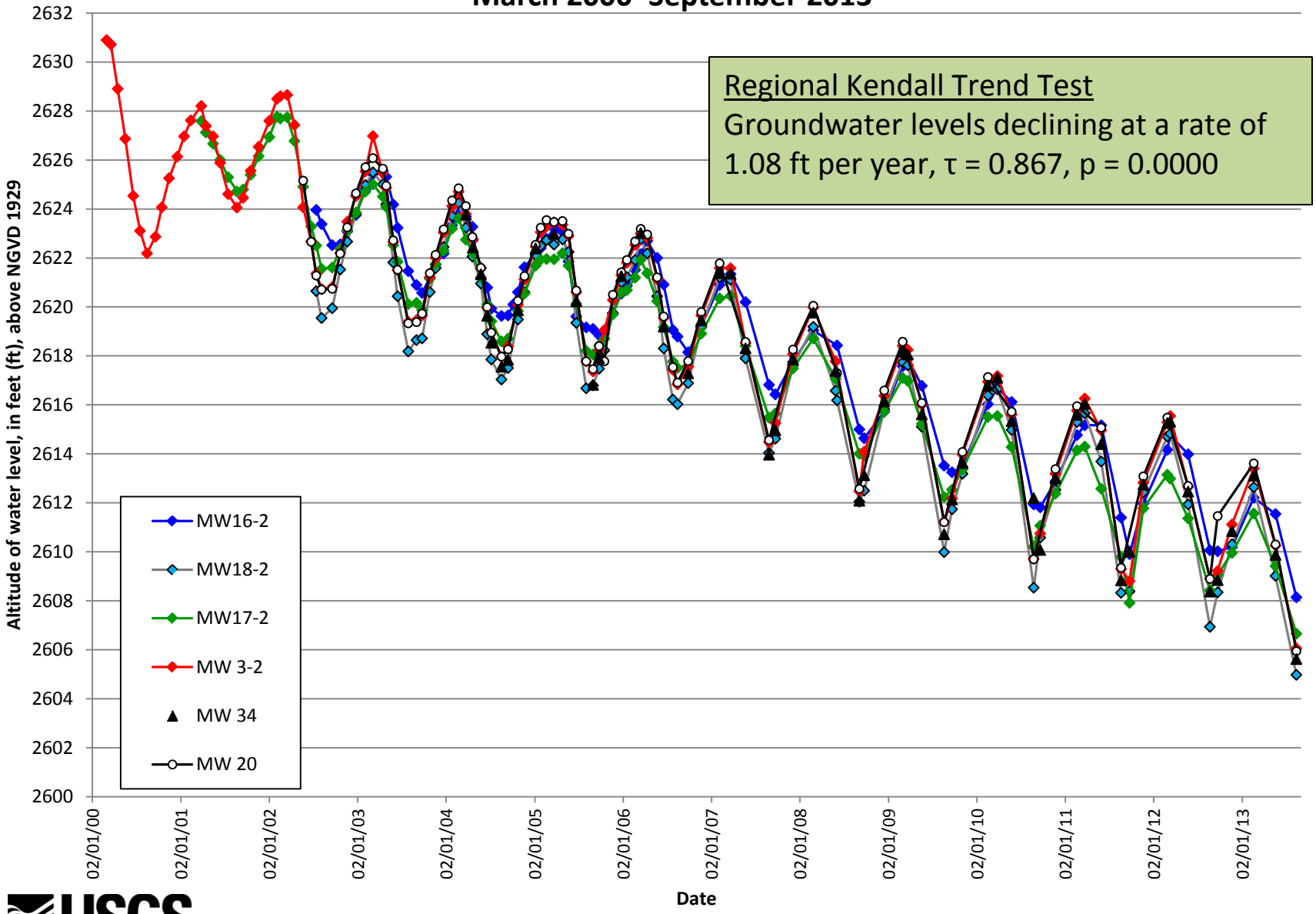
* data through October 2012

Key Findings

- MHAFB groundwater levels are declining at an average rate of about 1.08 feet per year based on Kendall Regional Test
- Nitrate concentration trend results:
  - 3 wells (18 percent) show an **increasing** nitrate concentration trend
  - 3 wells (18 percent) show a **decreasing** nitrate concentration trend
  - And 11 wells (64 percent) show **no nitrate concentration trend**
- 6 wells (35 percent) exceed the MCL of 10 mg/L for nitrate (measured as nitrogen)

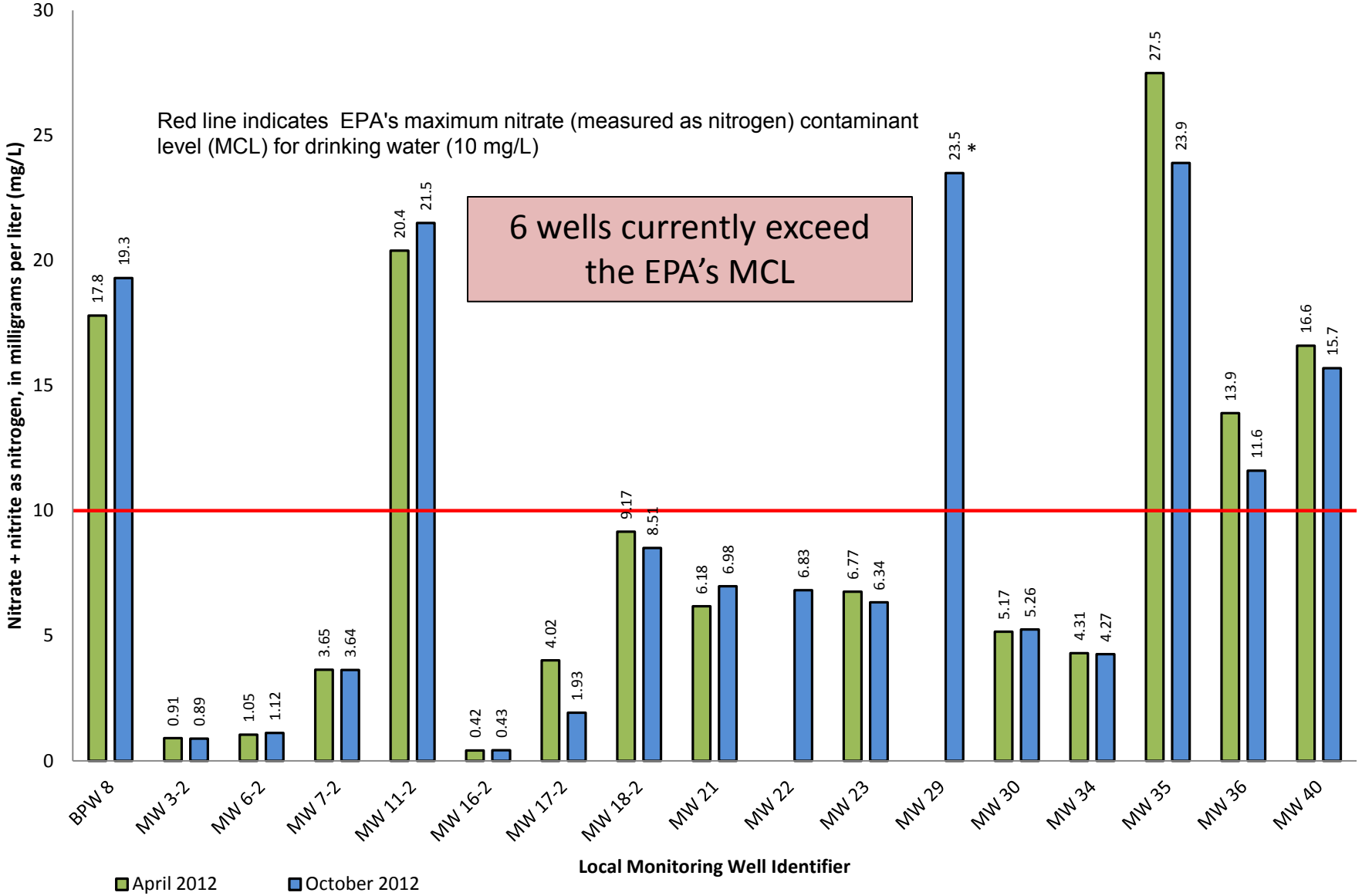
USGS

Altitude of water levels — MW 16-2, 18-2, 17-2, 3-2, 20, and 34, March 2000–September 2013



USGS

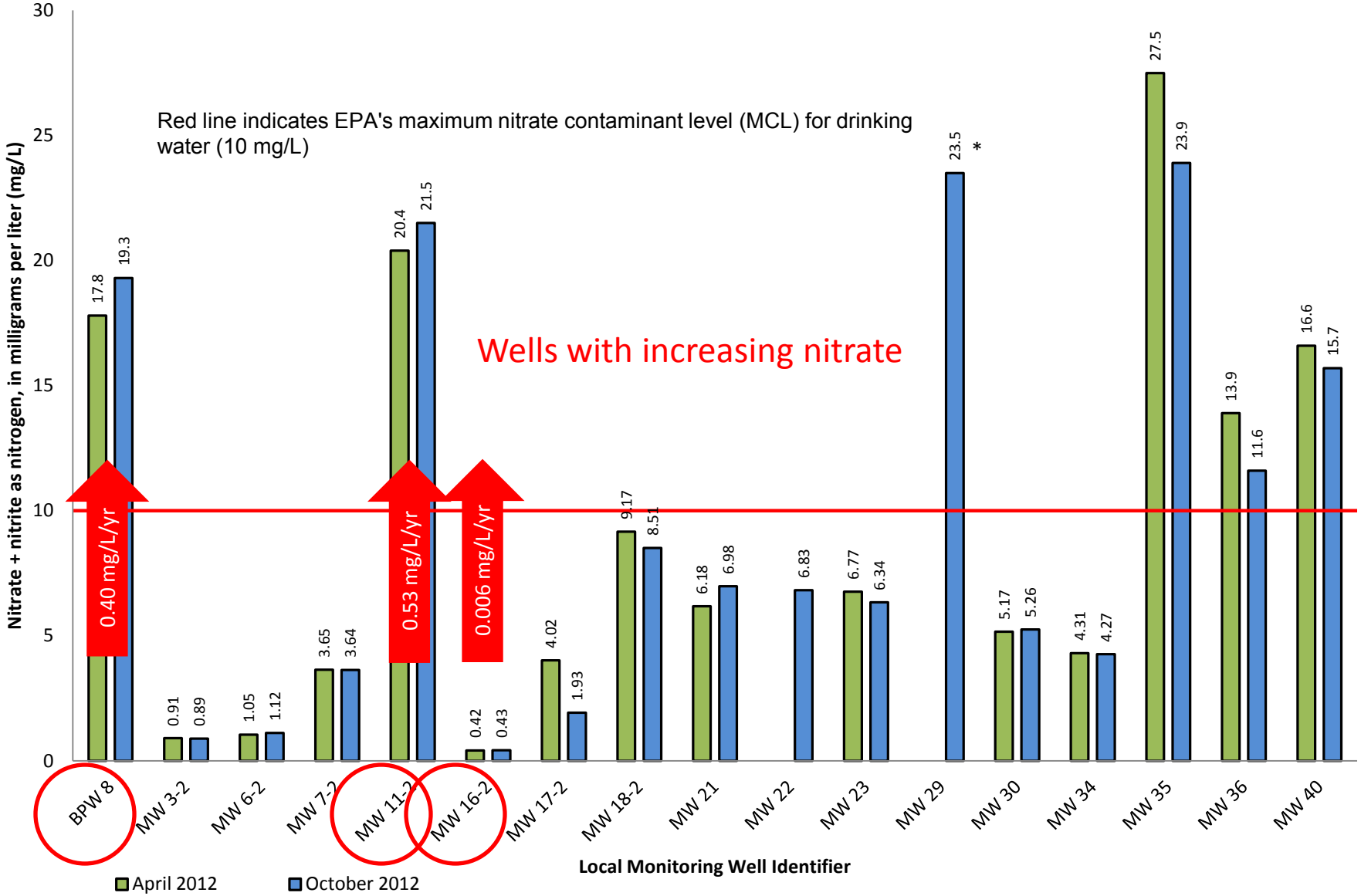
Nitrate Concentration by Groundwater Monitoring Well — Spring and Autumn 2012



USGS

* Sampled in November 2012

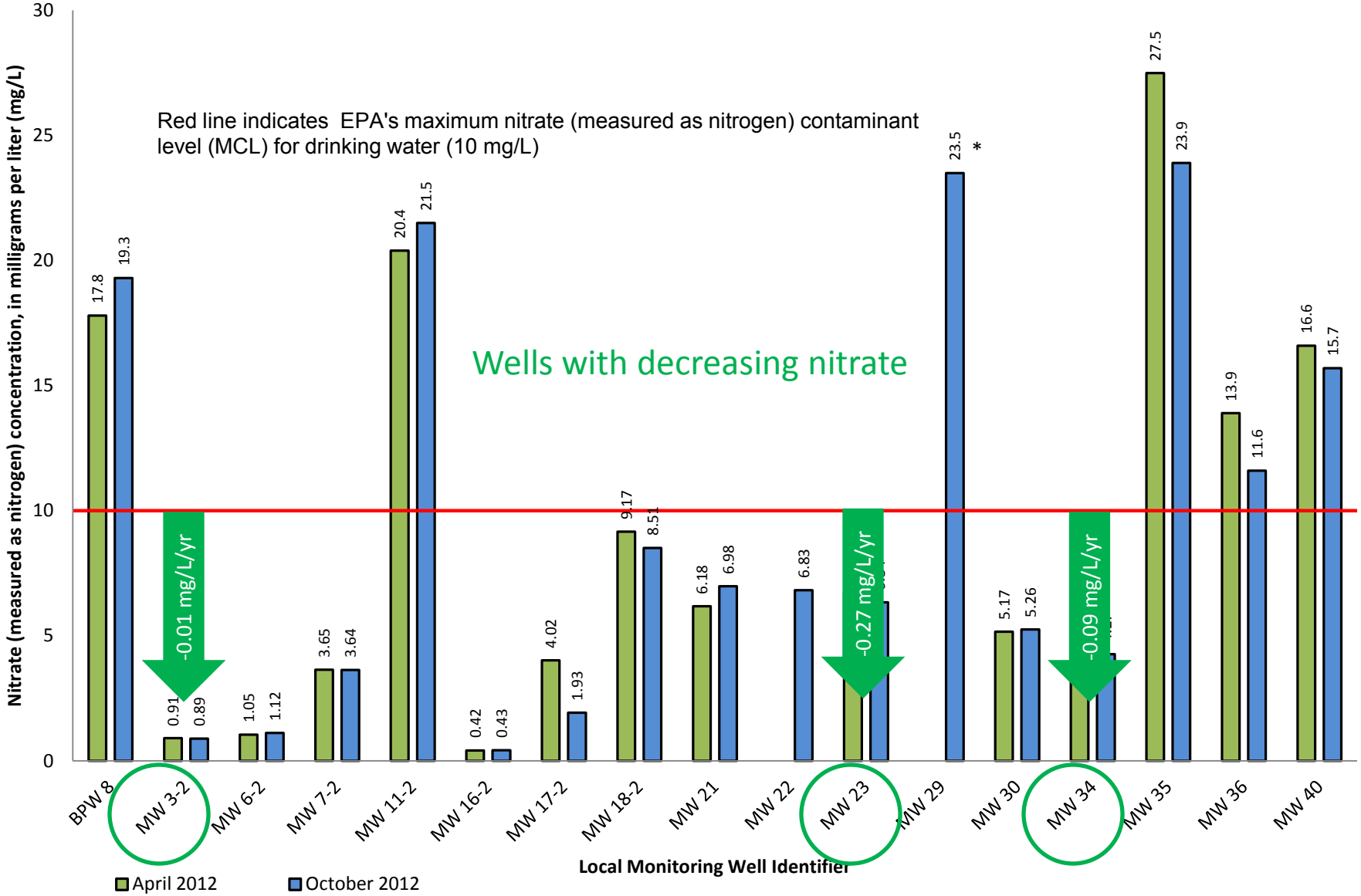
Nitrate Concentration by Groundwater Monitoring Well — Spring and Autumn 2012



USGS

* Sampled in November 2012

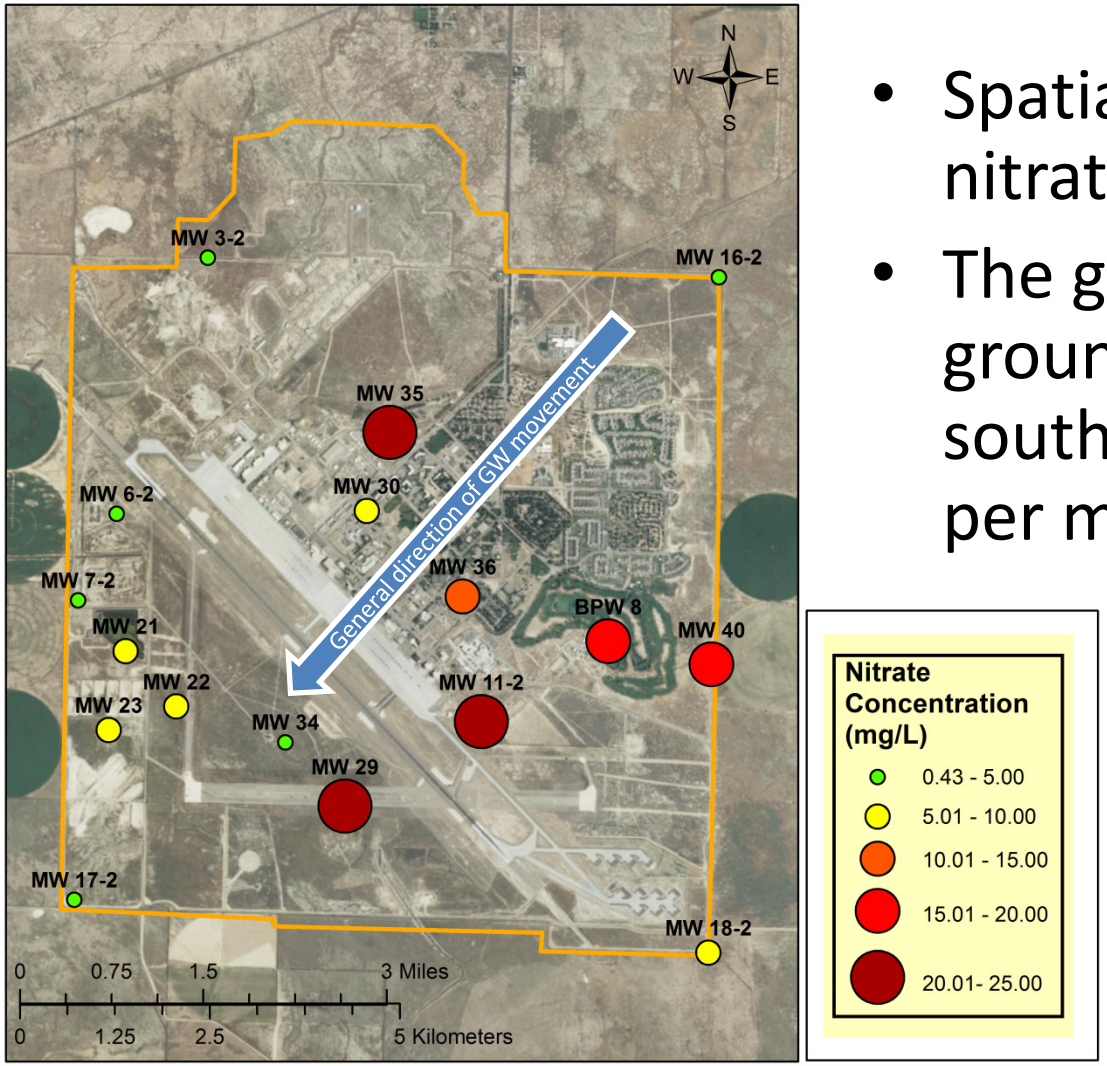
Nitrate Concentration by Groundwater Monitoring Well — Spring and Autumn 2012



USGS

* Sampled in November 2012

Nitrate Concentration by MW Location

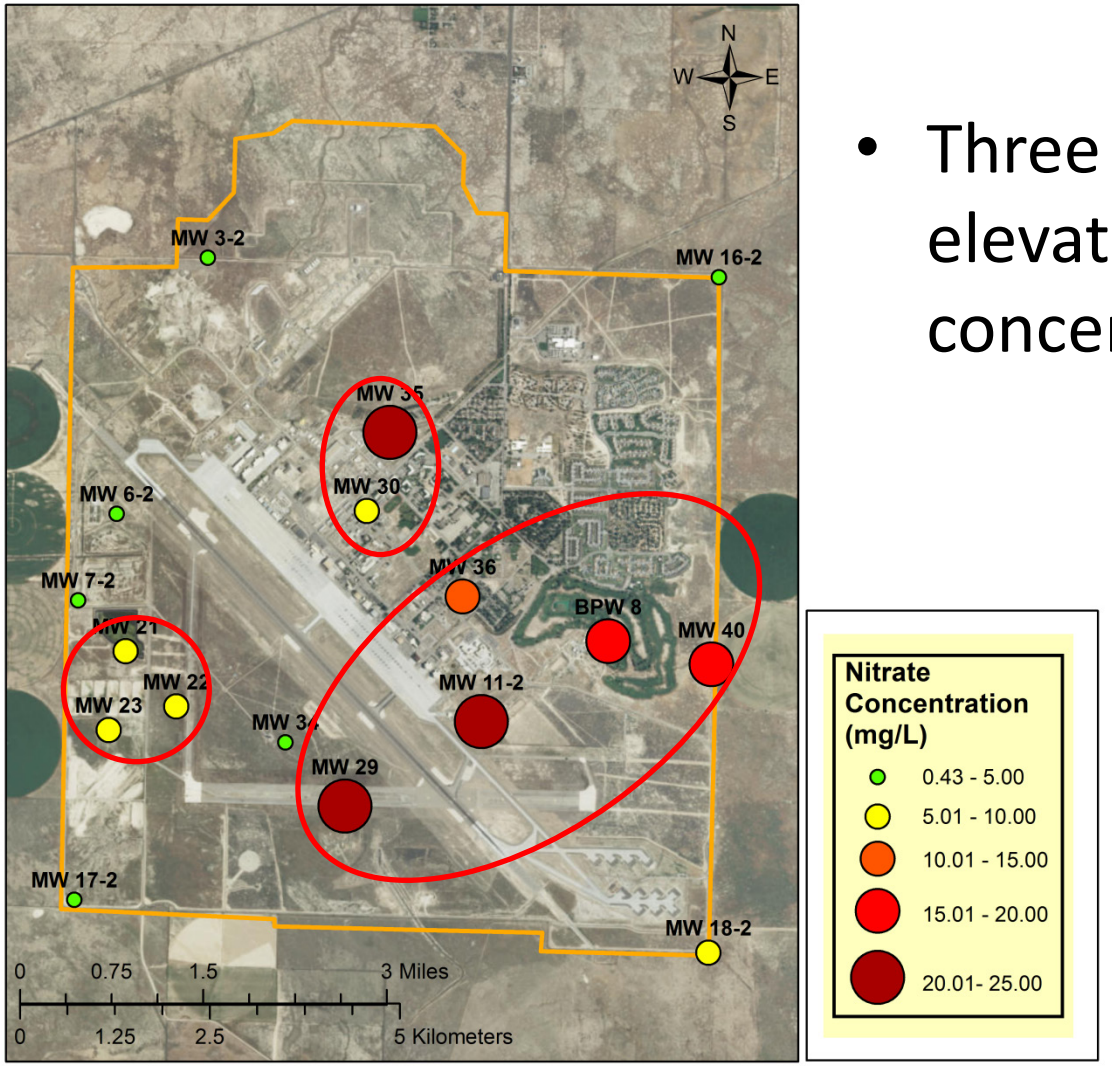


- Spatial distribution of nitrate concentration
- The general movement of groundwater is to the southwest with a 3 inches per mile gradient*

USGS

*Schwarz and Parliman (2010)

Nitrate Concentration by MW Location

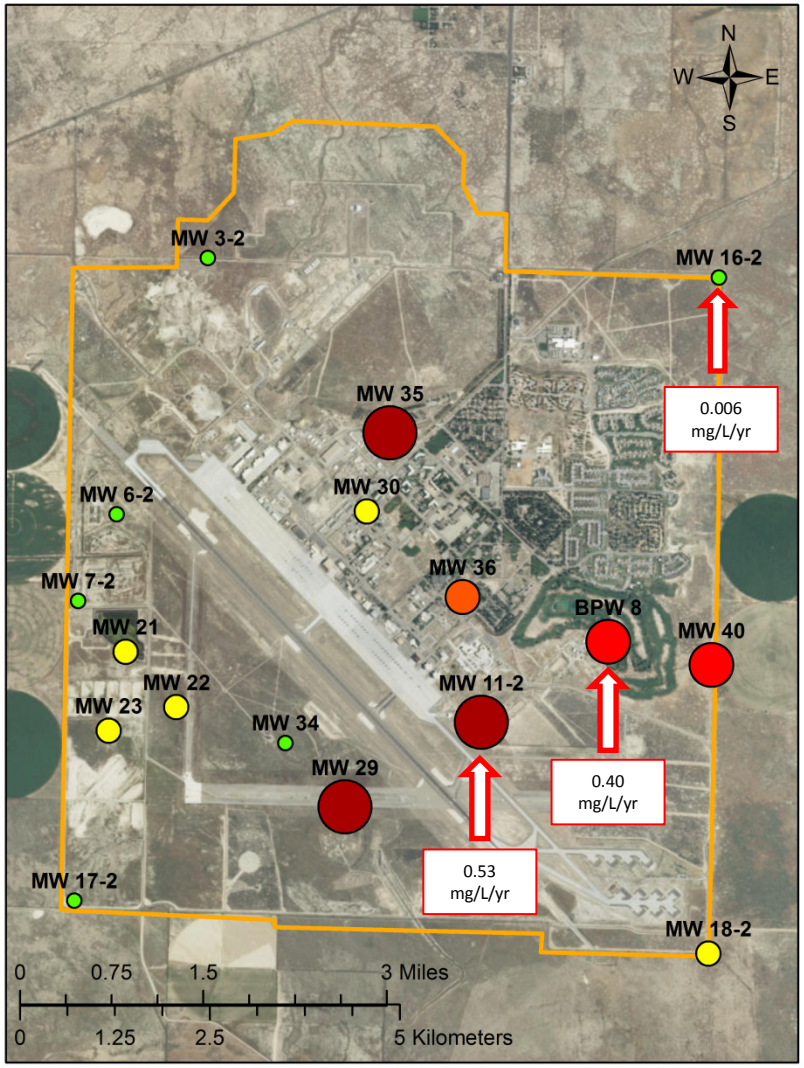


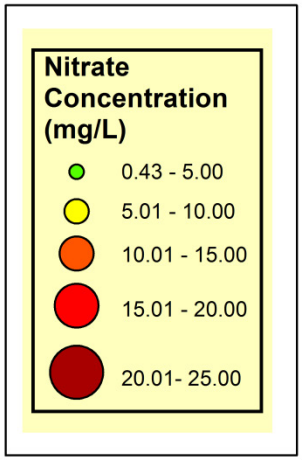
- Three clustered areas of elevated nitrate concentration*

USGS

*Schwarz and Parliman (2010)

Nitrate Concentration by MW Location

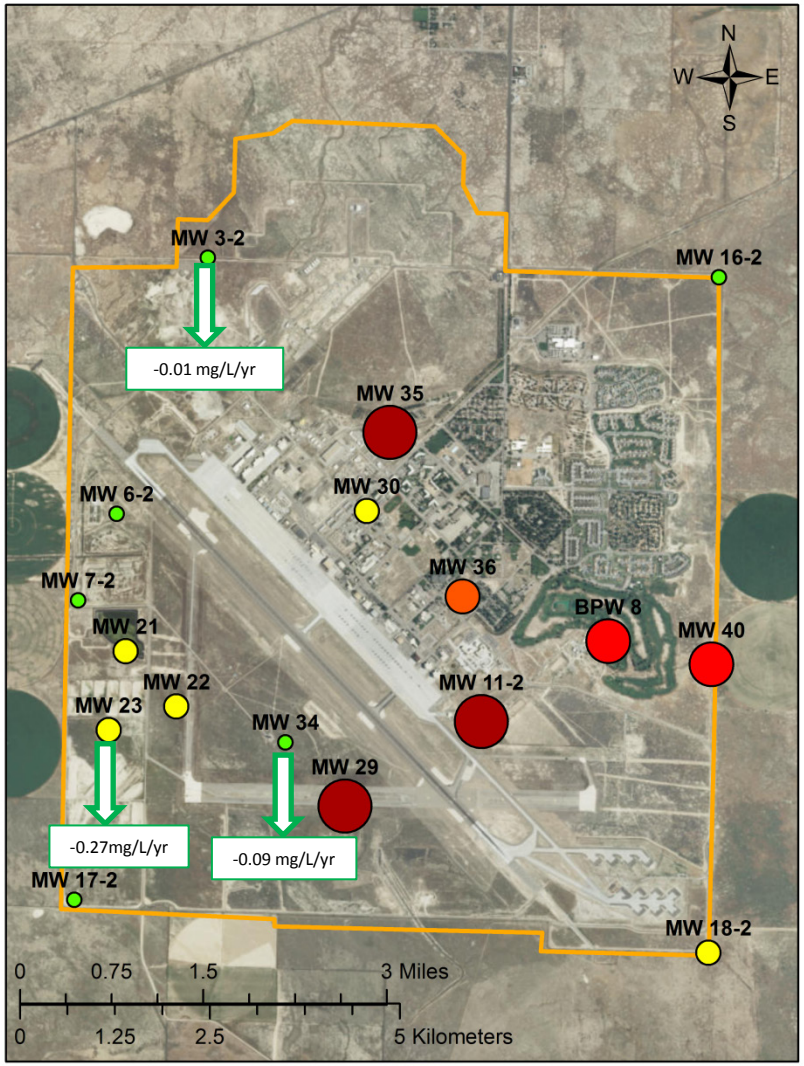


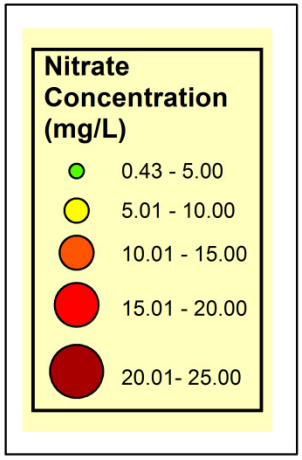


- 3 out of 17 MW wells show nitrate increases

USGS

Nitrate Concentration by MW Location

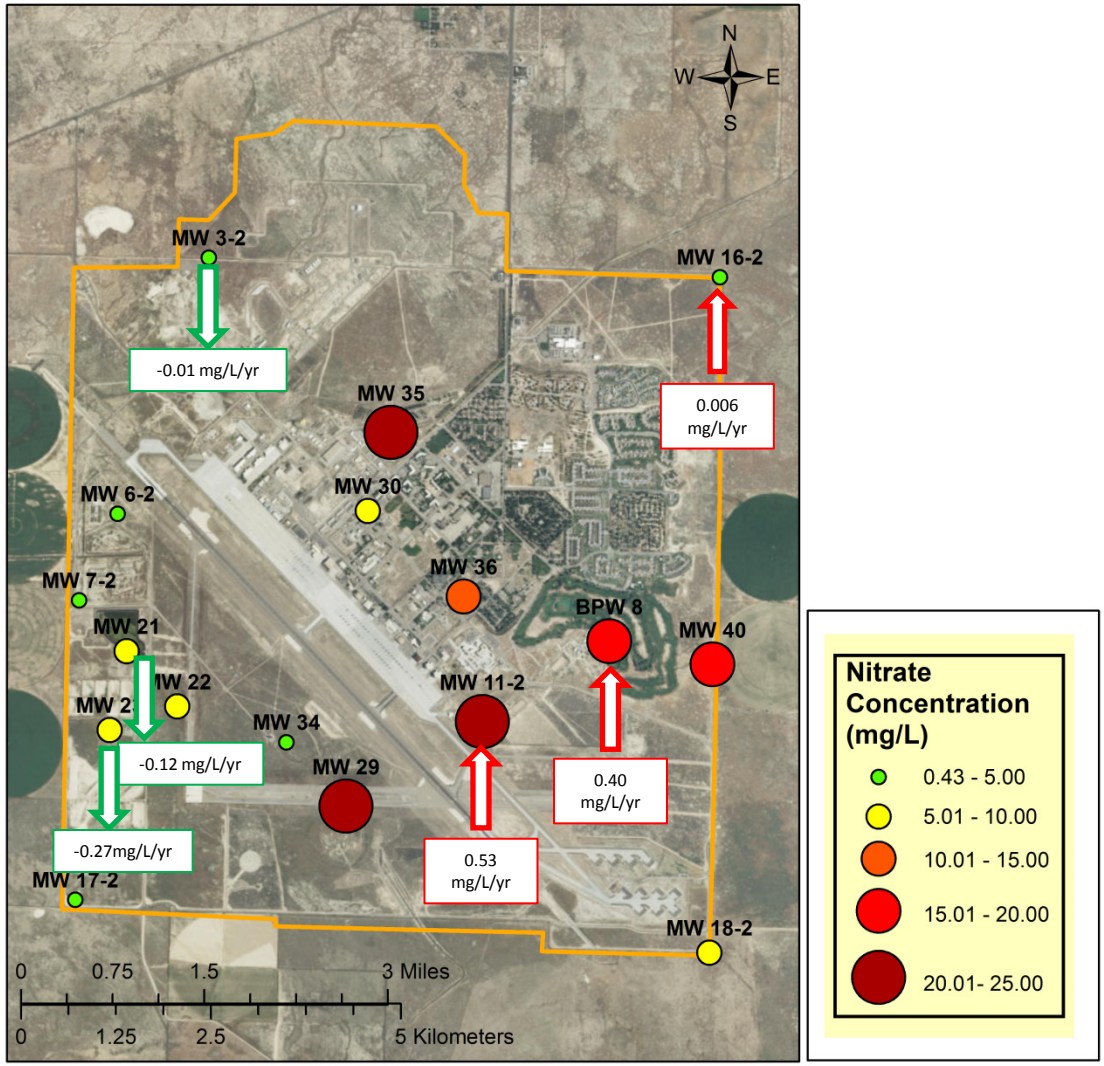




- 3 out of 17 wells decrease in nitrate concentration

USGS

Nitrate Concentration by MW Location



USGS

Summary Table

Local well No.	Groundwater level trend	Magnitude (ft/yr)	Nitrate concentration trend	Magnitude (mg/L/yr)	Exceeds MCL of 10 mg/L
MW 3-2	Declining	-1.18	Decreasing	-0.01	No
MW 6-2	Declining	-1.17	No significant trend	--	No
MW 7-2	Declining	-1.25	No significant trend	--	No
BPW 8	--	--	Increasing	0.40	Yes
MW 11-2	Declining	-1.21	Increasing	0.53	Yes
MW 16-2	Declining	-1.20	Increasing	0.01	No
MW 17-2	Declining	-1.29	No significant trend	--	No
MW 18-2	Declining	-1.16	No significant trend	--	No

USGS

Summary Table—Continued

Local Well No.	Groundwater level trend	Magnitude (ft/yr)	Nitrate concentration trend	Magnitude (mg/L/yr)	Exceeds MCL of 10 mg/L
MW 21	Declining	-1.27	No significant trend	--	No
MW 22	Declining	-1.27	No significant trend	--	No
MW 23	Declining	-1.29	Decreasing	-0.27	No
MW 29	Declining	-1.15	No significant trend	--	Yes
MW 30	Declining	-1.11	No significant trend	--	No
MW 34	Declining	-1.12	Decreasing	-0.09	No
MW 35	Declining	-1.18	No significant trend	--	Yes
MW 36	Declining	-1.11	No significant trend	--	Yes
MW 40	No trend	--	No significant trend	--	Yes

USGS

Summary of Findings

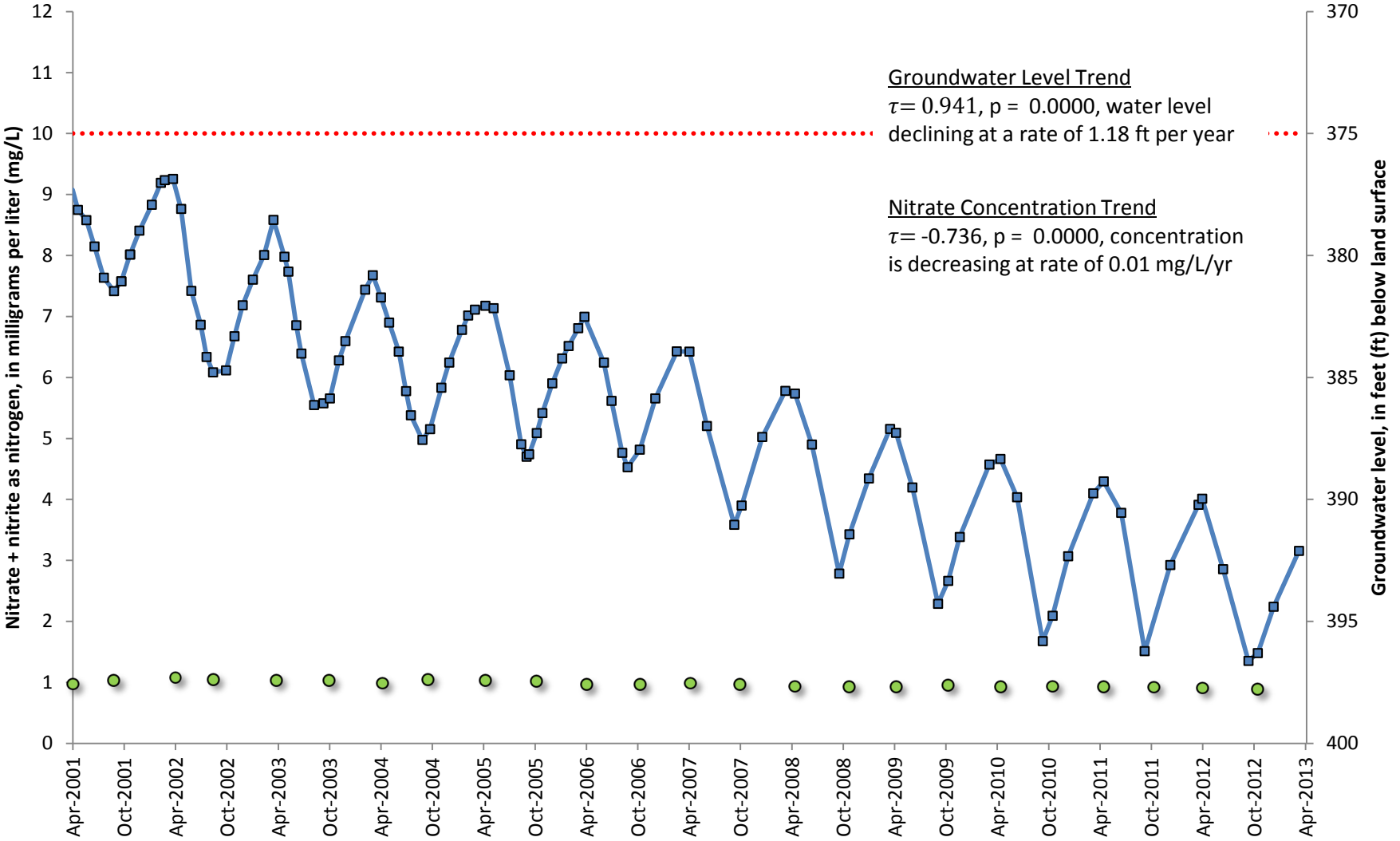
- MHAFB groundwater levels are declining at an average rate of about 1.08 feet per year based on Kendall Regional Test
- Nitrate concentration trend results:
  - 3 wells (18 percent) show an **increasing** nitrate concentration trend
  - 3 wells (18 percent) show a **decreasing** nitrate concentration trend
  - And 11 wells (64 percent) show **no nitrate concentration trend**
- 6 wells (35 percent) exceed the MCL of 10 mg/L for nitrate (measured as nitrogen)

USGS

Supplementary Information

USGS
science for a changing world

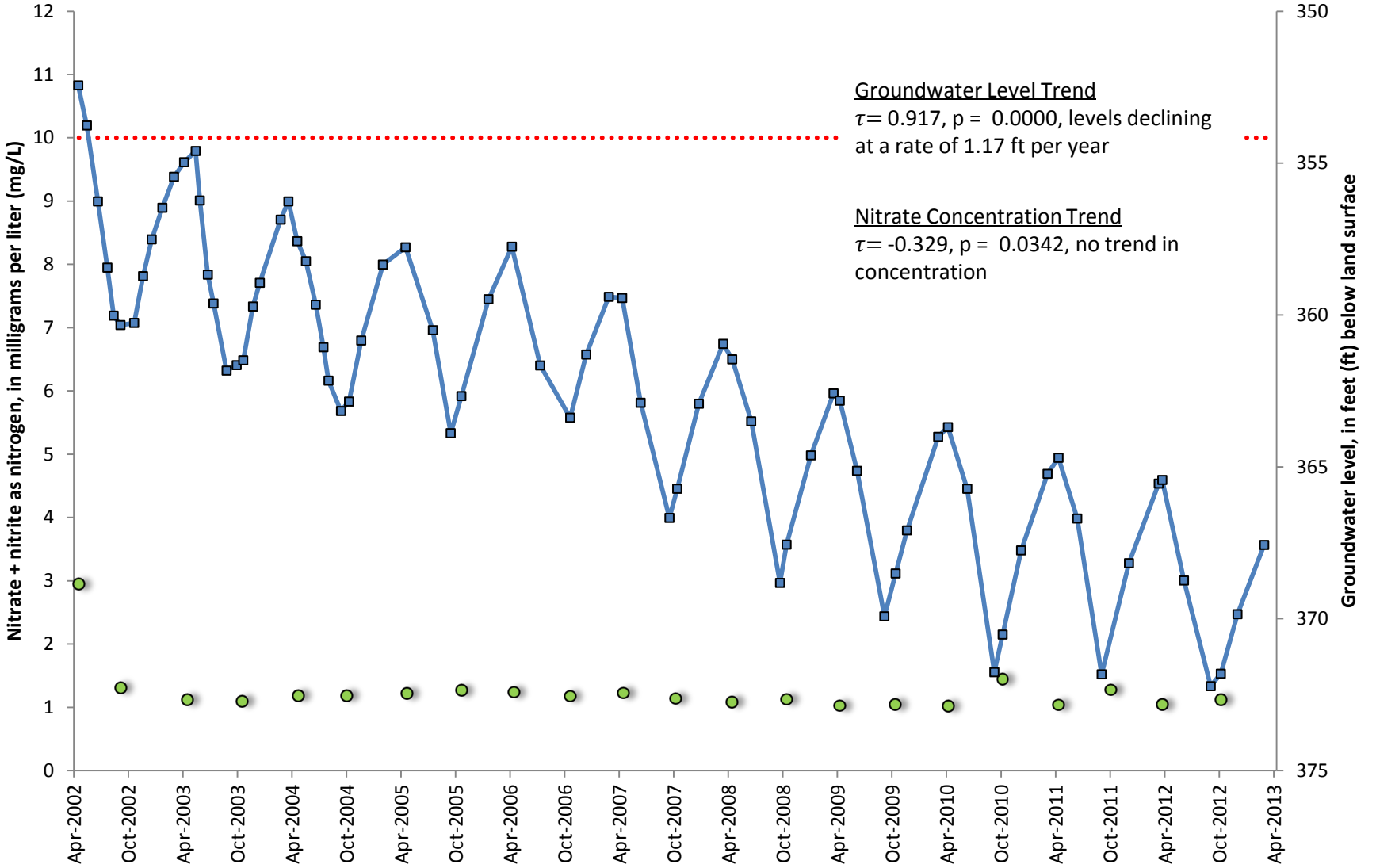
Monitoring Well 3-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April 2001–March 2013



USGS

Back

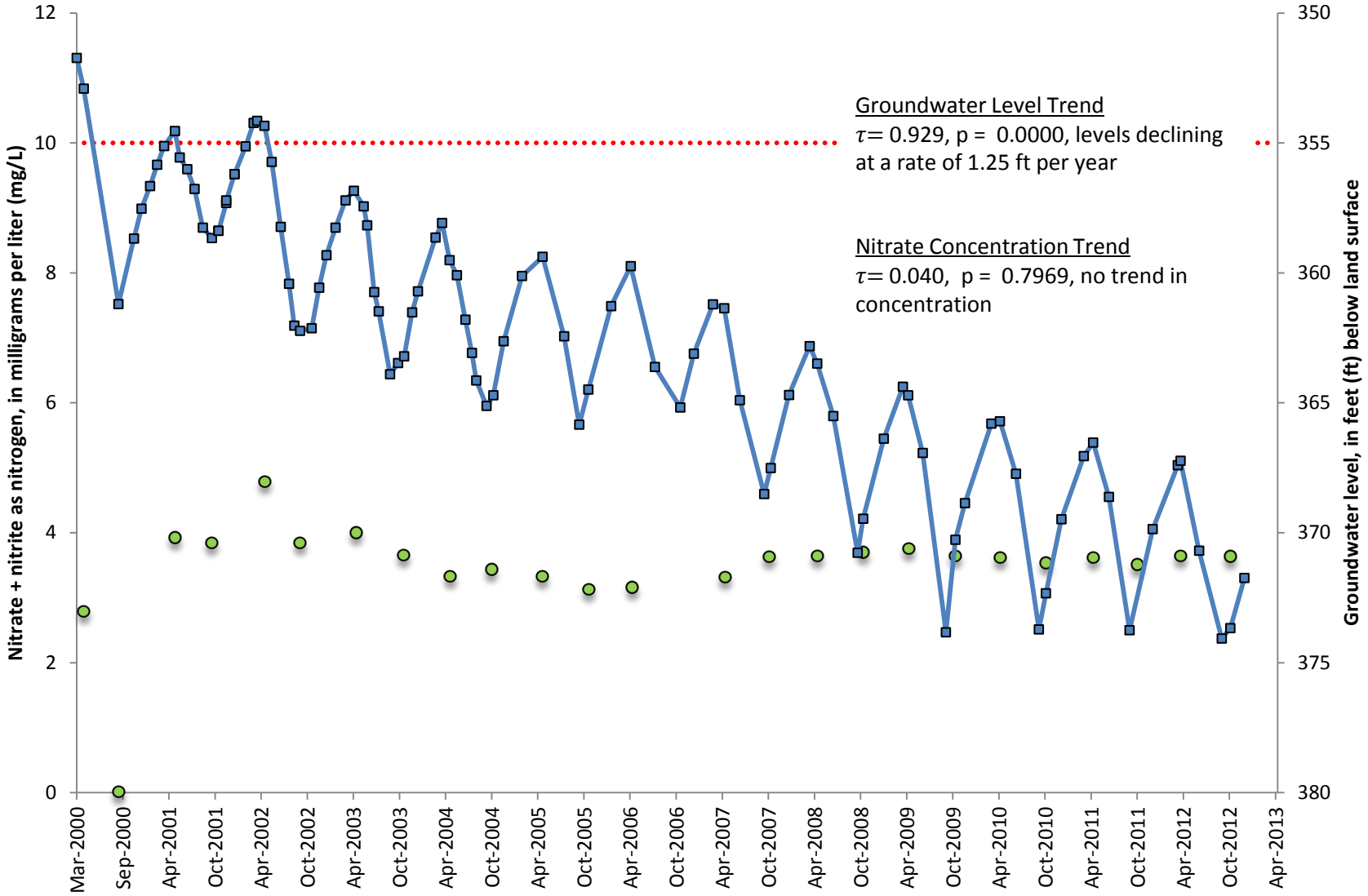
Monitoring Well 6-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April–March 2013



USGS

Groundwater Level Trend
τ = 0.701, p = 0.0000, levels declining at a rate of -1.29 ft per year

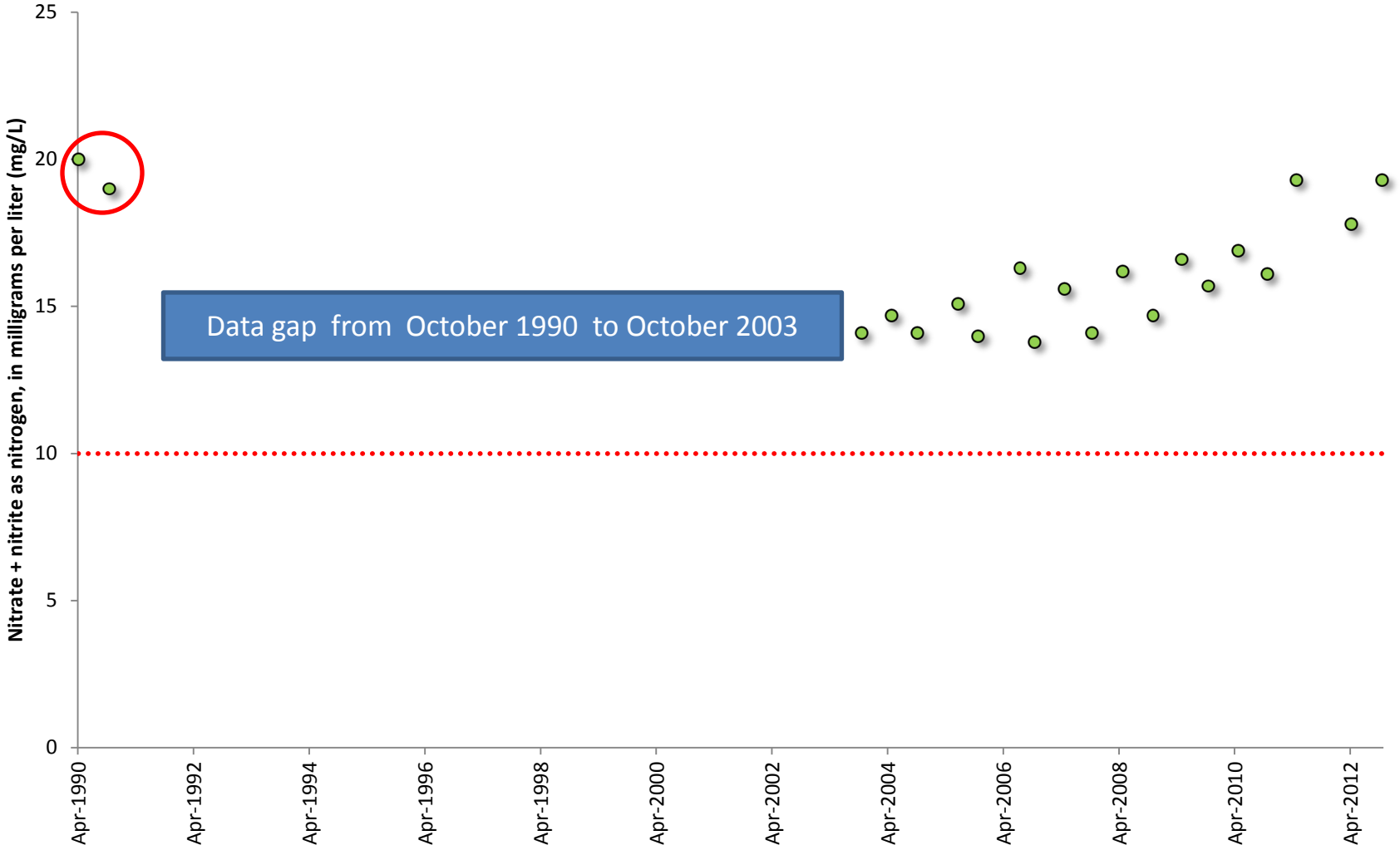
Monitoring Well 7-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, March 2000–March 2013



USGS

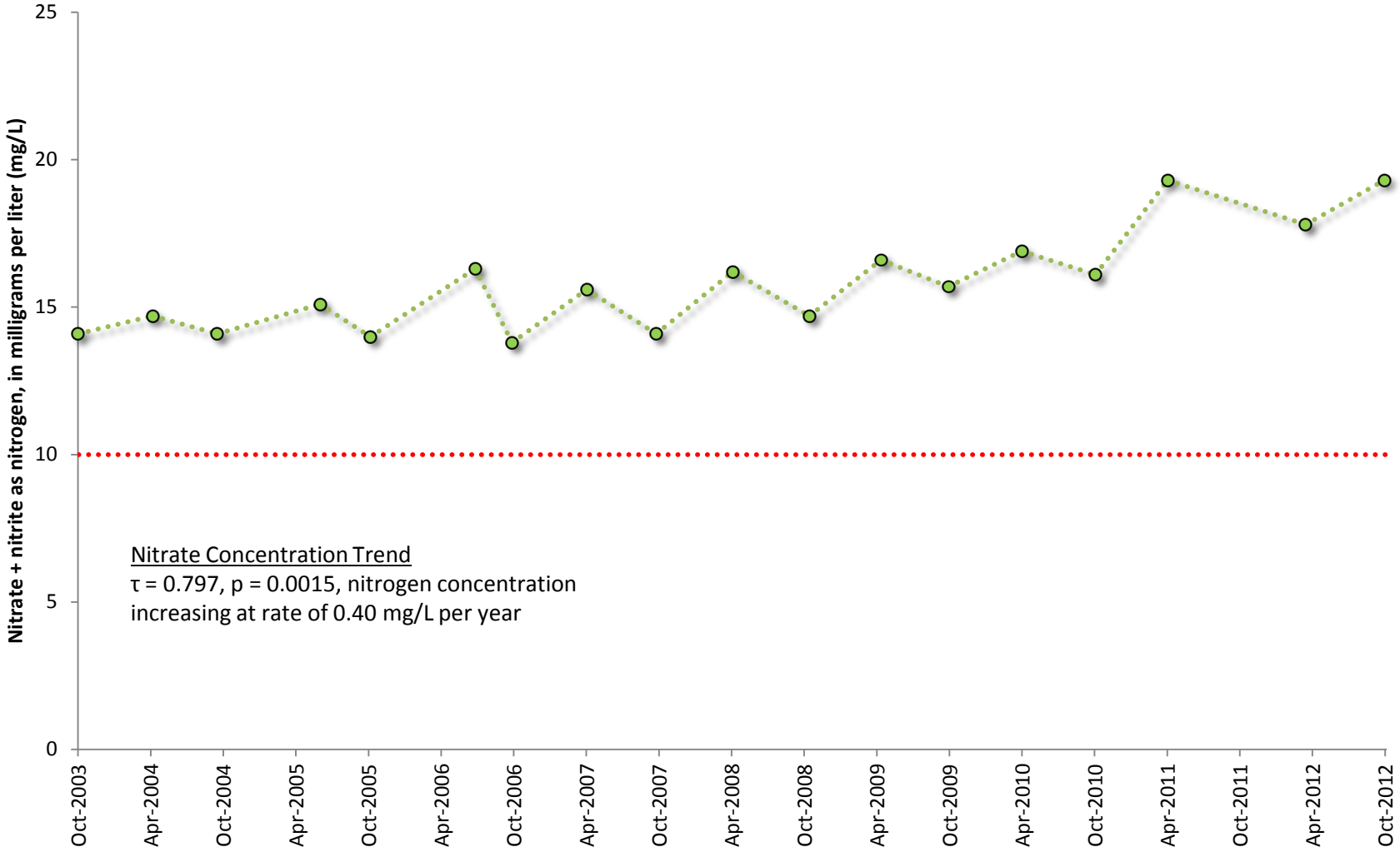
Nitrogen Concentration Trend
τ = 0.015, p = 0.9702, no significant trend in concentration

Base Production Well 8, Mountain Home AFB, Idaho
Nitrate Concentrations, April 1990–October 2012



USGS

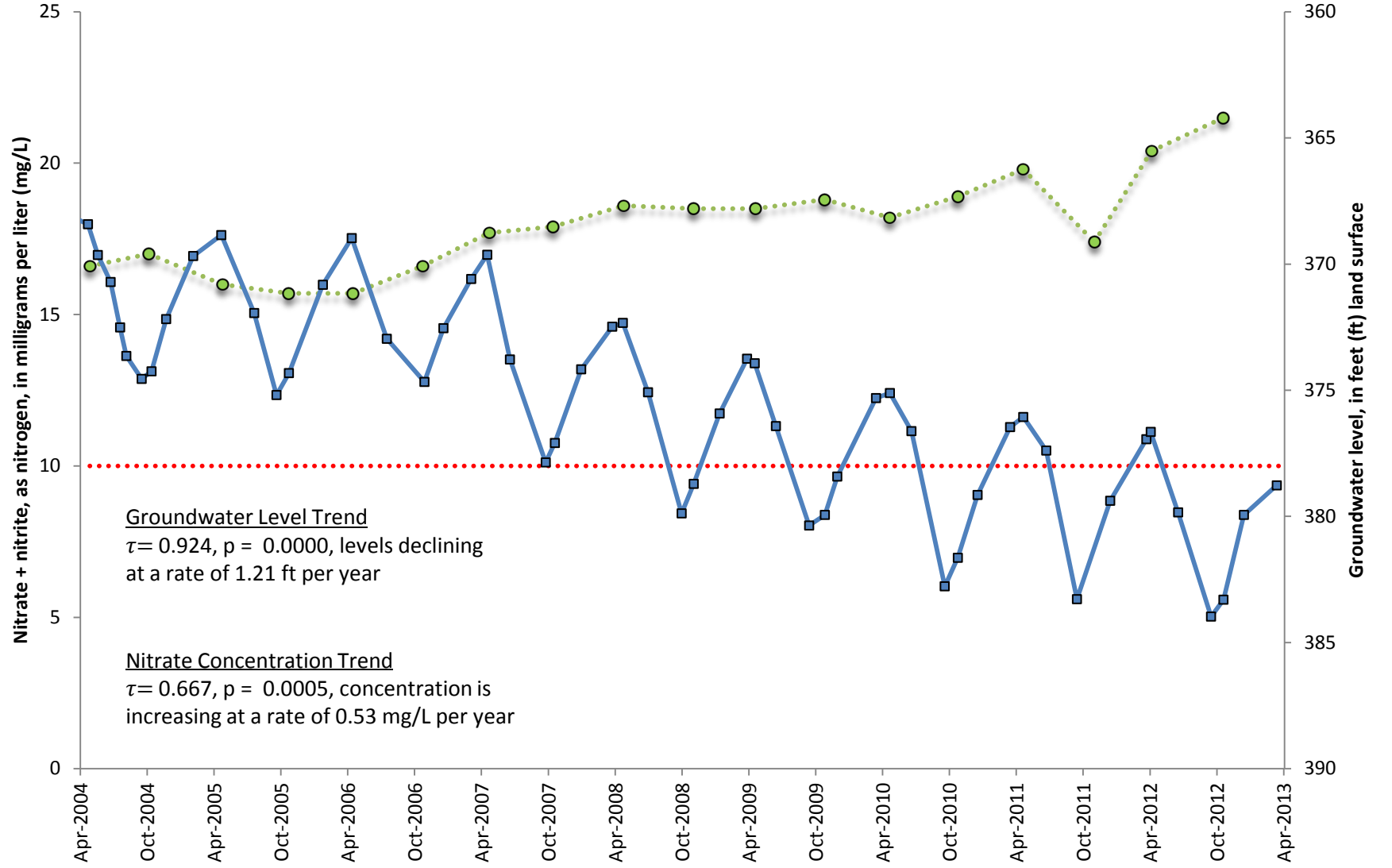
Base Production Well 8, Mountain Home AFB, Idaho
Nitrate Concentrations, October 2003–October 2012



USGS

Back

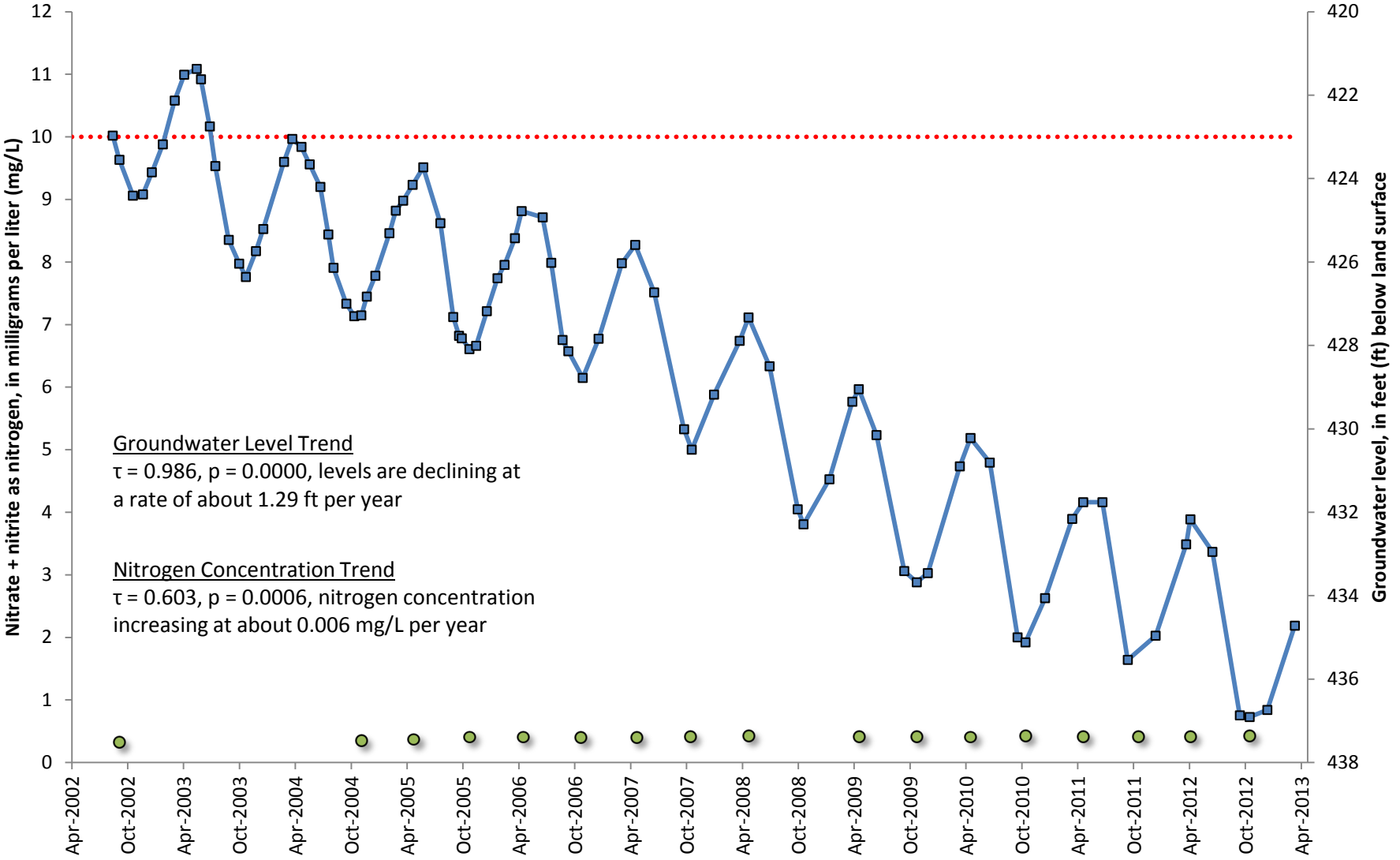
Monitoring Well 11-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April 2004–March 2013



USGS

Groundwater Levels
τ = 0.698, p = 0.0000, levels declining at a rate of -1.26 ft per year

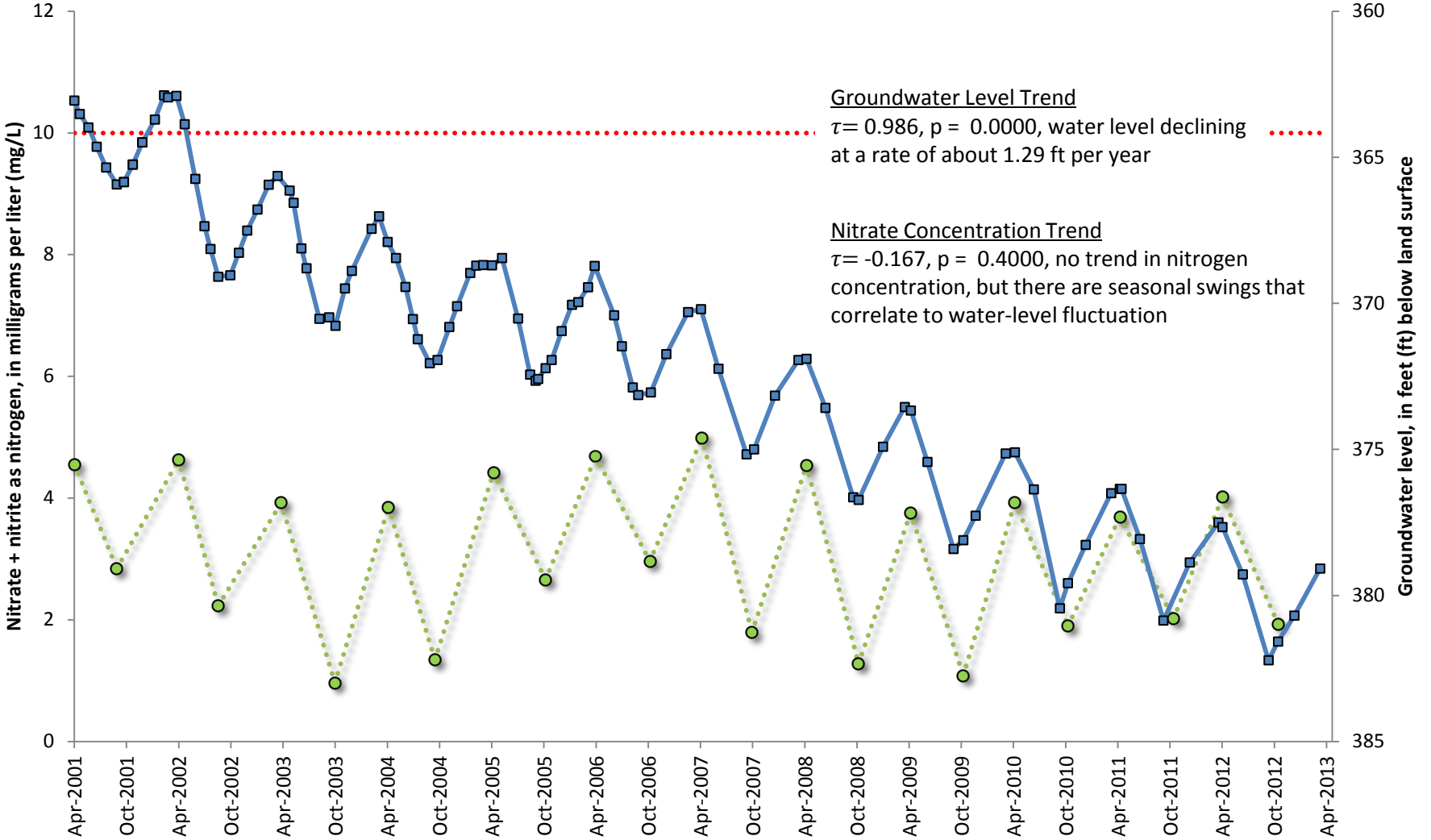
Monitoring Well 16-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, August 2002–March 2013



USGS

Back

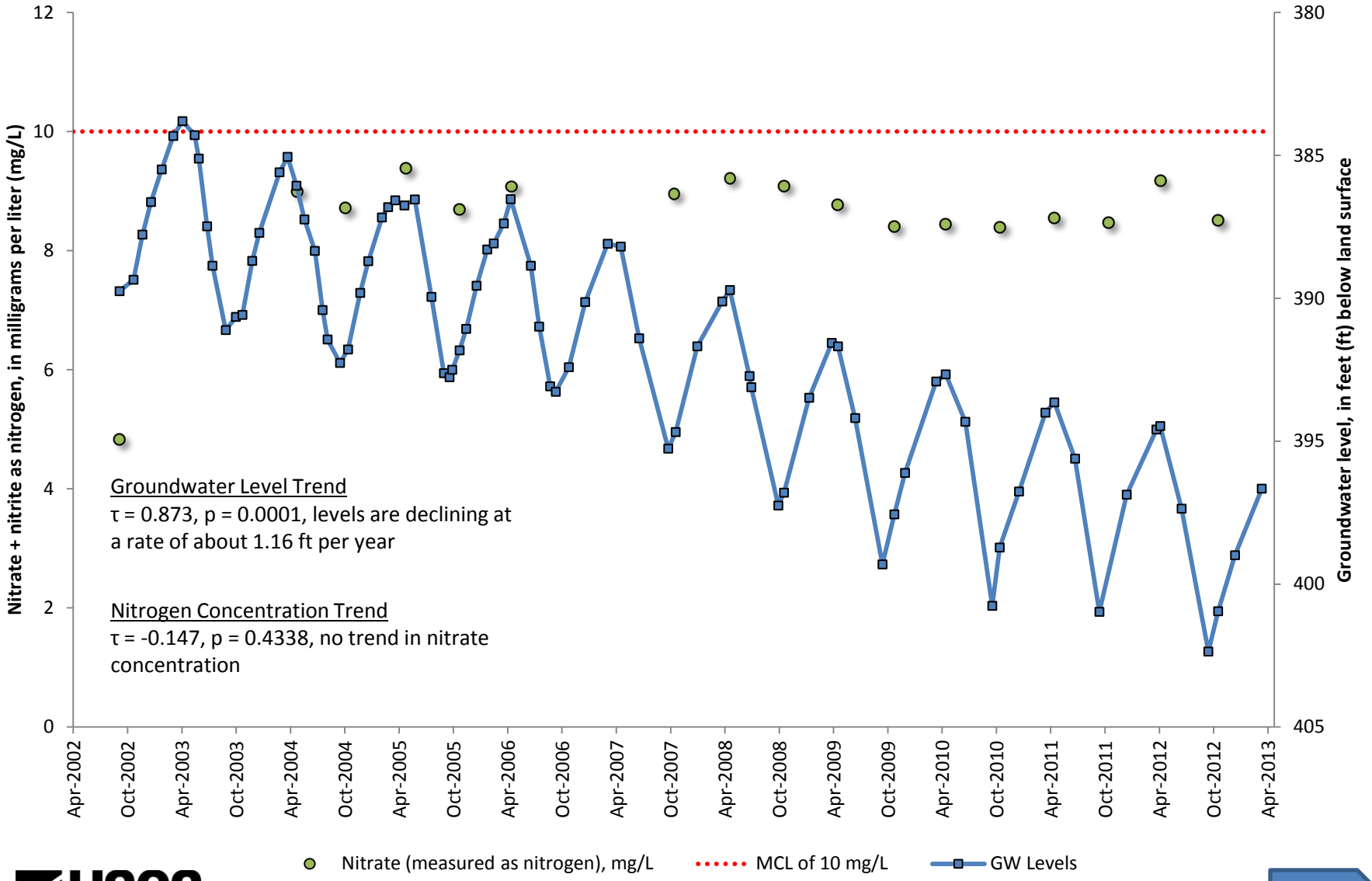
Monitoring Well 17-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April 2001–March 2013



USGS

Groundwater Level
τ = 0.776, p = 0.0000, water level declining at a rate of about -1.35 ft per year

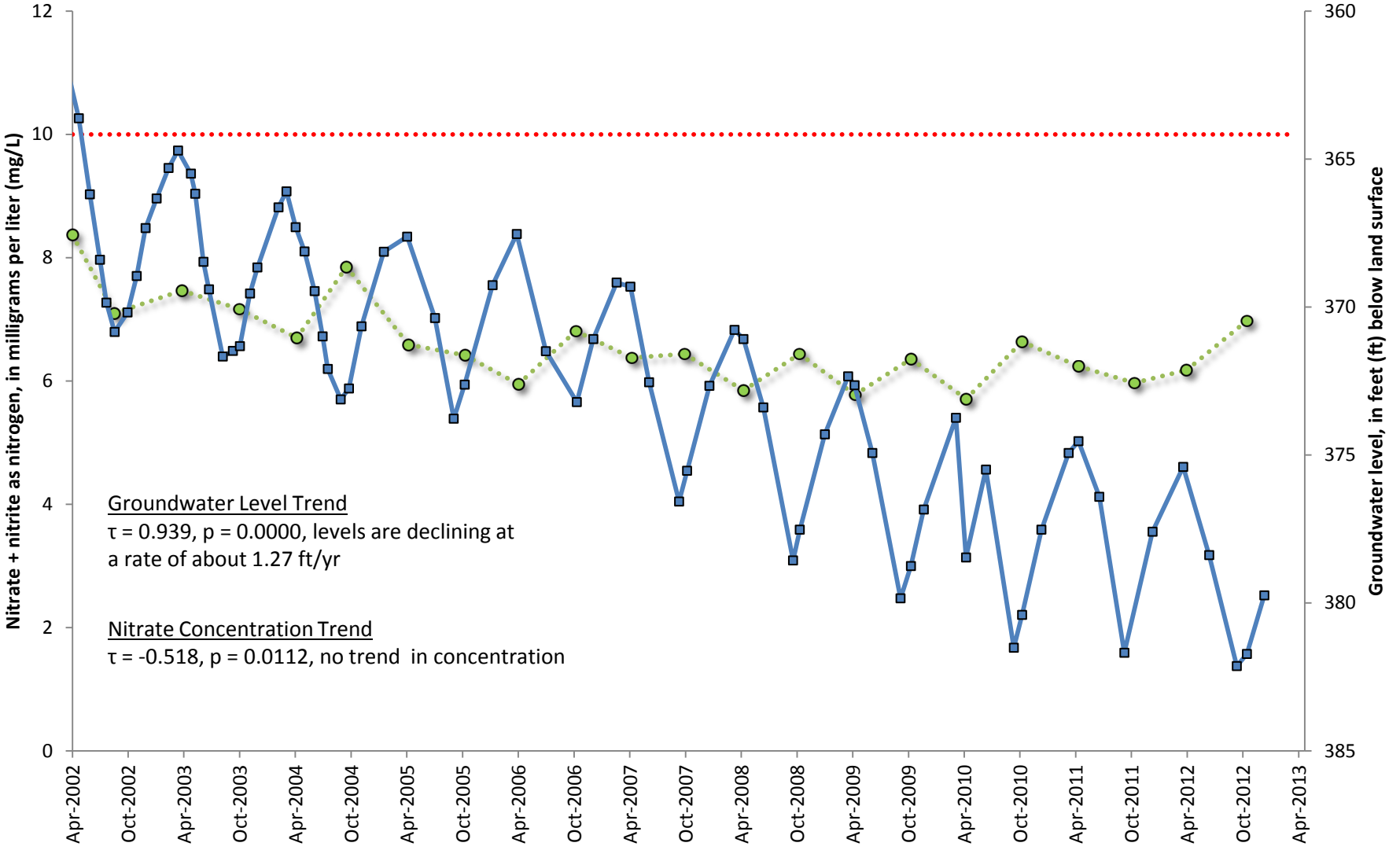
Monitoring Well MW 18-2, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, September 2002–March 2013



USGS

Back

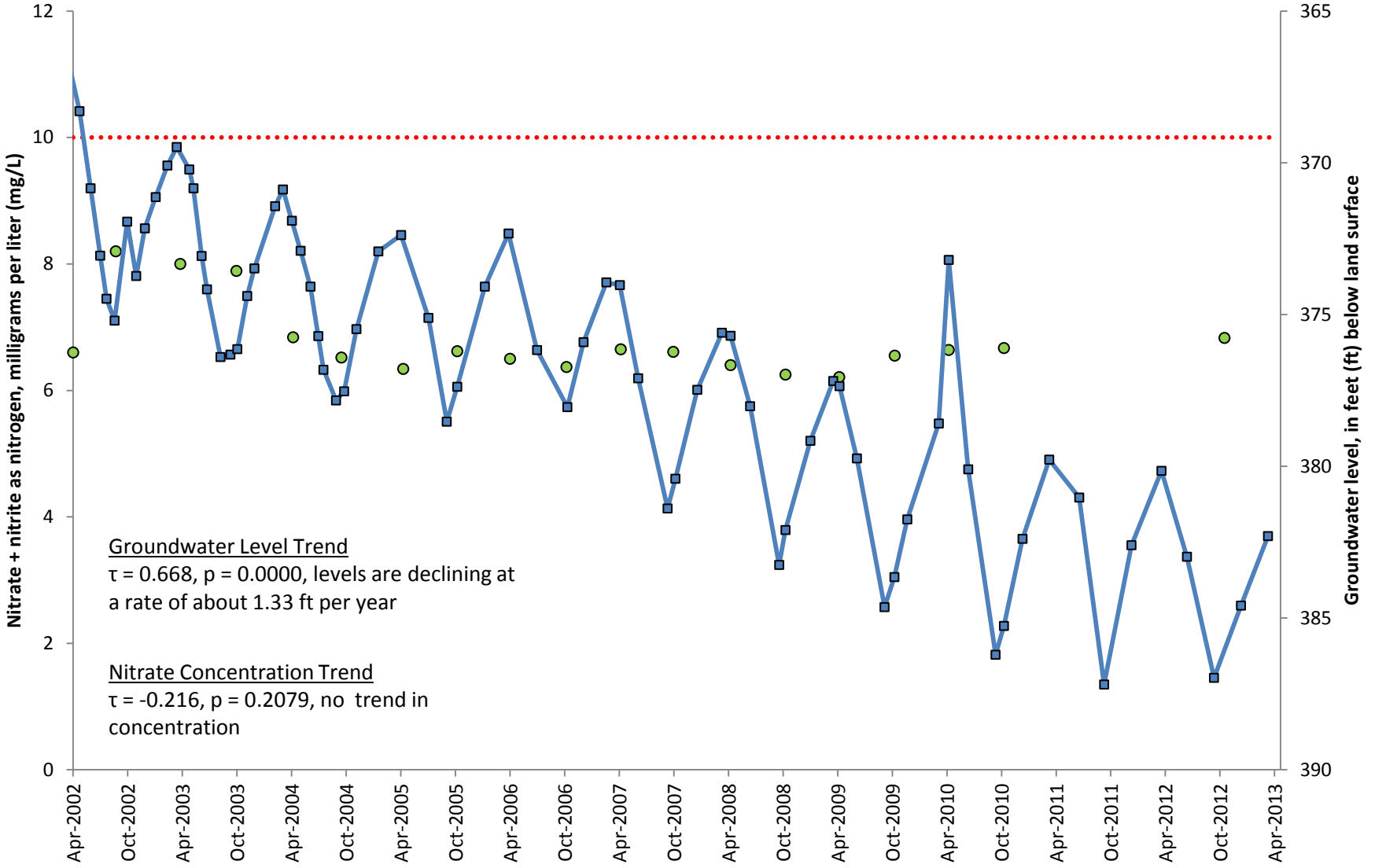
Monitoring Well MW 21, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April 2002–March 2013



USGS

Back

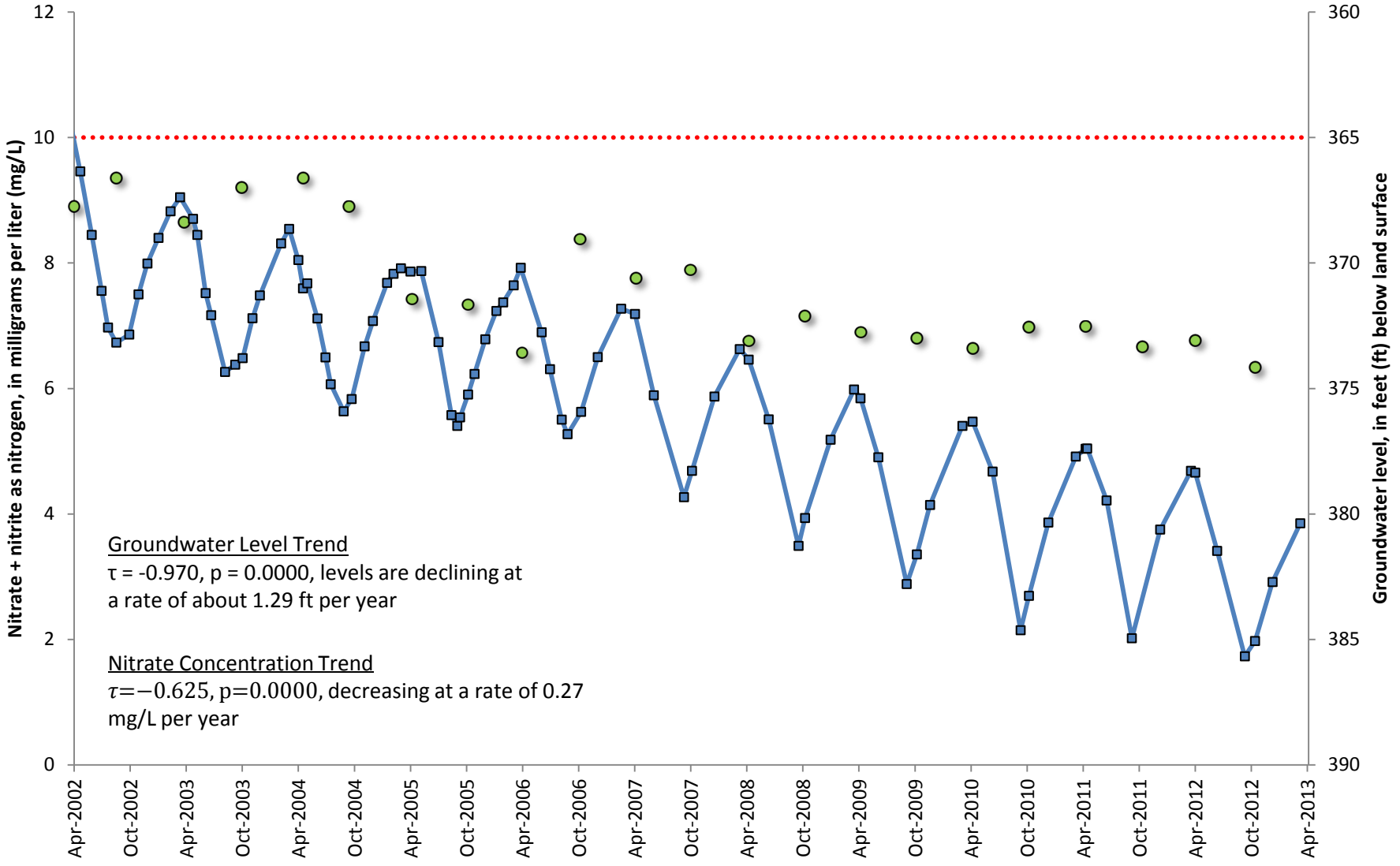
Monitoring Well MW 22, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April 2001–March 2013



USGS

Back

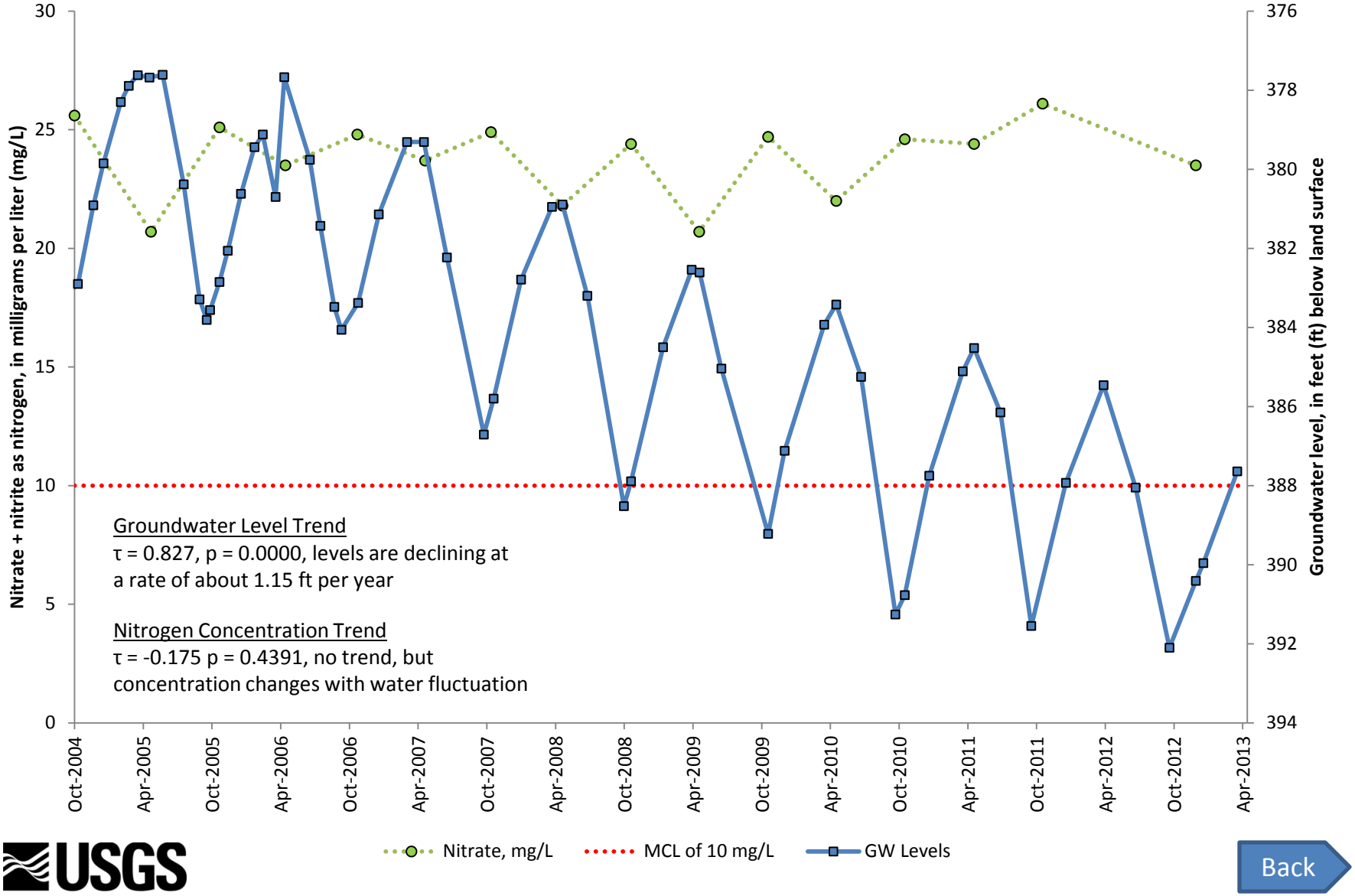
Monitoring Well 23, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, April 2002–March 2013



USGS

Back

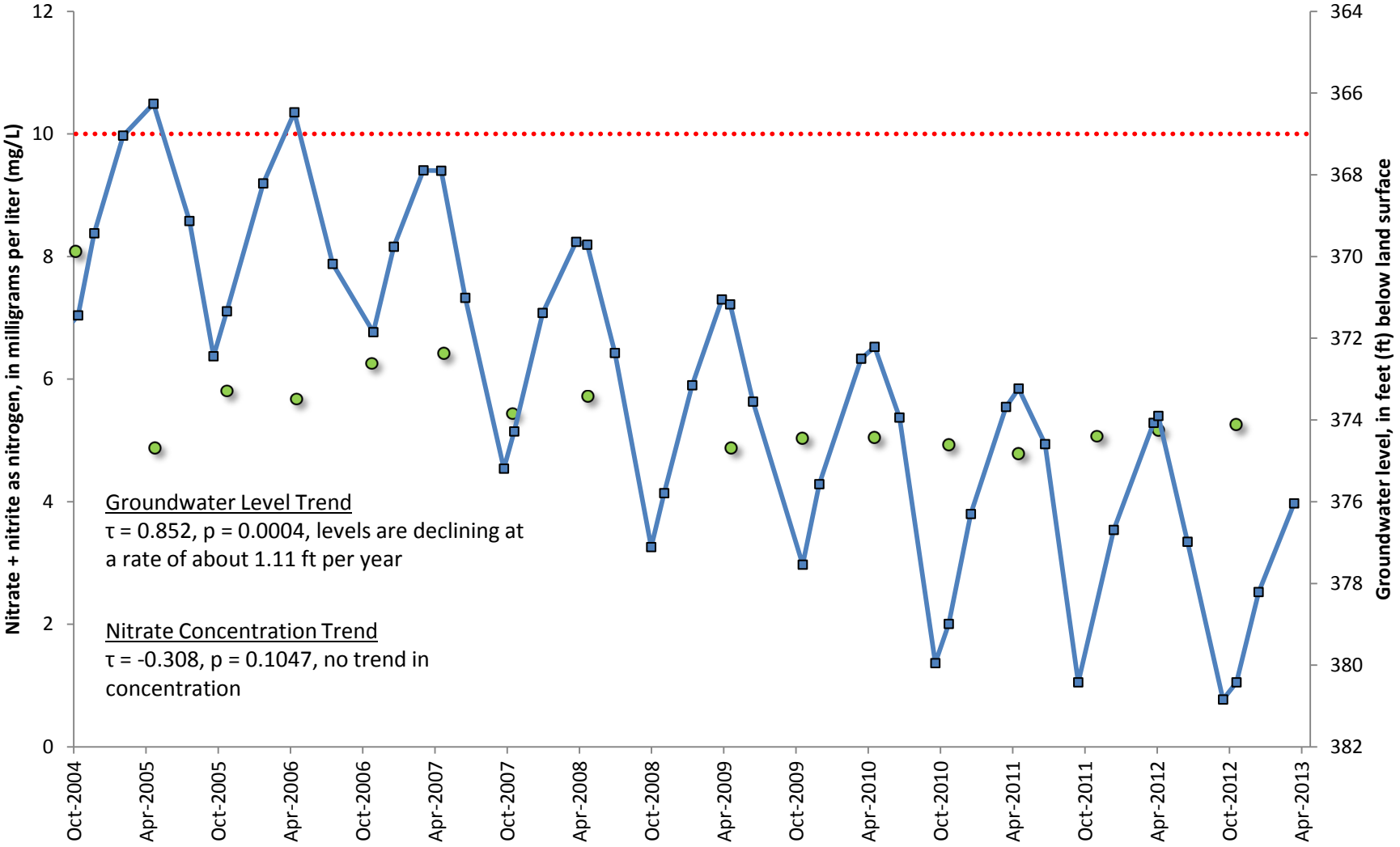
Monitoring Well 29, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, October 2004–March 2013



USGS

Back

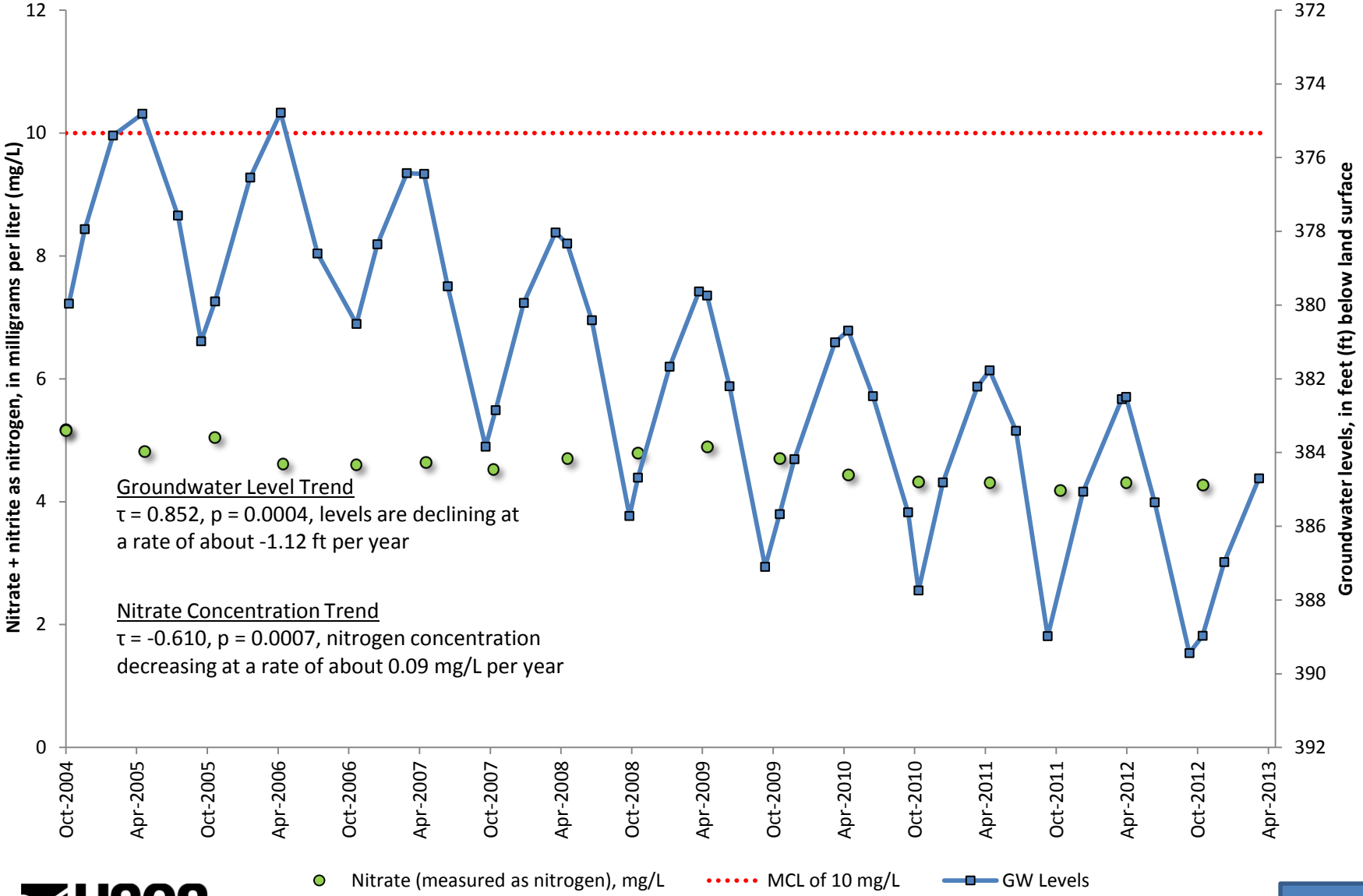
Monitoring Well 30, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, October 2004–March 2013



USGS

Back

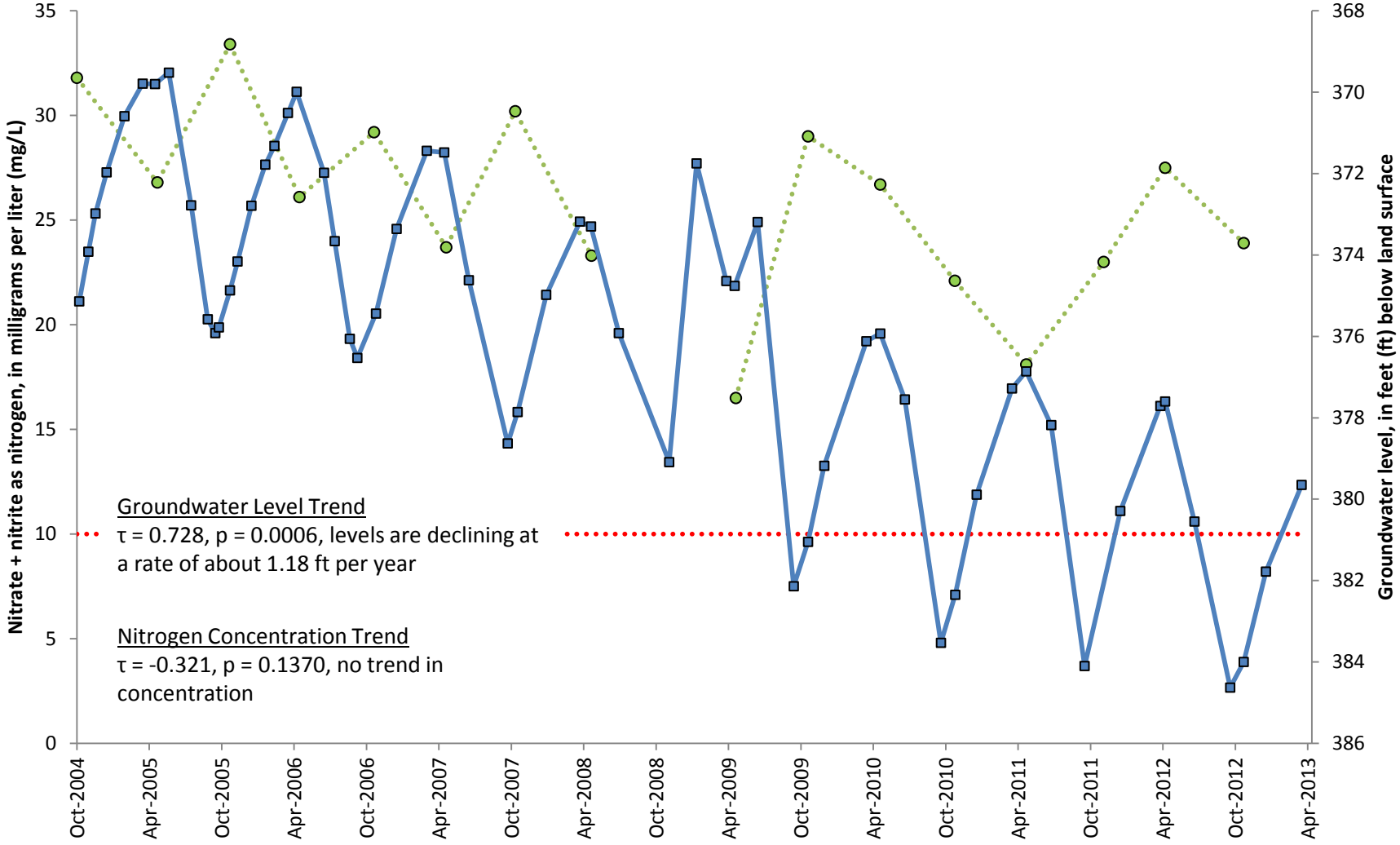
Monitoring Well 34, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, October 2004–March 2013



USGS

Back

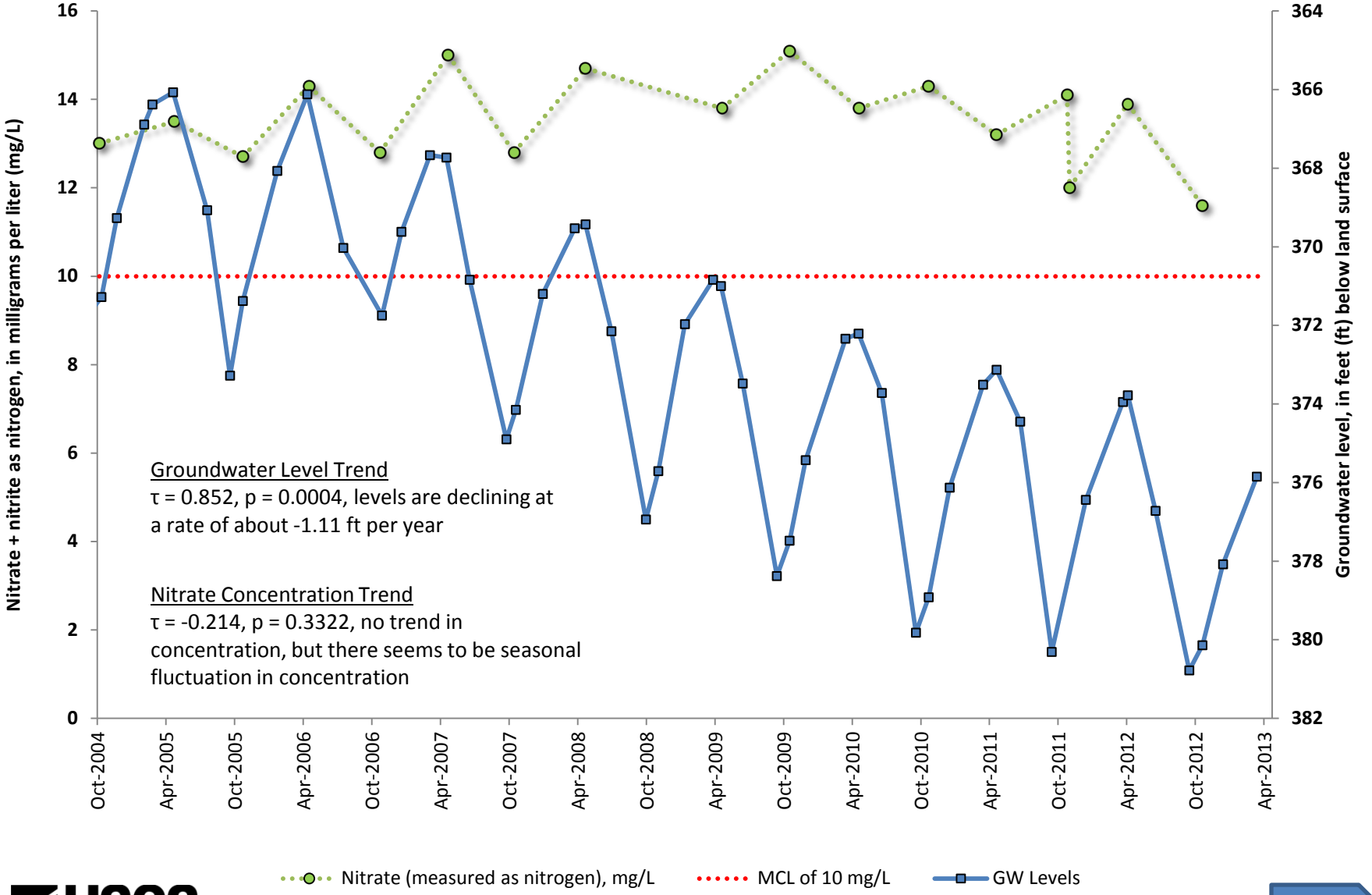
Monitoring Well 35, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, October 2004–March 2013



USGS

Back

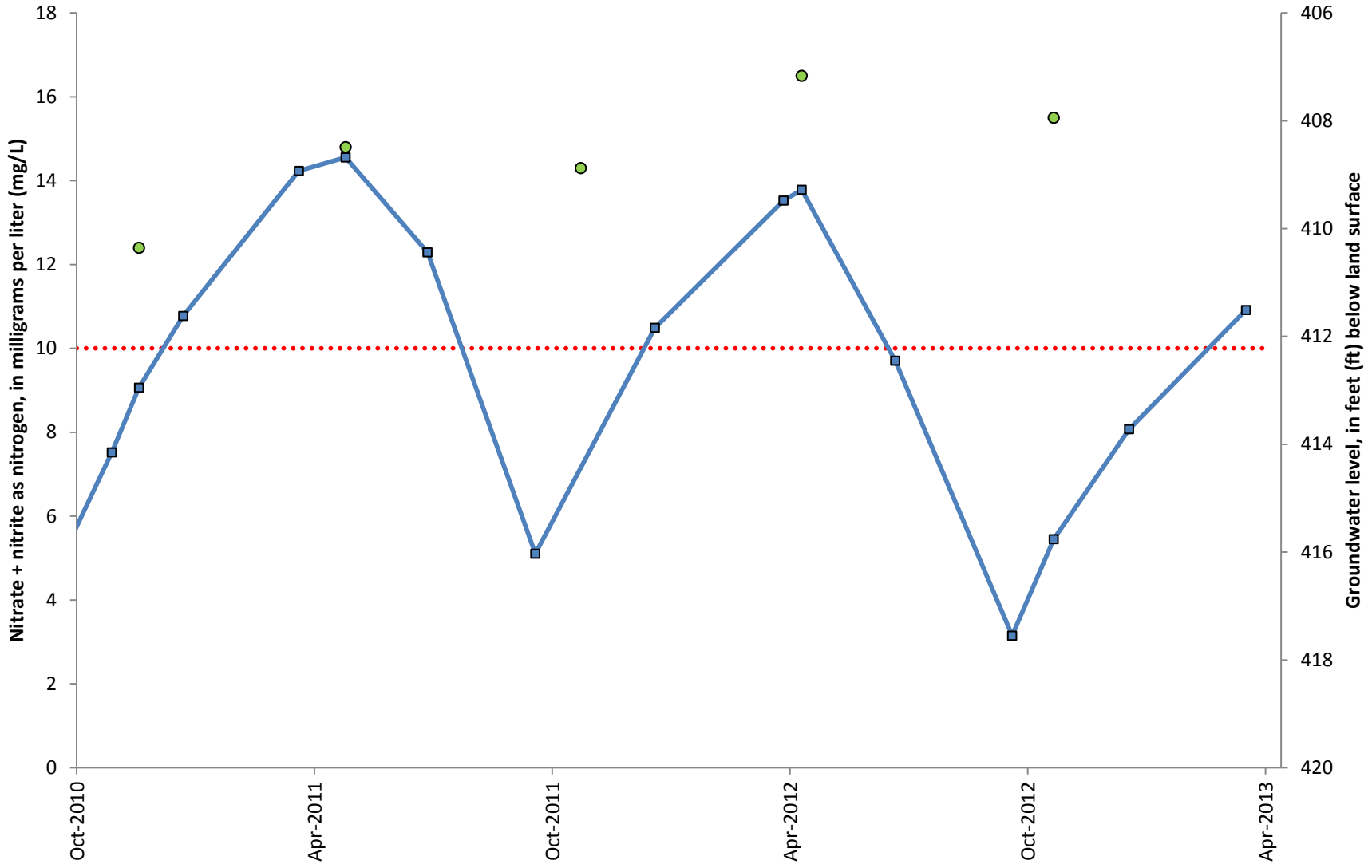
Monitoring Well 36, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, October 2004–2013



USGS

Back

Monitoring Well 40, Mountain Home AFB, Idaho
Nitrate Concentration and Groundwater Levels, October 2010–March 2013



USGS

Back

References

Helsel, D.R., Mueller, D.K., and Slack, J.R., 2006, Computer program for the Kendall family of trend tests: U.S. Geological Survey Scientific Investigations Report 2005-5275, 4 p., computer program, http://pubs.usgs.gov/sir/2005/5275/.

Hirsch, R.M., and Slack, J.R., 1984, A nonparametric trend test for seasonal data with serial dependence: Water Resources Research, v. 20, no. 6, p. 727–732, doi: 10.1029/WR020i006p00727.

Idaho Department of Environmental Quality, 2008, Idaho Nitrate Priority Areas: IDEQ , 108 p., accessed December 9, 2013, at http://www.deq.state.id.us/media/471611-ranking_2008.pdf.

Idaho Department of Water Resources, 2013, Critical Ground Water Areas, Ground Water Management Areas & Areas of Drilling Concern: IDWR Web site, accessed December 9, 2013, at http://www.idwr.idaho.gov/WaterInformation/GroundWaterManagement/.

Kendall, C., and McDonnell, J. J., eds., 1998, Isotope tracers in catchment hydrology: Elsevier Science BV, Amsterdam, The Netherlands, 839 p.

Norton, M.A., Ondrechen, W., and Baggs, J.L., 1982, Ground water investigation of the Mountain Home Plateau, Idaho: Idaho Department of Water Resources, accessed December 9, 2013, at http://www.idwr.idaho.gov/WaterInformation/Publications/ofr/ofr-gw_investigations_mthome_plateau_id.pdf.

Parliman, D.J., and Young, H.W., 1990, Hydrologic and chemical data from selected wells and springs in southern Elmore County, including Mountain Home Air Force Base, southwestern Idaho, fall 1989: U.S. Geological Survey Open-File Report 90-112, 35 p., http://pubs.er.usgs.gov/publication/ofr90112.

USGS

References—Continued

Ralson, D.R., and Chapman, S.L., 1968, Ground water resources in the Mountain Home Area, Elmore County: Idaho Department of Reclamation Water Information Bulletin no. 4, 63 p.

Schwarz, D.L., and Parliman, D. J., 2010, Use of human pharmaceuticals to determine a sewer water nitrate source to the regional aquifer, Mountain Home Air Force Base, Idaho: URS Group, Inc., Idaho, 40 p.

U.S. Environmental Protection Agency, 2013, Drinking Water Contaminants: EPA Web site, accessed December 9, 2013, at http://water.epa.gov/drink/contaminants/#Inorganic.

USGS