USGS Training Resources for Ground-Water Hydrology

A. Reports, videotapes, self-study manuals

I. General

1. Heath, R.C., 1983, Basic ground-water hydrology: U.S. Geological Survey Water-Supply Paper 2220, 84 p. (available on the Internet at http://water.usgs.gov/pubs/wsp/wsp2220/)

2. Franke, O.L., Reilly, T.E., Haefner, R.J., and Simmons, D.L., 1990, Study guide for a beginning course in ground-water hydrology: part 1-- course participants: U.S. Geological Survey Open-File Report 90-183, 184 p. (available on the Internet at http://water.usgs.gov/pubs/of/ofr90-183/)

3. Franke, O.L., Reilly, T.E., Buxton, H.T., and Simmons, D.L., 1993, Study guide for a beginning course in ground-water hydrology: part 2-- instructor's guide: U.S. Geological Survey Open-File Report 92-637, 128 p. (available on the Internet at http://water.usgs.gov/pubs/of/ofr_92-637/)

II. Ground-Water Hydraulics

1. Bennett, G.D., 1976, Introduction to ground-water hydraulics — A programmed text for self-instruction: Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter B2, 172 p. (available on the Internet at http://water.usgs.gov/pubs/twri/twri3-b2/)

2. Franke, O.L., Reilly, T.E., and Bennett, G.D., 1987, Definition of boundary and initial conditions in the analysis of saturated ground-water flow systems--An introduction: U.S. Geological Survey Techniques of Water-Resources Investigations 3-B5, 15 p. (available on the Internet at http://water.usgs.gov/pubs/twri/twri3-b5/)

III. Aquifer Tests and Radial-Flow Simulation

1. Videotapes by USGS on "Determining Aquifer Properties"
   - #1. Burns, A.W., 1997, Aquifer Test Design, 15 min.
   - #2. Weeks, E.P., 1997, The Theis Equation, 39 min.
   - #3. Weeks, E.P., 1997, Theis Recovery Methods, 22 min.
   - #4. McLean, J.S., 1997, Aquifer Boundaries and the Theory of Images, 34 min.
   - #5. Riley, F.S., 1997, Leaky Aquifer Methods, part 1 - 46 min., part 2 - 38 min.
   - #6. Moench, A.F., 1997, Unconfined Methods, 48 min.
   - #7. Belitz, K.R., 1997, Slug Tests, 35 min.

Each District was originally sent a set of videotapes by the Office of Ground Water. Additional copies are available for purchase from NGWA (www.ngwa.org), and a few copies are still available for free from the Office of Ground Water.

2. Barlow, P.M., and Moench, A.F., 1999, WTAQ—A computer program for calculating drawdowns and estimating hydraulic properties for confined and water-table aquifers: U.S. Geological Survey Water-Resources Investigations Report 99-4225, 74 p. (available on the Internet at http://ma.water.usgs.gov/publications/WRIR_99-4225/index.htm)

3. Bennett, G.D., Reilly, T.E., and Hill, M.C., 1990, Technical training note in ground-water hydrology: Radial flow to a well: U.S. Geological Survey Water-Resources Investigations Report 89-4134, 83 p. (available on the Internet at http://pubs.er.usgs.gov/pubs/wri/wri894134)

4. Bentall, Ray (compiler), 1963, Methods of determining permeability, transmissibility and drawdown: U. S. Geological Survey Water-Supply Paper 1536-I, p. 243-341.

5. Ferris, J.G., Knowles, D.B., Brown, R.H., and Stallman, R.W., 1962, Theory of aquifer tests: U. S. Geological Survey Water-Supply Paper 1536-E, 174 p. (available on the Internet at http://water.usgs.gov/pubs/wsp/wsp1536-E/)

6. Lohman, S.W., 1972, Ground-Water Hydraulics: U. S. Geological Survey Professional Paper 708, 70 p.

IV. Ground-Water Flow Simulation

1. Franke, O.L., Bennett, G.D., Reilly, T.E., Laney, R.L., Buxton, H.T., and Sun, R.J., 1991, Concepts and modeling in ground-water hydrology -- A self-paced training course: U.S. Geological Survey Open-File Report 90-707, 416 p. (available on the Internet at http://pubs.er.usgs.gov/pubs/ofr/ofr90707)
(A little outdated because of the units used and the references provided, but still a useful training document.)

2. Hsieh, P.A., 2001, TOPODRIVE and PARTICLEFLOW—Two computer models for simulation and visualization of ground-water flow and transport of fluid particles in two dimensions: U.S. Geological Survey Open-File Report 01-286, 30 p. (available on the Internet at http://water.usgs.gov/nrp/gwsoftware/tdpf/tdpf.html)
(These programs are not intended to be comprehensive modeling tools, but are designed for modeling at the exploratory or conceptual level, for visual demonstration, and for educational purposes.)

3. Reilly, T.E., 2001, System and boundary conceptualization in ground-water flow simulation: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter B8, 26 p. (available on the Internet at http://water.usgs.gov/pubs/twri/twri-3_B8/)

V. Data Collection

1. Ground-Water Technical Procedures (available on the Intranet at http://water.usgs.gov/usgs/ogw/tech_proc/index.html). A technical-procedure document is a detailed description of a sequence of actions to be used to collect data to ensure repeatability of the work and comparability of results.

GWPD 1 -- Water-level measurement using graduated steel tape
GWPD 2 -- Minimum set of data elements to identify a ground-water site
GWPD 3 -- Establishing a permanent measuring point
GWPD 4 -- Water-level measurement using an electric tape
GWPD 5 -- Locating a well
GWPD 6 -- Recognizing and removing debris from a well
GWPD 7 -- Well discharge measurement from a naturally flowing well
GWPD 8 -- Well discharge measurement in a pumping well using the trajectory free fall or jet flow method
GWPD 9 -- Maximum and minimum water-level recording devices
GWPD 10 -- Well discharge measurement in a pumping well using a circular orifice weir
GWPD 11 -- Well-depth measurement using a graduated steel tape
GWPD 12 -- Water-level measurement in a flowing well
GWPD 13 -- Water-level measurement using an air line
GWPD 14 -- Continuous water-level measurements using a float-activated recorder
GWPD 15 -- Obtaining permission to install, maintain, and use a well on private property

2. Koterba, M.T., 1998, Ground-Water data-collection protocols and procedures for the National Water-Quality Assessment Program: Collection, documentation, and compilation of required site, well, subsurface, and landscape data for wells: U.S. Geological Survey Water-Resources Investigations Report 98-4107, 91 p.

3. Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1997, Guidelines and standard procedures for studies of ground-water quality: Selection and installation of wells, and supporting documentation: U.S. Geological Survey Water-Resources Investigations Report 96-4233, 110 p. (available on the Internet at http://water.usgs.gov/owq/pubs/wri/wri964233/)

4. National Field Manual for the Collection of Water-Quality Data: Techniques of Water-Resources Investigations of the United States Geological Survey, Book 9 (available on the Internet at http://water.usgs.gov/owq/FieldManual/)

5. Shuter, Eugene, and Teasdale, W.E., 1989, Application of drilling, coring, and sampling techniques to test holes and wells: Techniques of Water-Resources Investigations of the United States Geological Survey, Book 2, Chapter F1, 97 p. (available on the Internet at http://water.usgs.gov/pubs/twri/twri2-f1/)

VI. Geophysical methods

Online training in selected geophysical methods is available at the Geophysical Technology Transfer (G2T) web site at http://water.usgs.gov/ogw/bgas/g2t.html

Online modules are available on the Geophysical Technology Transfer (G2T) web site for:

1. Borehole imaging
2. Vertical-Radar profiling (VRP)
3. 2D-Resistivity
4. Electromagnetic Induction
5. Continuous Seismic-reflection profiling
6. Continuous-Resistivity Profiling

VII. Some classic USGS publications on selected topics that may be dated but are excellent foundational documents.

Brown, R.H., 1963, The cone of depression and the area of diversion around a discharging well in an infinite strip aquifer subject to uniform recharge: in Shortcuts and special problems in aquifer tests, Ray Bentall (compiler): U.S. Geological Survey Water-Supply Paper 1545-C, p. C69-C85.

Cooper, H.H., Kohout, F.A., Henry, H.R., and Glover, R.E., 1964, Sea water in coastal aquifers: U.S. Geological Survey Water-Supply Paper 1613-C, 84 p.

Ferris, J.G., Knowles, D.B., Brown, R.H., and Stallman, R.W., 1962, Theory of aquifer tests: U. S. Geological Survey Water-Supply Paper 1536-E, 174 p. (available on the Internet at http://water.usgs.gov/pubs/wsp/wsp1536-E/)

Konikow, L .F., and Grove, D.B., 1977, Derivation of equations describing solute transport and dispersion in ground water: U. S. Geological Survey Water-Resources Investigations 77-19, 30 p.

Lohman, S.W., 1972, Ground-Water Hydraulics: U. S. Geological Survey Professional Paper 708, 70 p.

Lohman, S.W., and others, 1972, Definitions of selected ground-water terms – Revisions and conceptual refinements: U.S. Geological Survey Water-Supply Paper 1988, 21 p. (available on the Internet at http://water.usgs.gov/pubs/wsp/wsp_1988/)

McDonald, M.G., and Harbaugh, A.W., 1988, A modular three-dimensional finite-difference ground-water flow model: Techniques of Water-Resources Investigations

of the United States Geological Survey, Book 6, Chapter A1, 586 p. (available on the Internet at http://water.usgs.gov/pubs/twri/twri6a1/)

Slichter, C.S., 1899, Theoretical investigations of the motion of ground waters: U.S. Geological Survey 19th Annual Report, Part II, p. 295-384.

Theis, C.V., 1940, The source of water derived from wells: Civil Engineering, v. 10, no. 5, p. 277-280. (available on the Internet at http://water.usgs.gov/usgs/ogw/training/gw2192tc/files/Theis.1940.pdf)

VIII. Regional Summaries

Back, William, Rosenshein, J.S., and Seaber, P.R. (eds.), 1988, The Geology of North America, Volume O-2, Hydrogeology: The Geological Society of America, Boulder, Colorado, 524 p.

Heath, R.C., 1984, Ground-Water regions of the United States: U.S. Geological Survey Water-Supply Paper 2242, 78 p.

Miller, J.A., ed., 2000, Ground Water Atlas of the United States: U.S. Geological Survey Hydrologic Atlas 730, Chapters B-N published separately (available on the Internet at http://capp.water.usgs.gov/gwa/).

IX. Recent USGS Circulars that provide an initial overview on selected topics

Alley, W.M., Reilly, T.E., and Franke, O.L., 1999, Sustainability of ground-water resources: U.S. Geological Survey Circular 1186, 79 p. (available on the Internet at http://water.usgs.gov/pubs/circ/circ1186/)

Barlow, P.M., 2003, Ground water in freshwater-saltwater environments of the Atlantic coast: U.S. Geological Survey Circular 1262, 113 p. (available on the Internet at http://water.usgs.gov/pubs/circ/2003/circ1262/)

Focazio, M.J., Reilly, T.E., Rupert, M.G., and Helsel, D.R., 2002, Ground-water vulnerability assessment: An overview of approaches and scientific credibility: U.S. Geological Survey Circular 1224, 33 p. (available on the Internet at http://pubs.water.usgs.gov/circ1224/)

Franke, O. Lehn, Reilly, Thomas E., Pollock, David W., and LaBaugh, James W., 1998, Estimating areas contributing recharge to wells – Lessons from previous studies: U.S. Geological Survey Circular 1174, 14 p (Third printing, 1999). (available on the Internet at http://water.usgs.gov/ogw/pubs/Circ1174/)

Galloway, D. L., Alley, W.M, Barlow, P.M., Reilly, T.E., and Tucci, P., 2003, Evolving issues and practices in managing ground-water resources – Case studies on the role of science: U.S. Geological Survey Circular 1247, 73 p. (available on the Internet at http://pubs.water.usgs.gov/circ1247/)

Galloway, D.L., Jones, D.R., and Ingebritsen, S.E., eds., 1999, Land subsidence in the United States: U.S. Geological Survey Circular 1182, 175 p. (available on the Internet at http://water.usgs.gov/pubs/circ/circ1182/)

Winter, T.C., Harvey, J.W., Franke, O.L., and Alley, W.M., 1998, Ground water and surface water – A single resource: U.S. Geological Survey Circular 1139, 79 p. (available on the Internet at http://water.usgs.gov/pubs/circ/circ1139/)

X. Non-USGS Textbooks

Ahlfeld, D.P., and Mulligan, A.E., 2000, Optimal management of flow in groundwater systems: San Diego, Calif., Academic Press, 185 p.

Anderson, M.P., and Woessner, W.W., 1992, Applied groundwater modeling: Academic Press, San Diego, Calif., 381 p.

Bear, Jacob, 1979, Hydraulics of groundwater: New York, McGraw-Hill Inc., 569 p.

Bear, Jacob, 1988, Dynamics of fluids in porous media: Toronto, Dover Publications Inc., (reprint edition, originally published 1972, New York, American Elsevier), 764 p.

Bouwer, Herman, 1978, Groundwater hydrology: McGraw-Hill, New York, NY, 480 p.

de Marsily, Ghislain, 1986, Quantitative hydrogeology--Groundwater hydrology for engineers: Orlando, Florida, Academic Press, 440.

Deming, David, 2002, Introduction to hydrogeology: McGraw-Hill, New York, NY, 468 p.

Domenico, P.A., and Schwartz, 1998, Physical and chemical hydrogeology (Second edition): John Wiley and Sons, New York, 506 p.

Driscoll, F.G., 1986, Groundwater and wells (Second edition): Johnson Division, St. Paul, Minnesota, 1089 p.

Fetter, C.W., 2000, Applied hydrogeology (Fourth edition): Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 691 p.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 604 p.

Ingebritsen, S.E., and Sanford, W.E., 1998, Groundwater in geologic processes: Cambridge, United Kingdom, Cambridge University Press, 341 p.

Kruseman, G.P., and de Ridder, N.A., 1990, Analysis and evaluation of pumping test data (Second edition): International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, 377 p.

Todd, D.K., 1980, Ground-water hydrology: John Wiley and Sons, New York, 535 p.

Zheng, Chunmiao, and Bennett, G.D., 2002, Applied contaminant transport modeling (Second edition): John Wiley and Sons, New York, 621 p.

B. Traditional Training Classes

The National Training Center courses, Regional Training courses, and Local Training Courses, are another resource. And obviously, local University courses if available are an excellent training opportunity.

The list of courses offered by the National Training Center is available at http://training.usgs.gov/ntc/courses/Course_Info/course_catalog.cfm. A summary of the ground-water courses is:

Course #	Course Name	Coordinator
GW1227TC	GW Principles and Field Techniques	Linda Geiger/ Eve Kuniansky
GW1266TC	Intro. to Geophysics for Hydrological and Environmental Studies	John Lane
GW1273TC	GWSI for Users and Database Administrators	Linda Geiger
GW2010TC	Optimization for GW Management	Paul Barlow
GW2046TC	Analytical Methods to Determine Aquifer Properties and to Predict Aquifer Response	Ed Weeks
GW2080TC	Modeling of Ground-Water Solutes	Lenny Konikow
GW2081TC	Modeling of Ground-Water Solutes Workshop	Lenny Konikow
GW2096TC	Modeling Ground-Water Flow with MODFLOW 2000	David Pollock
GW2097TC	Finite-Element Modeling of Ground-Water Flow	Lynn Torak
GW2192TC	Ground-Water Flow Systems Analysis and Modeling	Herb Buxton
GW3001TC	Fluid Flow and Solute Transport in Fractured Rocks	Paul Hsieh
GW3003TC	Ground-Water and Geologic Processes	Steve Ingebritsen
GW3021TC	Geochemistry for GW Systems	David Parkhurst
GW3039TC	Using a GIS in Modeling GW Flow	Darrel Pope
GW3070TC	Coupled Modeling of GW Transport and Geochemical Reactions	Ward Sanford
GW3075TC	Advanced Gephysical Log Analysis	John Williams
GW3089TC	Calibration and Uncertainty of Models	Mary Hill
GW3099TC	Advanced Modeling of Ground-Water Flow	Stan Leake
ID2015TC	GW/SW Relationships	Tom Winter
ID2019TC	Isotope Hydrology	Carol Kendall