READERS' FORUM

LET'S PROMOTE GROUND-WATER HYDROLOGY!

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Hopefully, this letter will be read by all the technical members of the Association of Ground Water Scientists and Engineers and others in any way related to or dependent upon ground-water development.

One of the purposes of the Association is to promote the field of ground-water hydrology. However, bedrock ground water is often referred to in technical and non-technical publications and in ordinary conversations as a "finite" resource and that a water supply based on such ground water must ultimately be replaced by a reliable "renewable" water supply. Implication is that surface water through senior rights is the desired "infinite renewable" water supply.

Finite means "existing or enduring for a limited time only," or "having bounds." Infinite means "without bounds, or limits," or "immeasurably great, as in extent or duration." Since both surface water and ground water are part of the hydrologic cycle, neither is finite or both are. It is unfortunate that too many technical persons who should know better have joined the ranks of the non-technical persons who use the term finite when speaking of our deep ground-water resources. The result has been an erroneous belief that the deep aquifers will be "dried up" if ground-water appropriations, development, and use are allowed based on current statutes.

Colorado's 200-year-old surface-water rights appropriation system assures the senior water rights their water first when it is available in the river. The junior ground-water user must not even theoretically affect the surface water in an unmeasurable amount of 0.1% in 100 years without providing a plan that shows that theoretically the unmeasurable amount will become part of the surface-water system (a theoretical "return"). Hydraulic parameters whose values are not known within an accuracy of 20 to 200% are used along with geological unknowns to calculate surface system impact to an accuracy of .001. We do not even have reasonably available water meters to measure pump discharge within .01, and most meters will be off more than 10%.

The Colorado statute used to require a minimum useful life of an aquifer of 100 years. Now the "minimum useful" is gone and 100 years is fixed. At least one parameter is fixed. The applicant for deep ground-water rights can develop field data to determine values for other parameters. However, field and laboratory procedures to determine T, S, s, and other magic numbers will be accurate within 20 to 100%, with these numbers being used to "compute" ground-water withdrawal impact on the surface-water system to an accuracy of 0.1%. At last, we have found a means to do the impossible.

How are the use of the term finite and the computation of ground-water impact to a so-called accuracy of 0.001 related? Both show that we technical people in ground water are not being aggressive enough to present the facts about ground water to "promote the field of ground-water hydrology . . . ."

When will the public recognize the fact that ground-water withdrawals from aquifers such as the Denver Basin aquifers as water supplies for all the projected developments to be dependent on ground water is a small percentage of the total quantity of recoverable ground water available? When will the public understand that natural recharge to the aquifers will increase as water levels are lowered? When will the owners of surface-water rights recognize that surface flows are increased as development and application of ground water in storage provide more water to the surface (much greater than the statutory 4%)? When will the public understand that utilization of the bedrock ground water creates additional storage space underground, allowing the aquifer to be a more efficient and direct part of the hydrologic cycle and that the wells will not run dry? This will happen only when the technical people in ground water become aggressive and really try to promote the field of ground-water hydrology.

One of the more common reasons espoused by surface-water-dependent municipalities and other promoters of surface-water development is that the development and long-term use of the deeper ground-water supplies will become too expensive in the future. The argument is that the cost to withdraw ground water as the water levels are lowered will be so great that use of the ground-water resources will become uneconomical. Reference is often made to the rapid rate of decline of water levels in wells over the past 20 years or so, but always with no explanation that this is only a decline in the artesian head and not an actual water-table decline. It seems that the people who deal in the sale of surface-water rights have determined that it is cheaper to dam rivers, construct dams, tunnels, water treatment plants and large-diameter pipelines than to develop ground-water supplies. In order to promote the field of ground-water hydrology in Colorado, we technical people must be aggressive in pointing out the true economics of developing and utilizing ground-water supplies.

GROUND WATER IS DEFINITELY TWO SEPARATE WORDS

by A. Ivan Johnson, P.E., Water and Soils Engineering Consulting, 7474 Upham Court, Arvada, CO 80003

I recently received a copy of NWWA's "Ground Water—Defined." I have noted for many years NWWA's spelling of ground water as two words. Based on my own nearly 40 years of active experience in the field of ground-water hydrology, I highly commend NWWA for use of the two-word version.

I thought you might be interested in the following, which is some information that I recently assembled on the preferred use of ground water rather than groundwater:

1. Ground water is two words, or more, in French,

Russian, Spanish, Italian, and Portuguese (and possibly some other languages). Why should ground water be one word and surface water always two words?

2. In checking the latest published editions of dictionaries in bookstores, I find ground water as two words in the following (in a few cases, older editions had it as one word): (a) Webster's New Universal Unabridged Dictionary, 2nd edition, 1979, Simon and Schuster, New York, NY; (b) Webster's New World Dictionary, 1982, Simon and Schuster, New York, NY; (c) Webster's New Twentieth Century Dictionary, Unabridged, 1979, 2289 pages, Simon and Schuster; (d) Macmillan Dictionary for Students, 1984, Macmillan Pub. Co., New York, NY; (e) Webster's New Riverside University Dictionary, 1984, Riverside Publ. Co., Houghton Mifflin Co.; (f) Funk and Wagnalls Standard Dictionary, 1980; (g) New York Times Everyday Dictionary, 1982, New York Times Co., NY; (h) Random House College Dictionary, 1984, Random House, Inc., NY; and (i) American Heritage Dictionary, 1982, Houghton Mifflin Co., Boston.

3. The following technical glossaries also use the two-word version of *ground water* (italics is for emphasis): (a) "Interagency Glossary on *Ground-Water* Flow and Transport" (1985), Subcommittee on *Ground Water* of (Federal) Interagency Advisory Committee on Water Data, Washington, D.C.; (b) "Glossary" in *Ground-Water* Management, ASCE Manual 40, 1986; (c) International Dictionary of Metallurgy, Mineralogy, and Geology (English-French-German-Italian), 1968, McGraw-Hill Book Co., NY; (d) Glossary of Geology, 1972, American Geological Institute, Washington, D.C.; (e) A Dictionary of Mining, Mineral, and Related Terms, 1968, U.S. Dept. of the Interior, Bureau of Mines, 1269 pages; (f) Thesaurus of Engineering and Scientific Terms, 1967, Engineer's Joint Council and U.S. Dept. of Defense; (g) Multilingual Technical Dictionary on Irrigation and Drainage, 1976, International Commission on Irrigation and Drainage; (h) Nomenclature for Hydraulics, 1962, ASCE Manual No. 43, ASCE, NY; (i) General Introduction and Hydrologic Definitions *in* Part 1, General Surface-Water Techniques, 1960, U.S. Geological Survey Water-Supply Paper 1541-A; (j) A Glossary of Karst Terminology, 1970, U.S. Geological Survey Water-Supply Paper 1899-K; (k) Definitions of Selected *Ground-Water* Terms, 1972, U.S. Geological Survey Water-Supply Paper 1988; (l) Russian-English-French-German Hydrological Dictionary, 1967, Scientific Information consultants, Limited, London; (m) Glossary of Water 2—Geological, Hydrological, Meteorological Terms (English, French, German, Finnish), 1970, Swedish Center of Technical Terminology Pub. No. 45, Uppsala, Sweden; (n) Glossary of Selected Geologic Terms for Use in Engineering, 1955, Colorado Scientific Society, Denver, CO; (o) Dictionary of Geological Terms, 1954, Edwards Brothers, Inc., Ann Arbor, Michigan; (p) Glossary of Soil Science Terms, 1975, Soil Science Society of America, Madison, WI; (q) Standard Terms and Symbols Relating to Soil and Rock, ASTM Standard D653 (1986), ASTM, Philadelphia, PA; and (r) Compilation of ASTM Standard Definitions, 1986, ASTM, Philadelphia, PA.

4. The following technical journals and reports use two words for ground water: (a) "*Ground Water*" and "*Ground Water* Monitoring Review" of the National Water Well Association, probably the primary organization in the world that is specifically involved with ground water; (b) the international organization UNESCO published their manual "*Ground-Water* Studies" and the report "Guidebook to Studies of Subsidence Due to *Ground-Water* Withdrawal," (1985); EPA's report "*Ground-Water* Protection Strategy" (which likely is the prime mover in emphasizing ground-water problems that need solving in the future) and their recent "Resource Document for the *Ground-Water* Monitoring Strategy Workshop;" (d) the bi-weekly newsletter "*Ground-Water* Monitor" of the Business Publishers, Inc. (BPI), Silver Spring, MD, publishers of many other water and environmental newsletters; (e) Short courses, activities, and "*Ground Water* Modeling Newsletter" of the International *Ground Water* Modeling Center at the Holcomb Research Institute of Butler University; (f) short courses, reports, and activities of the Environmental and *Ground Water* Institute, University of Oklahoma and other Ground Water Institutes sponsored by EPA; (g) "GPO Style Manual," which all Federal agencies are supposed to use; (h) ASTM recently changed to the two-word version for all of its publications, i.e. their Special Technical Publication "*Ground-Water* Contamination Field Methods;" (i) the many Water-Supply Papers and other publications produced during the 100-year plus history of the U.S. Geological Survey; and (j) the classical Water-Supply Papers 489 and 494 and the textbook "Hydrology" by O. E. Meinzer, who usually is referred to as the father of ground-water hydrology.

SHOULD PROPRIETARY CODES BE BANNED FOR GROUND-WATER PROBLEMS?*

by James W. Mercer, President, GeoTrans, Inc., Reston, Virginia

Should proprietary codes be banned for use in solving ground-water problems, particularly if the results are to be used in the courtroom? This is a question that government regulatory officials are trying to answer.

To answer this question, we first need a definition of a proprietary code. A proprietary code consists of computer software used for modeling ground-water problems, that is sold, leased, or used on a royalty basis, which generally limits its distribution. According to this definition, proprietary codes could include: (1) ground-water simulation codes, (2) databases, (3) statistical packages, and (4) graphical packages. To ban one of the above, and not all, would be selective and inconsistent.

Be that as it may, the use of proprietary databases, statistical packages, and graphical packages is accepted; the current regulatory questions focus specifically on the use of ground-water simulation codes. For this reason, this editorial focuses on the use of proprietary ground-water simulation codes.

Because this is an editorial, I get to express an opinion. This opinion is based on my experience, which includes the business of selling proprietary software. There-

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