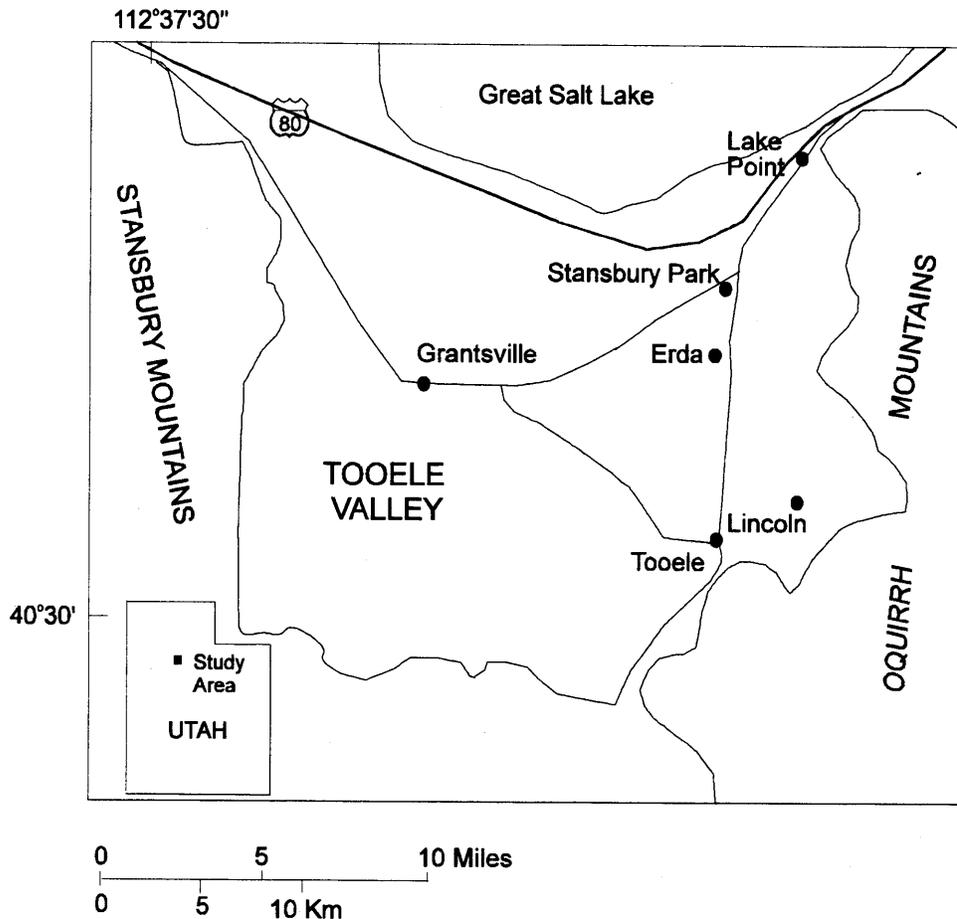


THE POTENTIAL IMPACT OF SEPTIC TANK SOIL- ABSORPTION SYSTEMS ON WATER QUALITY IN THE PRINCIPAL VALLEY-FILL AQUIFER, TOOELE VALLEY, TOOELE COUNTY, UTAH — ASSESSMENT AND GUIDELINES

by
Janae Wallace and Mike Lowe



Report of Investigation 235 March 1998
UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources



DEPARTMENT OF NATURAL RESOURCES

Ted Stewart, Executive Director

UTAH GEOLOGICAL SURVEY

M. Lee Allison, Director

UGS Board

Table with 2 columns: Member and Representing. Lists board members and their respective industries.

UTAH GEOLOGICAL SURVEY

The UTAH GEOLOGICAL SURVEY is organized into five geologic programs with Administration, Editorial, and Computer Resources providing necessary support to the programs. The ECONOMIC GEOLOGY PROGRAM undertakes studies to identify coal, geothermal, uranium, hydrocarbon, and industrial and metallic resources; initiates detailed studies of these resources including mining district and field studies; develops computerized resource data bases, to answer state, federal, and industry requests for information; and encourages the prudent development of Utah's geologic resources. The APPLIED GEOLOGY PROGRAM responds to requests from local and state governmental entities for engineering-geologic investigations; and identifies, documents, and interprets Utah's geologic hazards. The GEOLOGIC MAPPING PROGRAM maps the bedrock and surficial geology of the state at a regional scale by county and at a more detailed scale by quadrangle. The GEOLOGIC EXTENSION SERVICE answers inquiries from the public and provides information about Utah's geology in a non-technical format. The ENVIRONMENTAL SCIENCES PROGRAM maintains and publishes records of Utah's fossil resources, provides paleontological and archeological recovery services to state and local governments, conducts studies of environmental change to aid resource management, and evaluates the quantity and quality of Utah's ground-water resources.

The UGS Library is open to the public and contains many reference works on Utah geology and many unpublished documents on aspects of Utah geology by UGS staff and others. The UGS has several computer data bases with information on mineral and energy resources, geologic hazards, stratigraphic sections, and bibliographic references. Most files may be viewed by using the UGS Library. The UGS also manages a sample library which contains core, cuttings, and soil samples from mineral and petroleum drill holes and engineering geology investigations. Samples may be viewed at the Sample Library or requested as a loan for outside study.

The UGS publishes the results of its investigations in the form of maps, reports, and compilations of data that are accessible to the public. For information on UGS publications, contact the Department of Natural Resources Bookstore, 1594 W. North Temple, Salt Lake City, Utah 84116, (801) 537-3320.

UGS Editorial Staff

Table with 2 columns: Name and Role. Lists editorial staff members and their roles.

The Utah Department of Natural Resources receives federal aid and prohibits discrimination on the basis of race, color, sex, age, national origin, or disability. For information or complaints regarding discrimination, contact Executive Director, Utah Department of Natural Resources, 1594 West North Temple #3710, Box 145610, Salt Lake City, UT 84116-5610 or Equal Employment Opportunity Commission, 1801 L Street, NW, Washington DC 20507.



Printed on recycled paper

**THE POTENTIAL IMPACT OF SEPTIC TANK SOIL-ABSORPTION SYSTEMS ON
WATER QUALITY IN THE PRINCIPAL VALLEY-FILL AQUIFER, TOOEELE VALLEY,
TOOEELE COUNTY, UTAH
ASSESSMENT AND GUIDELINES**

by
Janae Wallace and Mike Lowe

ABSTRACT

Nitrate can be used to identify potential deleterious effects of development using septic tank soil-absorption systems. We use a mass-balance approach to provide a valley-wide assessment of the potential impact of nitrate from septic tank soil-absorption systems on ground-water quality. Approximately 800 septic systems exist in Tooele Valley. Our calculations indicate the number of septic tank soil-absorption systems in Tooele Valley should not exceed 3,000, representing a valley-wide average septic-system density of about 53 acres/system (0.2 km²/system), to maintain an overall nitrate concentration of 3.5 ppm (3.5 mg/L). This allows a 1 mg/L degradation of water quality with respect to nitrate from the current background level of 2.5 ppm (2.5 mg/L). We also provide site-specific recommendations for evaluating the effects of septic systems on ground-water quality for proposed subdivisions in Tooele Valley.

INTRODUCTION

Tooele Valley, Tooele County (figure 1), is experiencing an increase in residential, commercial, and industrial development. Most of this development, much of which uses septic tank soil-absorption systems for waste-water disposal, is on unconsolidated deposits of the principal valley-fill aquifer. Ground water provides almost all of Tooele Valley's drinking-water supply. Preservation of ground-water quality and the potential for ground-water-quality degradation are critical issues which should be considered in determining the extent and nature of future development in Tooele Valley. Local government officials in Tooele County have expressed concern about the potential impact that development may have on ground-water quality. This report was prepared as part of a ground-water-quality classification project funded by the Tooele County Engineering Department.

Nitrate from sewers, septic-tank-soil-absorption systems, fertilizer, and other anthropogenic sources is a useful indicator of human impact on ground-water quality. Nitrate can thus be used to identify potential deleterious effects of development which uses septic tank soil-absorption systems. The purpose of this document is to: (1) provide a valley-wide assessment of the potential impact of nitrate from increasing the number of septic tank soil-absorption systems on ground water in Tooele Valley using methods similar to those used by Hansen, Allen, and Luce, Inc. (1994) for Heber and Round Valleys, Wasatch County, Utah; and (2) provide site-specific recommendations for evaluating the effects of septic systems on ground-water quality for proposed subdivisions in Tooele Valley. We use the methods of Hansen, Allen, and Luce (1994) for valley-wide water-quality degradation assessments because they have been used in other Utah

counties (Wasatch, Washington) for land-use planning purposes, and are easily applied and require limited data. We also provide recommendations for site-specific evaluations so that developers may hire ground-water consultants to evaluate specific subdivision sites for cases where valley-wide results do not meet their needs.

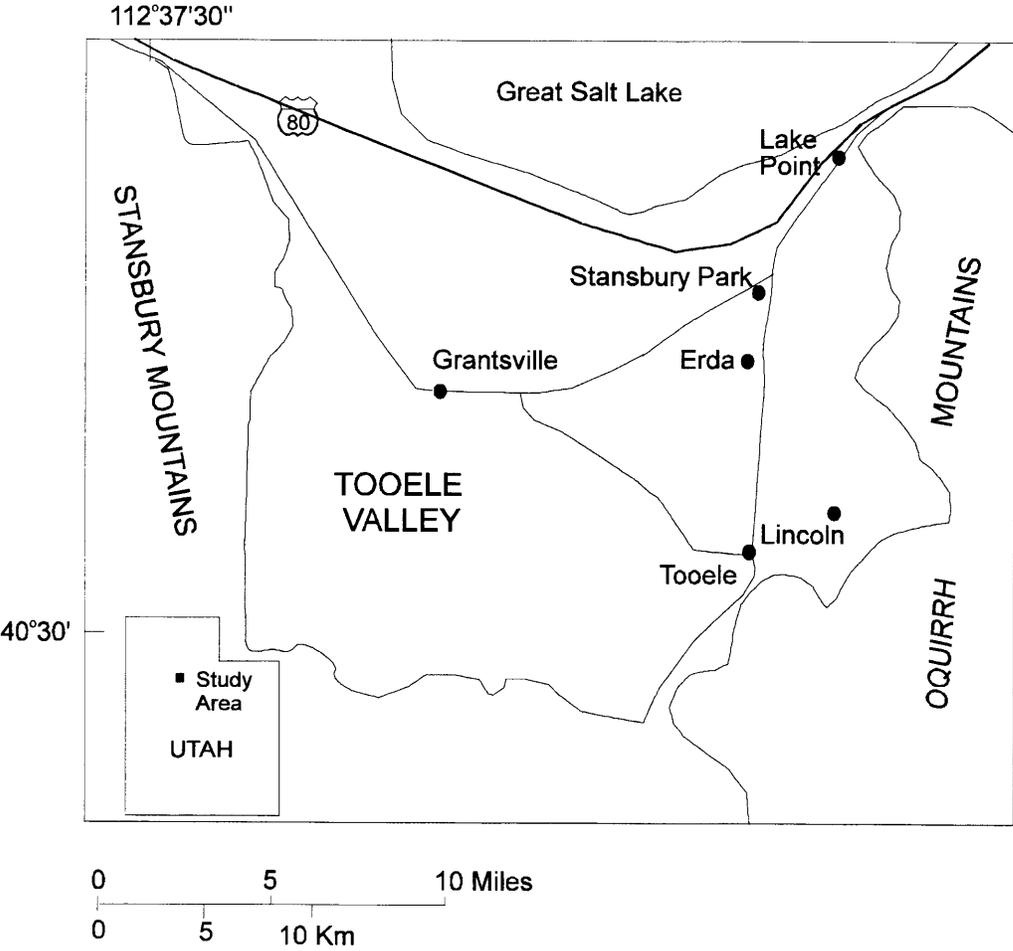


Figure 1. Location of study area.

VALLEY-WIDE ASSESSMENT

Introduction

Most development in Tooele Valley uses septic tank soil-absorption systems for waste-water disposal. Ammonium from septic-tank effluent under aerobic conditions can convert to nitrate, contaminating ground water and posing potential health risks to humans (primarily very young infants). The U.S. Environmental Protection Agency ground-water-quality standard for nitrate is 10 ppm (10 mg/L). With continued growth and installation of septic tank soil-absorption systems in new developments, the potential for nitrate contamination will increase. One way to evaluate the potential impact of septic-tank systems on ground-water quality is to perform a mass-balance calculation using methodologies developed by Hansen, Allen, and Luce, Inc. (1994). This type of valley-wide analysis may be used as a gross model for evaluating the impact of proposed developments using septic-tank systems for waste-water disposal on ground-water quality and allow planners to more effectively determine appropriate average development densities (lot sizes).

Mass-Balance Approach

In the mass-balance approach of Hansen, Allen, and Luce, Inc. (1994) to compute projected nitrate concentrations, the nitrogen mass from projected new septic tanks is added to the existing, ambient mass of nitrogen in ground water and then diluted with the ground-water

flow available for mixing, plus water that is added to the system by septic tanks. The method of Hansen, Allen, and Luce, Inc. (1994) estimates a discharge of 400 gallons (1,500 L) of effluent/day for a domestic home, and determines a best-estimate nitrogen loading of 40 ppm (40 mg/L) of effluent per domestic septic tank, with 80 ppm (80 mg/L) and 30 ppm (30 mg/L) per septic system as appropriate high and low values for nitrogen loadings. Ground-water flow available for mixing is the difference between ground-water recharge and the sum of evapotranspiration and discharge to springs/seeps above the area of septic-system influence. The major control on nitrate concentration in aquifers using the Hansen, Allen, and Luce, Inc. (1994) approach is the amount of ground water available for mixing (Lowe and Wallace, 1997).

Results

Figure 2 shows a plot of projected nitrate concentration in Tooele Valley's aquifer versus septic-tank density and number of septic-tank units. Background concentration for Tooele Valley is 2.5 ppm (2.5 mg/L) (Steiger and Lowe, 1997). Approximately 800 septic systems exist in Tooele Valley (B. Slade, verbal communication, 1997). Tooele Valley has an area of approximately 160,000 acres (648 km²), so the average septic-system density is about 200 acres/system (0.8 km²/system). The valley also supports three sanitary sewer systems (Tooele City, Grantsville, and Stansbury Park). Based on Razem and Steiger's (1981) estimated hydrologic budget for 1977, ground-water flow available for mixing in Tooele Valley is 46.96 ft³/s (1.3 m³/s). For Tooele Valley to maintain an overall nitrate concentration of 3.5 ppm (3.5 mg/L) (which allows 1 mg/L of degradation, a value adopted by Wasatch County as an

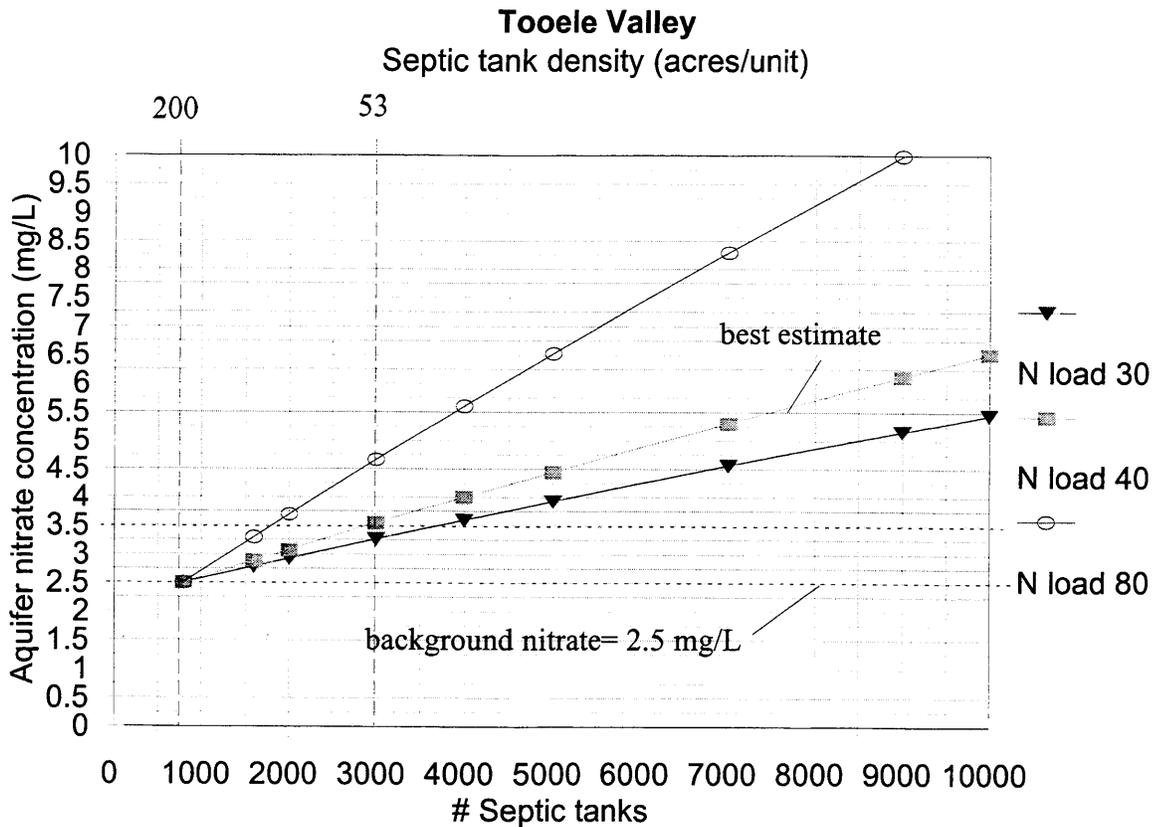


Figure 2. Graph showing projected septic-tank-system density versus nitrate concentration for the principal valley-fill aquifer in Tooele Valley, Tooele County, Utah. N load 30, N load 40, and N load 80 refer to the low, best-estimate, and high nitrogen loadings per liter of waste-water from septic tanks (Hansen, Allen, and Luce, 1994).

acceptable level of degradation), the number of new homes using septic tank soil-absorption systems should not exceed 2,200 based on the best estimate nitrogen load of 40 ppm (40 mg/L) per septic-tank system (figure 2). This corresponds to a valley-wide total of 3,000 septic systems and an average septic-system density of about 53 acres/system (0.2 km²/system).

Limitations To The Mass-Balance Approach

There are many limitations to this mass-balance approach.

1. Computations are typically based on a short-term hydrologic budget.
2. Background nitrate concentration is attributed to natural sources, agricultural practices, and septic-tank systems, but projected nitrate concentrations are for septic-tank systems only and do not include nitrate from other potential sources (such as lawn and garden fertilizer).
3. Calculations do not account for localized, high-concentration nitrate plumes associated with individual or clustered septic-tank systems.
4. The procedure assumes negligible denitrification.
5. The procedure assumes uniform, instantaneous ground-water mixing for the entire aquifer below the site.
6. Calculations do not account for pumping water wells.
7. Calculations are based on aquifer parameters for the entire valley (not specifically targeted to areas experiencing growth).

GUIDELINES FOR SITE-SPECIFIC SEPTIC-TANK-DENSITY

STUDIES FOR PROPOSED SUBDIVISIONS

The guidelines outlined herein describe one method for assessing the site-specific impact of septic tank soil-absorption-field systems on ground-water quality for proposed subdivisions in

Tooele Valley. The procedure uses a mass-balance approach similar to the analysis conducted by Hansen, Allen, and Luce, Inc. (1994) in Wasatch County and outlined above. The site-specific approach is subject to the limitations listed above, except calculations are based on site-specific rather than valley-wide estimates of aquifer parameters. This refinement of the valley-wide mass-balance approach provides a better understanding of the local effects on ground-water quality of development using septic-tank systems for waste-water disposal.

Site-specific evaluation of the effects of septic-tank systems on ground-water quality requires accurate determination of local aquifer parameters. Steps in the evaluation process include: (1) compiling existing topographic and geologic maps and driller's logs; (2) determining the ground-water-flow transect area (typically the subdivision area) and analyzing water-well driller's logs to determine the geologic characteristics, thickness, and extent of the aquifer; (3) determining the number of existing and proposed septic-tank systems in the area; (4) collecting samples for nitrate and analyzing data to identify background concentration; (5) measuring water levels from selected wells to determine hydraulic gradient and ground-water-flow direction; (6) selecting observation and pumping wells and conducting 24- to 100-hour aquifer tests to determine aquifer transmissivity values; and (7) calculating the projected site-specific nitrate concentration by applying the Hansen, Allen, and Luce, Inc. (1994) mass-balance approach using site-specific parameters obtained from steps 1 through 7 above to determine the existing nitrogen load and amount of ground water available for mixing. Ground water available for mixing (not including water in effluent) can be calculated using the following equation:

$$Q=TLI$$

where:

Q= volume of water in aquifer below subdivision available for mixing,

T= transmissivity,

L= length of flow through aquifer parallel to hydraulic gradient, and

I= hydraulic gradient.

Consultant's reports addressing site-specific effects of proposed developments using septic-tank systems for waste-water disposal and submitted to Tooele County officials for approval should contain: (1) detailed topographic and geologic maps showing the location of all relevant features (property boundaries, septic-tank systems, water wells, etc.), (2) water-well driller's logs used in the analysis, (3) laboratory data reporting nitrate concentrations, (4) static water-level measurements from wells, (5) tables reporting raw drawdown and recovery data from aquifer tests, (6) explanation of the methods/models used to interpret the aquifer-test data, and (7) all numbers (including conversion factors) and equations used to calculate results.

This site-specific evaluation process using the mass-balance approach can provide developers and Tooele County officials a defensible site-specific evaluation of acceptable septic-tank-system density for proposed subdivisions utilizing septic systems for waste-water disposal. The process also contributes to the protection of ground-water quality in areas experiencing rapid population growth.

REFERENCES

Hansen, Allen, and Luce, Inc. 1994, Hydrogeologic/water quality study, Wasatch County, Utah:

Salt Lake City, unpublished consultant's report, Hansen, Allen, and Luce, Inc., p.III-1 - III-18.

Lowe, Mike, and Wallace, Janae, 1997, The hydrogeology of Ogden Valley, Weber County,

Utah, and implications of increased septic-tank-soil-absorption system density: Geological Society of America Abstracts with Programs, v. 29, no.6, p.A-386.

Razem, A.C., and Steiger, J.I., 1981, Ground-water conditions in Tooele Valley, Utah, 1976-

1978: Utah Department of Natural Resources Technical Publication 69, 95 p.

Steiger, J.I., and Lowe, Mike, 1997, Recharge and discharge areas and quality of ground water in

Tooele Valley, Tooele County, Utah: U.S. Geological Survey Water Resources Investigations Report, 2 plates, scale 1:100,000.