

Hydrogeologic Analysis of the Water Supply for Ashton, Fremont County, Idaho

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INTRODUCTION

Ashton resides along the northeastern margin of the eastern Snake River plain in Fremont County, Idaho (Figure 1). The town of approximately 1200 people (IDEQ, 2001) obtains domestic water from two wells. Well #1 provides the primary supply of water while Well #2 functions as a backup, delivering additional water when needed. Both wells derive water from a basalt aquifer that underlies Ashton.

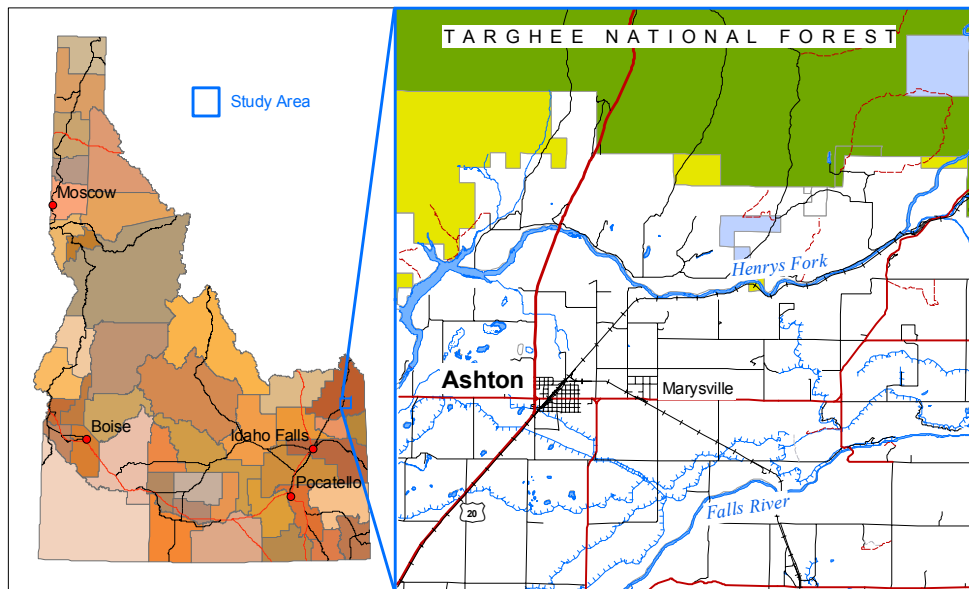


Figure 1 - Location map of the Ashton study area.

STATEMENT OF PROBLEM

Over 25% of the sampled wells in the Ashton area contain nitrate concentrations over the Environmental Protection Agency's (EPA) maximum contaminant level (MCL) of 10 mg/L (IDEQ, 2001). During the past several years, water quality results from the Ashton supply wells have displayed an annual nitrate trend peaking above the MCL in late spring. The community must obtain either a new water supply source with lower nitrate levels or install a treatment system to reduce nitrate from the existing supply.

PURPOSE AND OBJECTIVES

This study provides hydrogeologic information to support decisions about continued use of the current supply wells and/or future ground water development. Specific objectives include:

- Delineate the ground water flow system that supplies water to Ashton.
- Determine possible causes of nitrate contamination to the supply wells.
- Provide solutions for improving water quality for the Ashton wells.
- Identify possible ground water targets for future development.

GROUND WATER DEVELOPMENT AND CONCEPTS

Ground water occurs and moves through interconnected fractures and intergranular pore space in an aquifer. It moves under the force of gravity in an aquifer from higher elevation recharge areas to lower elevation discharge areas. Most recharge results from infiltration of precipitation, though some occurs from streams, lakes, canals and irrigation at elevations higher than the water table. Typical discharge areas include springs, streams, and lakes. Ground water moves slowly, generally less than 10 feet per day.

Subsurface geology provides strong controls on water movement within an aquifer. Therefore, an understanding of the subsurface distribution of unconsolidated sediment, lithified rock, faults, and their physical properties generally leads to a commensurate understanding of ground water flow systems. Mapping surface rock outcrops and reviewing logs of material penetrated by wells helps interpret these features.

Ground water pumping impacts the balance between natural recharge and natural discharge within an aquifer. Well operation lowers ground water levels, which in turn reduces natural discharge. The basis for proper ground water development requires characterizing natural ground water discharge from springs and seeps, knowing the discharge of interconnected streams, and understanding the quantity and location of annual aquifer recharge. Additionally, municipal water supplies need a recharge zone protected from contamination because pollutants can mix with ground water and contaminate the municipal supply.

GEOLOGY

REGIONAL GEOLOGY

Ashton resides along the northeastern fringe of the eastern Snake River Plain, near the boundary with the Yellowstone Plateau. Geologically, this part of the plain consists of a series of calderas that become younger to the northeast. Most lie buried beneath quaternary basaltic lava flows. The calderas erupted voluminous rhyolitic ash-flow tuffs and lavas that now form the hydrologic floor of the eastern Snake River Plain aquifer. The Quaternary basaltic lavas that form the aquifer erupted from approximately 2 million years to 500,000 years ago. Lavas at Craters of the Moon issued approximately 2000 years ago and represent the youngest volcanic activity in the eastern Snake River Plain. Basaltic eruptive centers for the basaltic volcanism include some fissure vents

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such as the Great Idaho Rift that extends from near American Falls Reservoir northerly to Craters of the Moon, and numerous shield volcanoes that dot the plain. Ashton lies just south of Island Park, one of the largest calderas in the world

(<http://www.mines.utah.edu/~rbsmith/RESEARCH/YellowstoneHotspot.html>).

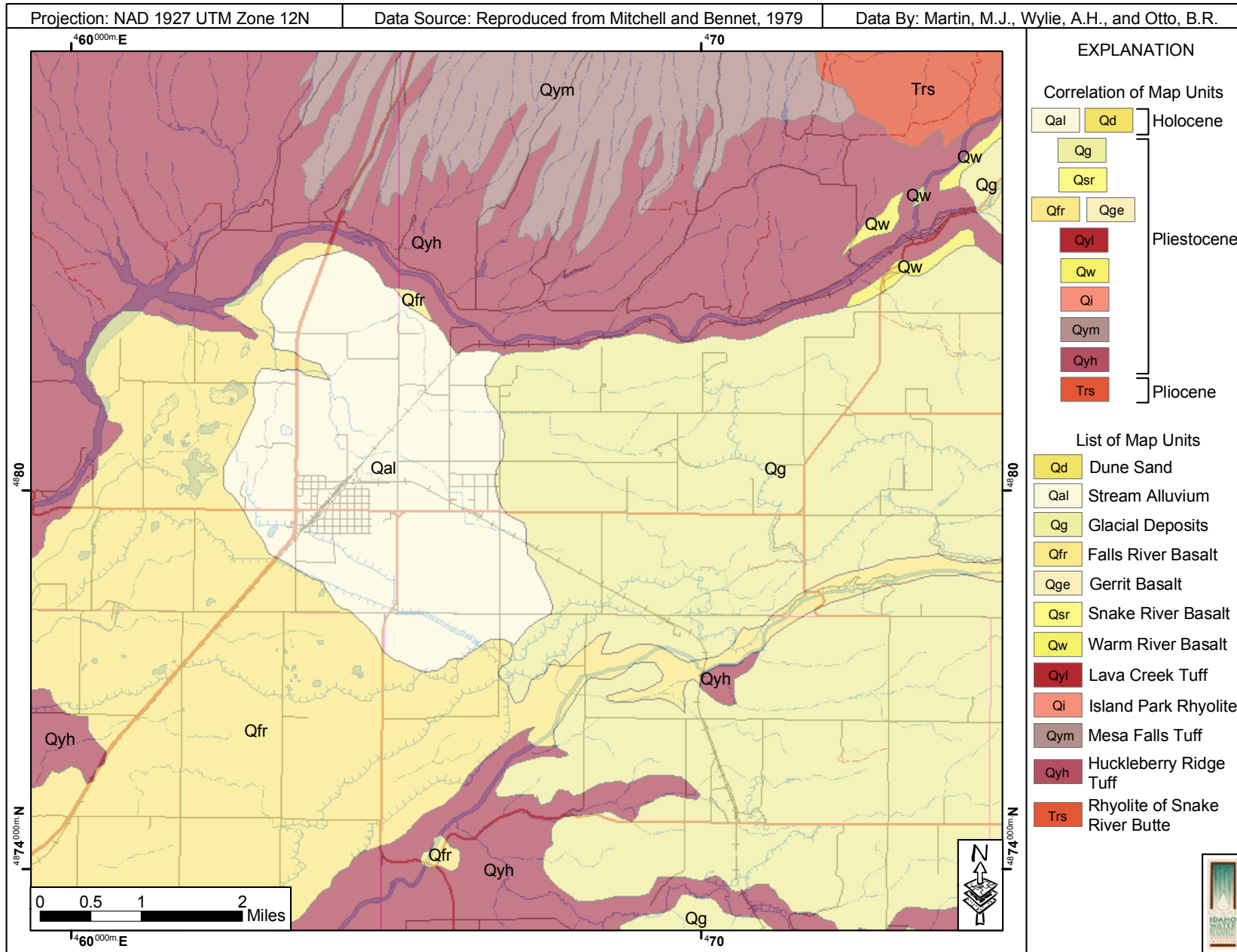


Figure 2 - Geologic map of the Ashton study area.

PROJECT AREA GEOLOGY

Rhyolitic ash flows erupted from two million year old Huckleberry Ridge tuff underlie basaltic lava flows at Ashton (Figure 2). The basalt lavas are relatively thin compared to the underlying ash-flow tuffs. A thin accumulation of Quaternary-age, glacially derived gravel and recent stream alluvium mantles the volcanic strata.

HYDROGEOLOGY

Ground water flows from recharge areas via higher hydraulic conductivity zones to discharge areas. An understanding of well-development potential requires accurate delineation of these ground water flow systems.

REGIONAL HYDROGEOLOGY

Basalt hosts the regional aquifer in the Ashton area. Shrinkage fractures, formed originally when the basaltic lavas cooled, provide conduits for ground water flow. Ground water flows generally west in this area. (Figure 3).

Recharge occurs from precipitation in the surrounding area, leakage from canals, and excess irrigated water from agricultural fields (Whitehead, 1978). Discharge occurs along the Henrys Fork west of Ashton.

PROJECT AREA HYDROGEOLOGY

Ashton utilizes two supply wells, both located at the eastern edge of town. Well #1 serves as the primary supply of water and Well #2 serves as a backup. The two wells are approximately 110 feet apart (IDEQ, 2001). Water level data for either well are not available because no measuring devices were installed. However, the United States Geological Survey (USGS) collects temporal water level data in this area.

Well #1 was initially drilled in 1923. The well log indicates it penetrates rhyolite to a depth of 105 feet below ground surface (bgs) with a static water level of 45 feet bgs. In addition to the well log, the community provided the team with a video log of this well taken on 5 August 2000. The video shows that the static water level was 28 feet bgs, it was cased to a depth of 53 feet bgs, and is 278 feet deep. The original log probably misinterpreted the upper section of the hole as rhyolite. The well, therefore, obtains water from a basalt aquifer approximately 70 feet bgs. Sediment has accumulated along contacts and fractures below 123 feet, which indicates that these deeper zones do not contribute much water.

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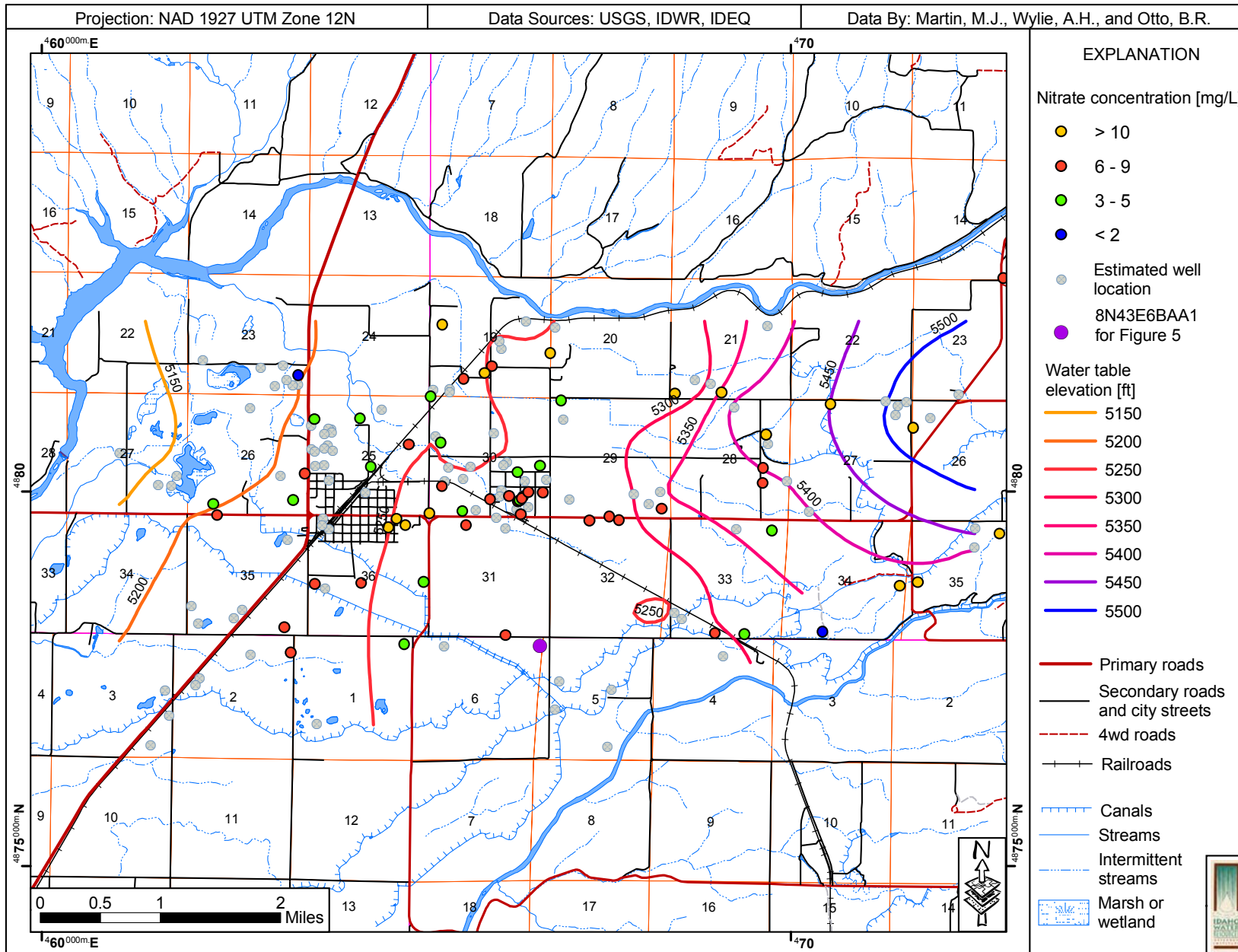


Figure 3 – Interpolated ground water elevations and water quality for the Ashton study area.

Ashton drilled Well #2 in 1959. The log shows the well penetrates basalt and sandstone to its total depth of 321 feet. The log indicates two producing zones; one in basalt between 35 and 57 feet bgs and the other in sandstone between 320 and 321 feet. Since there is only 110 feet between Well #1 and #2, we believe that the sandstone is either a local facies or is misinterpreted. Most likely Well #2 obtains water from the basalt aquifer. No video log was taken for this well.

WATER QUALITY ANALYSIS

The Idaho Department of Environmental Quality (IDEQ) studied nitrates in ground water near Ashton between July 1997 and October 1998. Figure 3 shows the average nitrate concentrations of samples taken from Well #1 and #2 for the past seven years. The widespread concentration of nitrate throughout the study area suggests that the entire aquifer is affected from surface sources.

Ashton samples the two supply wells monthly. Figure 4 shows the nitrate trend in the city wells over the past 6 years. Nitrates tend to increase during late fall through early spring, and then decrease through the summer. This process is likely related to the agricultural processes.

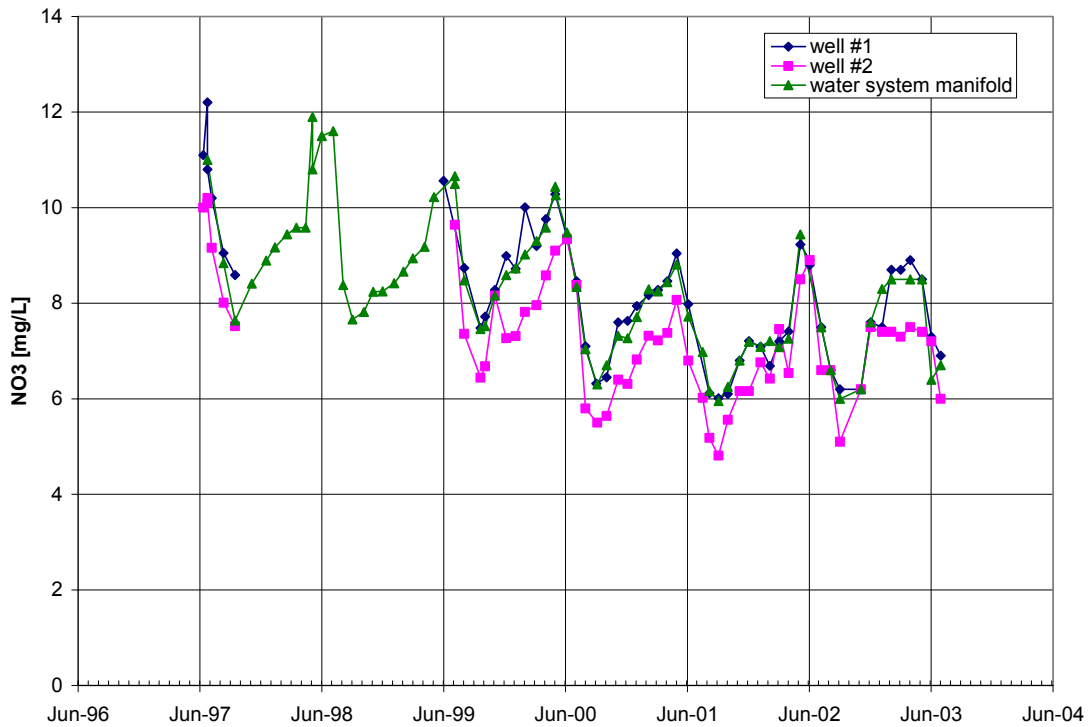


Figure 4 - Nitrate trend for the Ashton wells over the past five years.

There are no Ashton well water level data, so we compared a USGS monitored well with the nitrate data. This approach assumes the Ashton wells' water levels resemble the same trend as the USGS well. Figure 5 shows the water level and nitrate trends. The decrease in nitrate levels coincides with the irrigation season. Leakage from canals and excess irrigation water infiltrating from fields may play an important role in diluting the ground water nitrate concentration. Between fall and early spring, nitrate leaching increases the nitrate concentration in the aquifer.

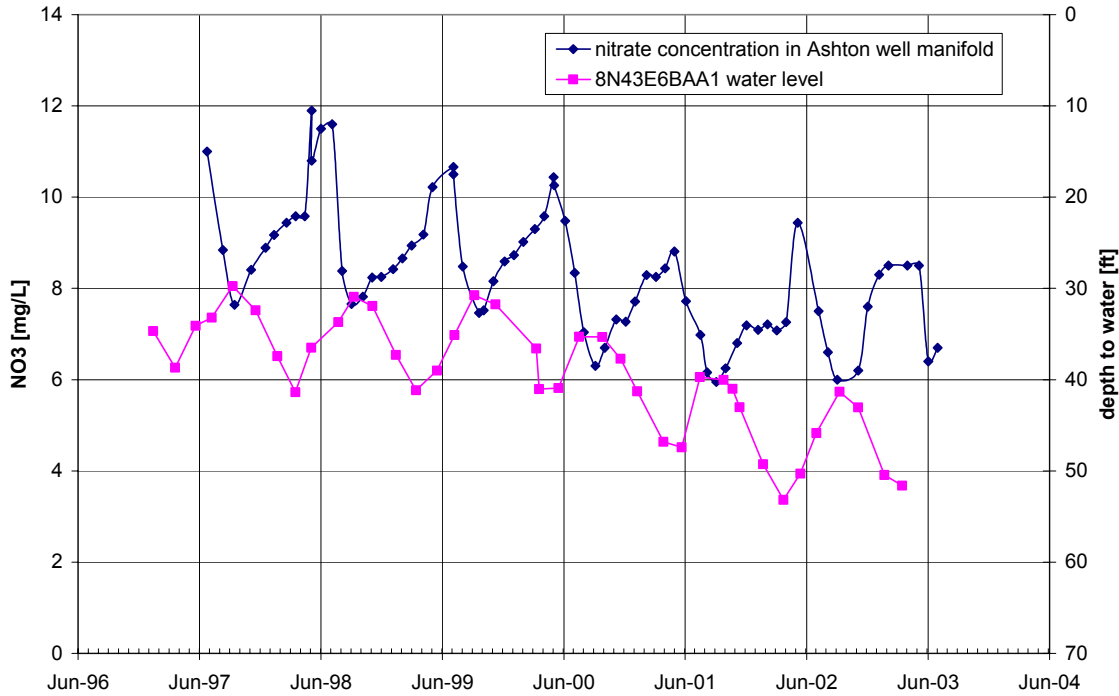


Figure 5 - Nitrate and water level trend correlation for the Ashton area (<http://idaho.usgs.gov>).

The USGS also analyzed nitrates in ground water near Ashton in year 2000. This analysis determined nitrate sources using nitrogen isotopes (Parlman, 2000). She found a well in Ashton that contained organic nitrogen from the soil, which implies that nitrates leached from the agricultural fields into the ground water. Additionally, a study by Shepherd and others (1996) found that nitrates would readily leach from soils after crops expire in the fall. They found potatoes were particularly prone to this process.

DISCUSSION OF RESULTS

The two Ashton supply wells currently derive water from a basalt aquifer, which is the only viable aquifer in this area for ground water development. The aquifer yields an adequate quantity, but unfortunately unacceptably high nitrate concentrations are present throughout the aquifer (Figure 3).

Nitrate contamination likely occurs from organic nitrogen in soil that leaches into the ground water during early fall through early spring. Winter and early spring precipitation and excess irrigation water percolating through the soil leaches nitrates from excess fertilizer and plant residue, and then recharges the aquifer. This part of the hydrologic cycle increases the nitrate concentration in the aquifer.

During the growing season, crops use most of the applied nitrogen fertilizer. Excess irrigation water and canal leakage contain low amounts of nitrates reducing the aquifer nitrate levels during the late spring and summer. This component of recharge to the aquifer will dilute the ambient nitrate concentration.

We believe the higher nitrate concentrations and water levels, 1998 through 2000, correspond to relatively wet years compared to the more recent dry years. During these wet years, available irrigation water after the crop growing season and more precipitation during the fall and winter months increase the nitrate leaching. Thus the higher nitrate peak during these years. The recent dry years without extra irrigation water at the end of the growing season and little winter precipitation means less water to leach the nitrates.

Shepherd and others (1996) describe two approaches to reduce nitrate leaching. The first option, planting a cereal cover crop after harvest, will mitigate nitrate leaching. During the winter, cover crops retain the nitrogen and thus reduce available nitrates for leaching. Studies, however, indicate that a late harvest may prevent establishment of a cover crop, and potatoes are harvested late in the Ashton area. This method may therefore not be feasible. The second option is to leave the field in fallow, because cultivation increases available nitrates for leaching. This approach may be the most feasible.

CONCLUSIONS AND RECOMMENDATIONS

The basalt aquifer is the only one available for ground water development in the Ashton area. The Ashton wells derive water from this aquifer. Ground water generally flows west with recharge occurring primarily from leaky canals, excess infiltration from agricultural fields, and from local precipitation (Figure 3).

A new supply source away from town may have lower nitrate concentrations (Figure 3). However, the monthly temporal trend is not known. It would likely exhibit the same trend as the current city wells. If so, nitrate concentrations would be higher during April and May than presented in Figure 3 since wells in the area were sampled in June and/or October. Monthly nitrate samples in the surrounding area are needed to determine if a new supply source away from town is feasible.

Water percolating through the soil preferentially leaches nitrate, from expired crops, between the fall and early spring affecting the entire aquifer in the vicinity of Ashton. The timing and amount of recharge influences nitrate concentration in

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the aquifer. In addition, a wet or dry year influences the nitrate peak. Wet years tend to have higher nitrate concentrations compared to dry years.

Reducing nitrate leaching during the fall through early spring period will necessitate management practices on agricultural fields. The practices need to minimize the easy liberation of nitrate. Post harvest practices could include leaving fields in fallow or if possible, planting a cover crop. A cover crop uses the nitrates which would otherwise be available for leaching. Reducing post crop tillage by leaving the field in fallow may decrease available nitrates for leaching. This approach requires cooperation with the area farmers up gradient of Ashton.

Another approach to solve the nitrate issue is to implement a treatment system. Since the nitrate concentrations have a fairly consistent trend, employing a treatment system to operate only during the peak months, April through June, may be viable. Investigation into possible treatment options and operational standards must be investigated to determine the feasibility.

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