LOW-VOLUME ROADS ENGINEERING

Best Management Practices

Updated June 18, 2013

G. Keller

Best Management Practices- General

Environmental Protection Agency. Draft 2001. National Management Measures to Control Non-point Source Pollution from Forestry. EPA Contract No. 68-C7-0014, Work Assignment #2-20. Prepared for Office of Water, U.S. Environmental Protection Agency by Tetra Tech, Fairfax, Virginia. (A comprehensive guide to measures for reducing water pollution from roads and logging activities.)

Michigan Department of Natural Resources. 1994. Water Quality Management Practices on Forest Lands.

Montana State University. 1991. Montana Forestry Best Management Practices. Montana State University Extension Service. July (BMPs also produced by Montana Department of State Lands in 1992.)

Ontario Ministry of Natural Resources. 1988. Environmental Guidelines for Access Roads and Water Crossings. Queen’s Printer for Ontario, Canada

U.S. Department of Agriculture, Forest Service. 2000. Water Quality Management for National Forest System Lands in California-Best Management Practices. Vallejo, CA: Pacific Southwest Region, U.S. Department of Agriculture, Forest Service. 186 p.

U.S. Department of Agriculture, Forest Service. Draft. 2001. Best Management Practices for Forest Roads: A performance-based framework. Washington, DC: A cooperative effort between the U.S. Department of Agriculture, Forest Service, and U.S. Environmental Protection Agency. 24 p.

\*U.S. Department of Agriculture, Forest Service. 2012. National Best Management Practices for water quality management on National Forest System lands, Volume 1-National core BMP technical guide. FS-990a. Washington, DC. April. Available at:

<http://www.fs.fed.us/biology/resources/pubs/watershed/FS_National_Core_BMPs_April2012.pdf>

\* Wisconsin Department of Natural Resources. 1995. Wisconsin’s Forestry Best Management Practices for Water Quality-Field Manual for Loggers, Landowners and Land Managers. Publication No. FR093. March. Madison, WI. 76 p.

**Note: If you just want to choose one or two (\*\*) or a few (\*) publications from any subject area list, these are what I consider the most useful documents or my personal favorites! Gordon**

**Environmental Analysis**

Bingham, C; Knausenberger, W; Fisher, W. 1999. Environmental Documentation Manual for P.L.480, Title II Cooperating Sponsors Implementing Food-aided Development Programs, February. Food Aid Management, U.S. Agency for International Development, Washington, DC.

Burpee, G; Harrigan, P; Remington, T. Second Edition 2000. A Cooperatoring Sponsor’s Field Guide to USAID Environmental Compliance Process- Based on Regulation 216 to the USAID Environmental Documentation Manual for PL 480 Title II Food for Development Programs. Published jointly by Catholic Relief Services and Food Aid Management. Baltimore, MD. 69 p.

Public Law 91-190. [S. 1075]. National Environmental Policy Act of 1969. Act of January 1, 1970. [An act to establish a national policy for the environment, to provide for the establishment of a Council of Environmental Quality, and for other purposes.] In its: United States statutes at large, 1969. 42 U.S.C. sec. 4231, et seq. (1970). Washington, DC: U.S. Government Printing Office; 1970: 852-856. Vol. 83.

World Bank, The. 1997. Roads and the Environment: A Handbook. Report TWU 13, and update WB Technical Paper No. 376. Washington, DC: The World Bank Environmentally Sustainable Development Vice-Presidency and Transportation, Water & Urban Development Department Transport Division. [Online] <http://www.worldbank.org/transport/publicat/reh/toc.htm>

**Environmental Issues and Special Applications**

California Invasive Plant Council. 2012. Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors. Cal-IPC Publication 2012-01, California Invasive Plant Council, Berkeley, California. 62p.

Available at: <http://pollinator.org/PDFs/TransportationUtilityCorridorsPreventionBMPs.pdf>

\*Clarkin, K. et al. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings. Gen. Tech Rep. 0877 1801- SDTDC. San Dimas Technology and Development Center, USDA Forest Service, San Dimas, CA. Available at: <http://www.stream.fs.fed.us/fishxing/aop_pdfs.html>

Clevenger, A.P.; Huijser, M. 2011. Wildlife Crossing Structure Handbook: Design and Evaluation in North America. FHWA-CFL/TD-11-003. Western Transportation Institute and Federal Highway Administration, Washington, DC. 224p.

Dykstra, D.; Heinrich, R. 1996. FAO Model Code of Forest Harvesting Practice. Rome, Italy:Food and Agriculture Organization of the United Nations. 85 p. (ISBN 92-5-103690-X). [Online] <http://www.fao.org>

\*Forman, R. T.; Sperling, D.; et al. 2003. Road Ecology: Science and Solutions. Washington, DC: Island Press. 482 p. (ISBN 1-55963-933-4) ( A comprehensive and thoughtful book addressing the many ecological impacts of roads, their principles, and approaches to solving transportation problems.)

\*Huijser, M.P.; McGowen, P.; Clevenger, A.P.; Ament, R. 2008. Wildlife Vehicle Collision Reduction Study: Best Practices Manual. Western Transportation Institute, Montana State University and Federal Highway Administration, McLean, VA. 174p. (See the link <http://www.fhwa.dot.gov/environment/wildlifecrossings/> for extensive information on this.)

\*Kilgore, R.; Bergendahl, B.; Hotchkiss, R. 2010. Culvert Design for Aquatic Organism Passage. Hydraulic Engineering Circular (HEC) 26, FHWA-HIF-11-008-HEC-26, Central Federal Lands Division, Federal Highway Administration, Lakewood, CO. 234 p. Available at:

[**http://www.fhwa.dot.gov/engineering/hydraulics/pubs/11008/hif11008.pdf**](http://www.fhwa.dot.gov/engineering/hydraulics/pubs/11008/hif11008.pdf)

PIARC World Roads Association. 1999. Natural Disaster Reduction for Roads, Final Report 72.02B, Paris, FR: PIARC Working Group G2. 275 p. (ISBN 2-84060-109-5) (Also see Comprehensive Report 72.01B, 1995.) [Online] http://www.piarc.org

Rajvanshi, A.; Mathur, V.; Teleki, G.; Mukherjee, S. 2001.Roads, Sensitive Habitats and Wildlife: Environmental Guidelines for India and South Asia. Wildlife Institute of India, Dehradun, India, in collaboration with Canadian Environmental Collaborative Ltd. Toronto, Canada. [Phone # 1-416-488-3313] 215 p. (ISBN 81-85496-10-2) ( A comprehensive book on the issues of wildlife, their habitats, and roads, discussing problems,mitigations, and case histories).

U.S. Department of Agriculture, Forest Service, 2000. Water/road Interaction Toolkit- FishXing: CD software and Interactive Learning for Fish Passage through Culverts. Water/Road Interaction Technology Series-SDTDC. November. Washington, DC: U.S. Department of Agriculture, Forest Service. San Dimas Technology & Development Program.

[Online] <http://www.stream.fs.fed.us>/fishxing (A CD covering various aspects of fish passage.)

**Basic Engineering Considerations for**

**Low-Volume Roads**

\*\*American Association of State Highway and Transportation Officials. 2001. Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400). Washington, DC. (ISBN

1-56051-166-4). [Online] <http://www.transportation.org> (Covers the geometric design standards for very low-volume, local roads.)

B. C. Ministry of Forests. 2002. Forest Roads Engineering Guidebook. Forest Practices BR., B.C. Min For. Victoria, B.C. Forest Practices Code of British Colombia Guidebook.

Casaday, E.; Merrill, B. 2001. Field Techniques for Forest and Range Road Removal. Eureka, California: California State Parks, North Coast Redwoods District. 63 p. (A useful Field Guide to Road Closure and Obliteration, with great photos and figures.)

Charles. R. 1997. Design of Low-Volume Low Cost Roads. UWI Public Information Series/Roads, Volume 1. Dept of Civil Engineering, University or West Indes, West Indes. 132 p. ( A practical design manual that covers all aspects of rural road design, particularly considering tropical climates).

Department of Transport, South African Roads Board. 1993. Guidelines for Upgrading of Low Volume Roads. RR 92/466/2, Division of Roads and Transport, South African Roads Board, Pretoria. (ISBN 1-874844-90-9). (A manual that provides information, considerations, and needs for upgrading rural gravel roads.)

\*Faiz, Asif. 2012. The Promise of Rural Roads: Review of the Role of Low-Volume Roads in Rural Connectivity, Poverty Reduction, Crisis Management, and Livability. Transportation Research Circular No. E-C167. Transportation Research Board of the National Academies, Washington, DC, September. 52p. Available at:

[**http://onlinepubs.trb.org/onlinepubs/circulars/ec167.pdf**](http://onlinepubs.trb.org/onlinepubs/circulars/ec167.pdf)

\*\*Gesford, A; Anderson, J. 2006. Environmentally Sensitive Maintenance for Dirt and Gravel Roads. PA-2006-001-CP-83043501-0, Pennsylvania State Center for Dirt and Gravel Roads Studies, in cooperation with Commonwealth of Pennsylvania, Pennsylvania DOT, and US EPA. Harrisburg, PA.

[**http://www.epa.gov/owow/nps/sensitive/sensitive.html**](http://www.epa.gov/owow/nps/sensitive/sensitive.html)

\*\*Giummarra, G., Editor. 2009. Unsealed Roads Manual: Guidelines to Good Practice, Third Edition. Australian Roads Research Board (ARRB Group Ltd.). Vermont South, Victoria, Australia. A useful manual for gravel road design and maintenance, particularly in semi-arid regions.) (Must be purchased).

[**http://www.arrb.com.au/Information-services/Publications/Reports-Manuals.aspx**](http://www.arrb.com.au/Information-services/Publications/Reports-Manuals.aspx)

Geunther, K. 1999. Low Maintenance Roads for Ranch, Fire and Utility Access. Wildland Solutions Field Guide Series, Clyde, CA: Wildland Solutions. 48 p. [Online] [www.wildlandsolutions.com](http://www.wildlandsolutions.com)

\*\*Keller, G.; WilsonMusser, S.; Bolander, P.; Barandino, V. 2011. Stabilization and Rehabilitation Measures for Low-Volume Forest Roads. 1177-1801*—*SDTDC. San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center. 333 p.

Available at**:** [**http://www.fs.fed.us/t-d/php/library\_card.php?p\_num=1177%201801P**](http://www.fs.fed.us/t-d/php/library_card.php?p_num=1177%201801P)

\*\*Keller, G; Sherar, J. 2003. Low-Volume Roads Engineering-Best Management Practices Field Guide. USDA Forest Service, Office of International Programs and US Agency for International Development, Washington, DC. 158 p. (Also available in Spanish)

[Online] [**http://www.fs.fed.us/global/topic/welcome.htm#12**](http://www.fs.fed.us/global/topic/welcome.htm#12)

Lay, M.G. 2009. Handbook of road technology (Fourth Edition). Spon Press, 936p.

\*Male, P (revised from Nichols, R; Irwin, L) 2010. The Basics of a Good Road. CLRP Report No. 08-06. Cornell University Local Roads Program. Ithaca, NY. 96 p.

[**http://www.clrp.cornell.edu/workshops/pdf/basics\_of\_a\_good\_road-2010-web.pdf**](http://www.clrp.cornell.edu/workshops/pdf/basics_of_a_good_road-2010-web.pdf)

Moll, J.E. 1996. A guide for road closure and obliteration in the Forest Service. San Dimas Technology and Development Program. Pub. No. 7700. Washington, DC: U.S. Department of Agriculture, Forest Service. 49 p.

[Online] <http://www.fs.fed.us/eng/pubs/pdfimage/96771205.pdf>

National Research Council, Transportation Research Board. 1978. Geometric Design Standards for Low-Volume Roads. Transportation Technology Support for Developing Countries Compendium 1. Washington, DC: National Academy of Sciences. 297 p. (Compendium contains ten selected texts intended to provide useful documentation to those in developing countries concerned with the geometric design of low-volume roads).

Oregon Department of Forestry. 2000. Forest Roads Manual. Forest Engineering Coordinator, State Forests Program, Oregon Dept. of Forestry, Salem, OR. (503-945-7371). (This manual provides basic logging road design, construction, and maintenance information.)

Paige-Green, P. 2009. Unsealed Roads: Design, Construction and Maintenance. Draft TRH 20, Version 1.5 (original draft version of TRH 20 produced in 1990), Department of Transport, Pretoria, South Africa. April. 106 p.

PIARC World Roads Association. 1994. International Road Maintenance Handbook-Practical guidelines for rural road maintenance. A Four Volume set published by Transport Research Laboratory, Crowthorne, Berkshire RG116AU, United Kingdom. (ISBN 0-9521860-12) (A comprehensive guide on all aspects of maintenance for rural paved and unpaved roads, drainage, structures, and traffic control devices. Available in English, Spanish, Portuguese, and French.)

U.S. Department of Agriculture, Forest Service. 1999. Road analysis: Informing decisions about managing the national forest transportation system.Misc. Report FS-643. Washington, DC: U.S. Deptartment of Agriculture, Forest Service. 222 p (Covers costs to maintain and mitigate in relationship to values at risk – uses and benefits as opposed to environmental damage.) .

[Online] http://[www.fs.fed.us/news/roads](http://www.fs.fed.us/news/roads)

U.S. Department of Agriculture, Forest Service. Forest Roads and the Environment- a DVD of Five different Videos on aspects of Road Maintenance. Available from San Dimas Technology and Development Center, San Dimas, California. (909) 599-1267. Ask for Publications!

\*Walbridge, T. A. 1997. The Location of Forest Roads. Virginia Polytechnical Institute and State University, Blacksburg, VA: Industrial Forestry Operations. 91 p. (A primer on basic road planning, reconnaissance, location and drainage in mountainous terrain. Also available in Spanish.)

\*Weaver, W; Hagans. D. 1994. Handbook for forest and ranch roads-A guide for planning, designing, constructing, reconstructing, maintaining, and closing wildland roads. Ukiah, CA: Pacific Watershed Associates for the Mendocino County Resource Conservation District, in cooperation with CDF and the NRCS. 161 p.

[Online] <http://mcrcd.org/wp-content/uploads/HandbookforForestandRanchRoads.pdf>

Weist, R. 1998. A landowner’s guide to building forest access roads. Report NA-TP-06-98. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area. Published in cooperation with State and Private Forestry. 45 p.

World Bank 2010. Highway Development and Management Model-HDM-4, The World Bank Washington, DC. (Available at: <http://www.worldbank.org/transport/roads/rd_tools/hdm4.htm>)

### Hydrology for Drainage Crossing Design

American Association of State Highway and Transportation Officials. 1999, Highway Drainage Guidelines (Metric Edition) (Fourth Edition). Washington, DC. (ISBN I-56051-126-5). [Online] <http://www.transportation.org> (A comprehensive guide on all aspects of highway drainage design). 630 p.

Jennings, M.E.; Thomas, W.O.; Riggs, H.C. 1994. Nationwide summary of U.S. Geological Survey regional regression equations for estimating magnitude and frequency of floods for ungaged sites, 1993. Water Resources Investigation Report 94-4002. Reston, VA: U.S. Geologic Survey. 38 p. Prepared in cooperation with FHWA and FEMA. (Available through NTIS, Springfield, Va. Phone (703) 605-6000) [Online] <http://www.ntis.gov>

Linsley, R.; Kohler,M.; Paulhus, J. 1958. Hydrology for engineers. New York, NY: McGraw-Hill Book Company, 340 p. (A classic text on hydrology.)

\*McCuen, R; Johnson, P; Regan, R. 2002. Highway Hydrology, Hydraulic Design Series No. 2, Second Edition, FHWA-NHI-02-001. Federal Highway Administration, National Highway Institute. Arlington, VA. 424p. (Covers hydrologic techniques and methods suitable to small drainage areas.) [Online] <http://www.fhwa.dot.gov/bridge>

\*Ries, K.G., III. 2006. The National Streamflow Statistics Program: A Computer Program for Estimating Streamflow Statistics for Ungaged Sites: [**http://pubs.usgs.gov/tm/2006/tm4a6/**](http://pubs.usgs.gov/tm/2006/tm4a6/) or

[**U.S. Geological Survey Techniques and Methods Report TM Book 4, Chapter A6**](http://pubs.usgs.gov/tm/2006/tm4a6/)**,** 45 p.

Ries K.G., III, Crouse, M.Y. 2002. The National Flood Frequency Program, Version3: A Computer Program for Estimating Magnitude and Frequency of Floods for Ungaged Sites. Water Resources Investigations Report 02-4168. <http://pubs.usgs.gov/wri/wri024168/#pdf>

Rosgen, D. 1996. Applied river morphology. Pagosa Springs, CO:Wildland Hydrology. (ISBN 0-9653289-0-2).

**Tools for Hydraulic and Road Design: Manning’s Formula;**

**Riprap; Filters; and Use of Geosynthetics**

Barnes, H. Jr. 1967. Roughness characteristics of natural channels. U.S. Geological Survey Water Supply Pap. 1849. Washington , DC: U.S.Government Printing Office. Available through U.S. Geological Survey, Arlington, VA. 213 p.

[Online] <http://www.engr.utk.edu/hydraulics/openchannels/cover.htm> (Presents many color photos comparing stream types and their Mannings Roughness Coefficient “n”.)

Brown, S.; Clyde, E. 1989. Design of riprap revetment. Hydraulic Engineering Circular No. 11, (HEC) No. 11, FHWA-IP-89-016March. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. 156 p. (Covers detailed design guidance for sizing and placing riprap. Updated from 1978 version.) [Online] <http://www.fhwa.dot.gov/bridge>.

Chow, V.T. 1959. Open channel hydraulics. New York, NY: McGraw-Hill Book Company. 680 p. (ISBN 07-010776-9) (A classic, basic textbook on hydraulics and flow in open channels.)

Copeland, R.; McComas, D.N.; Thorne,C.R.; Soar, P.J.; Jonas, M.M.; Fripp, J.B. 2001. Hydraulic Design of Stream Restoration Projects. ERDC/CHL TR-01-28, U. S. Army Engineeering Research and Development Center, U. S. Army Corps of Engineers. 175 p. [Online] <http://libweb.wes.army.mil/uhtbin/hyperion/CHL-TR-01-28.pdf> (Covers a systematic hydraulic design methodology to aid in the design of stream restoration projects).

Cramer, M. and Bates, K.; Editors (2003). Integrated Streambank Protection Guidelines. Published by Washington State Aquatic Habitat Guidelines Program, Washington State Department of Fish and Wildlife, Washington DOT, Washington Department of Ecology, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. 625p.

\*\*Holtz, R; Christopher, B; Berg, R. (2008). Geosynthetic Design and Construction Guidelines – Reference Manual. FHWA-NHI-07-092. (NHI Course 132013) (updated from FHWA NHI-95-038, Revised April, 1998), developed by the National Highway Institute and Federal Highway Administration, US Department of Transportation, Washington, DC. 592 p. [Online] [**http://www.fhwa.dot.gov/bridge**](http://www.fhwa.dot.gov/bridge) (A comprehensive guide on the use and design of geotextiles, geogrids, and geocomposites in highway applications.). Also available at: [**http://www.fhwa.dot.gov/pavement/pub\_details.cfm?id=1**](http://www.fhwa.dot.gov/pavement/pub_details.cfm?id=1)

Koerner, R. 1998. Designing with geosynthetics. 4th ed. Englewood Cliffs, NJ: Prentice Hall. 761 p. (ISBN 0-13-726175-6) (This updated edition covers the latest materials and design techniques using geosynthetics.)

\*Lagasse, P; Clopper, P; Pagan, G; Zevenbergen, L; Arneson, L; Schall, J; Girand, L. 2009. Bridge Scour and Stream Instability Countermeasures, Volume 1 and 2, Third Edition, Hydraulic Engineering Circular (HEC) No. 23, FHWA-NHI-09-111), Federal Highway Administration, and National Highway Institute. 256 p.

\*McCullah, J; Gray, D. 2005. Environmentally Sensitive Channel and Bank Protection Measures, NCHRP Report 544, National Cooperative Highway Research Program, Transportation Research Board, Washington, DC. 50 p. plus CD.

Order through: [**http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\_rpt\_544.pdf**](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_544.pdf)

Racin, J.; Hoover, T.; Avila, C. 1996. California bank and shore rock slope protection design. FHWA-CA-TL-95-10 Sacramento, CA: California Department of Transportation and Federal Highway Administration, 139 p. (A useful reference on riprap sizing and placement.)

\*Schall, J; Richardson, E; Morris, J. 2008. Introduction to Highway Hydraulics. Hydraulic Design Series (HDS) No. 4, FHWA NHI-08-090, Federal Highway Administration and National Highway Institute, Washington, DC. 204 p. (Covers hydaulic techniques applied to roadway surface drainage and for drainage crossings.) Available at: <http://www.fhwa.dot.gov/bridge>

Steward, J.; Williamson, R.; Mohney, J. 1977. Guidelines for use of fabrics in construction and maintenance of low-volume roads. Interim Rept. June. Portland, OR: U.S. Department of Agriculture, Forest Service, Region 6. 174 p. (Covers basic porous woven and non-woven fabrics use in road construction in the U.S. Forest Service.)

Natural Resources Conservation Service. 1994. Gradation design of sand and gravel filters. Chapter 26. In: Part 633, National Engineering Handbook. Washington, DC. 40 p.

Natural Resource Conservation Service. 1996.Streambank and shoreline protection. In: Engineering Field Handbook, Chapter 16. Rep. No. NEH-650-16. December. Washington, DC. 130 p. (Covers bank protection from scour and erosion by using vegetative plantings, soil bioengineering, and structural systems.) Online: [**http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba**](http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba)

\*Washington State Aquatic Habitat Guidelines Program. 2003. Integrated Streambank Protection Guidelines. Developed in conjunction with the Washington Department of Fish and Wildlife, Washington Department of Transportation, Washington Department of Ecology, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. [Online] <http://www.wa.gov/wdfw/hab/ahg/ispgdoc.htm> (Presents and describes a broad range of streambank protection techniques).

### Drainage of Low-Volume Roads

\*Blinn, C.R.; Dahlman, R.; Hislop, L.; Thompson, M. 1998.Temporary stream and wetland crossing options for forest management. Forest Service Gen. Tech. Rep. NC-202. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 136 p. (Discusses temporary options for crossing streams and wetland soil areas with forest harvesting equipment and logging trucks.)

Cedergren, H. 1989. Seepage, drainage, and flow nets. 3rd ed. New York: John Wiley and Sons. 496 p. (ISBN 0-471-61178-6.

\*Copstead, R.; Johansen, K.; Moll, J. 1998. Water/road interaction: Introduction to surface cross drains. Water/Road Interaction Technology Series. Res. Rep. 9877 1806 – SDTDC. September. Washington, DC: U.S. Department of Agriculture, Forest Service. San Dimas Technology & Development Program. 16 p. (A water-roads interaction toolkit is also available on a CD.)

Elliot, W.; Graves, S.; Hall, D.; Moll, J. 1998. The X-DRAIN cross drain spacing and sediment yield model. In: Water/Road Interaction Technology Series. Res. Rep. 9877 1801 – SDTDC. June. Washington, DC: U.S. Department of Agriculture, Forest Service. San Dimas Technology & Development Program. 23 p. [Online] <http://www.stream.fs.fed.us/water-road/index.htm>

Furniss, M.; Roelofs, T.; Yee, C. 1991. Road construction and maintenance. In:Meehan, W.R.,ed. Influences of forest and rangeland management on salmonid fishes and their habitat, Chapter 8. Special Pub. 19. Bethesda, MD: American Fisheries Society. pp. 297-324.

\*Orr, D. 1998 (Update 2003). Roadway and roadside drainage. CLRP Publication No. 98-5. Ithaca, NY: Cornell Local Roads Program and New York LTAP Center, Ithaca. NY. 104p.

Available at: <http://www.clrp.cornell.edu/workshops/pdf/drainage_08_reprint-web.pdf>

Packer, P.; Christensen, G. 1964. Guide for controlling sediment from secondary logging roads. [pamphlet] Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 42 p. (Government Printing Office 1980-682-866/222).

\*Zeedyk, W.D. 1996. Managing roads for wet meadow ecosystem recovery. November. Tech. Rep. FHWA-FLP-96-016. Albuquerque, NM: U.S. Department of Agriculture, Forest Service, Southwestern Region. 76 p. (Includes a riparian restoration guide for wet meadows.)

**Culvert Use, Installation, and Sizing**

\*\*Cafferata, P., Spittler, T., Wopat, M., Bundros, G., Flanagan, S. 2004. Designing Watercourse Crossings for Passage of 100-Year Flood Flows, Wood, and Sediment. California Forestry Report 1, Department of Forestry and Fire Prevention, The Resource Agency, State of California, Sacto, 39p. Online: <http://www.calfire.ca.gov/resource_mgt/downloads/reports/ForestryReport1.pdf>

Corrugated Steel Pipe Institute. 2007. Handbook of steel drainage and highway construction products. Corrugated Steel Pipe Institute. Canada. 518 p.

\*Furniss, M.; Love, M.; Flanagan, S. 1997. Diversion potential at road-stream crossings. In: Water/Road Interaction Technology Series. Res. Rep. 9777 1814 – SDTDC. December. Washington, DC: U.S. Department of Agriculture, Forest Service. San Dimas Technology & Development Program. 12 p.[Online] <http://www.stream.fs.fed.us/water-road/index.htm>

Furniss, M.; Ledwith, T.; Love, M.; McFadin, B.; Flanagan, S. 1998. Response of Road- Stream Crossings to Large Flood Events in Washington, Oregon, and Northern California. Report 9877-1806-SDTDC, San Dimas, CA. Technology and Development Center, U.S. Department of Agriculture, Forest Service. 14p.

Johansen, K.; Copstead, R.; Moll, J. 1997. Relief culverts. Water/Road Interaction Technology Series. Res. Rep 9777 1812-SDTDC. October. Washington, DC: U.S. Department of Agriculture, Forest Service, San Dimas Technology & Development Program. 7 p.

[Online] <http://www.stream.fs.fed.us/water-road/index.htm> (Covers surface drainage and ditch relief culvert spacing and design.)

\*\*Normann, J; Houghtalen, R; Johnston, W. 2001 (Revised 2005). Hydraulic Design of Highway Culverts, Hydraulic Design Series (HDS) No. 5, FHWA-NHI-01-020, Federal Highway Administration and National Highway Institute, Washington, DC. 376 p. (Includes a comprehensive design for both convetional culverts and culverts with inlet improvements.) [Online] [**http://www.fhwa.dot.gov/bridge/hydpub.htm**](http://www.fhwa.dot.gov/bridge/hydpub.htm)**.**

**Fords and Low-Water Crossings**

Berger, L.; Greenstein, J.; Arrieta, J. 1987. Guidelines for the design of low-cost water crossings. Transportation Res. Record 1106. Washington, DC: National Researach Council, Transportation Research Board. pp. 318-327.

\*\*Clarkin, K; Keller, G; Warhol, T; Hixson, S. 2006. Low-Water Crossings: Geomorphic, Biological and Engineering Design Considerations. 0625 1808P - SDTDC, San Dimas Technology and Development Center, USDA Forest Service, San Dimas, CA. 366 p. plus CD.

Online: [**http://www.fs.fed.us/eng/pubs/pdf/LowWaterCrossings/index.shtml**](http://www.fs.fed.us/eng/pubs/pdf/LowWaterCrossings/index.shtml%20)

\*Lohnes, R.A.; Gu, R.R.; McDonald, T.; Jha, M.K. 2001. Low-Water Stream Crossings: Design and Construction Recommendations. Final Report CTRE Project 01-78, IOWA DOT Project TR-453, Center for Transportation Research and Education, Iowa State University. 50 p. [**http://www.intrans.iastate.edu/reports/LWSC.pdf**](http://www.intrans.iastate.edu/reports/LWSC.pdf) (A useful publication on specific design information for low-water crossings).

\*Motayed, A.K.; Chang, F.M.; Mukherjee, D.K. 1982. Design and construction of low-water stream crossings. Report No. FHWA/RD-82/163. June. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. 119 p. (A thorough review on low-water stream crossing structure design criteria, site selection, and structure types. This publication is currently being revised and updated by Robert Gu at Iowa State University.)

Moll, J. 1997. Site and selection of low water crossings. In Ecosystem Road Management. Compiled by San Dimas Technology and Development Center, San Dimas, CA:U.S. Department of Agriculture, Forest Service.

Ring, S.L. 1987. The design of low-water stream crossings. Transportation Res. Record 1106. Washington, DC: National Research Council, Transportation Research Board. pp. 309-318.

U.S. Department of Transportation, Transportation Research Board. 1979. Low-cost water crossings. Compendium 4, Transportation Technology Support for Developing Countries. Prepared for U.S. Agency for International Development. Washington, DC. 203 p. (Provides useful information for those in deveoping countries who have direct responsibility for low-cost water crossings.)

Warhol, T.; Pyles, M. 1989. Low water fords: An alternative to culverts on forest roads. August 27-30; Coeur d’Alene, ID: Proc. 12th Annual Council on Forest Engineering Meeting

### Bridges

\*AASHTO (American Association of State Highway and Transportation Officials). (2007). Standard Specifications for Highway Bridges, and AASHTO LRFD (Load and Resistance Factor Design) Bridge Design Specifications. Washington, DC.Online] <http://www.aashto.org> and http://www.transportation.org. (Covers all aspects of design for wood, steel, and concrete bridges, substructures, foundations, as well as structural plate structures and culverts.)

\*Adams, M.; Nicks, J.; Stabile, T.; Wu, J.; Schlatter, W.; Hartmann, J. 2011. Geosynthetic Reinforced Soil Integrated Bridge System Synthesis Report, FHWA-HRT-11-027. Federal Highway Administration. US Department of Transportation, Washington, DC. 64 p. Information available at:

<http://www.fhwa.dot.gov/publications/research/infrastructure/structures/11027/index.cfm>

\*Groenier, J. S.; Gubernick, R. A. 2009. Locating your Trail Bridge for Longevity, 0971-2810-MTDC, Missoula Technology and Development Center, USDA Forest Service. Missoula, MT. 27 p. Available at: <http://www.fs.fed.us/eng/pubs/pdfpubs/pdf10232808/pdf10232808dpi72.pdf>

\*Lagasse, P; Clopper, P; Pagan, G; Zevenbergen, L; Arneson, L; Schall, J; Girand, L. 2009. Bridge Scour and Stream Instability Countermeasures, Volume 1 and 2, Third Edition, Hydraulic Engineering Circular (HEC) No. 23, FHWA-NHI-09-111), Federal Highway Administration, and National Highway Institute. 256 p. Available at: <http://www.fhwa.dot.gov/engineering/hydraulics/pubs/09111/index.cfm>

Nagy, M; Trebett, J; Wellburn, G. 1980. Log bridge construction handbook. FERIC Handbook #3, Vancouver, B.C., Canada: Forest Engineering Research Institute of Canada. (ISSN 0701-8355). 421 p.

\*\*Neill. C. 2004. Guide to bridge hydraulics (Second Edition) (plus Metric Revision Supplement). Toronto, ON: Project Committee on Bridge Hydraulics, Roads and Transportation Association of Canada, University of Toronto Press. 191 p.

\*Richardson, E.V.; Davis S.R. 2001. Evaluating Scour at Bridges, Fourth Edition, Hydraulic Engineering Circular (HEC) No. 18, Federal Highway Administration and National Highway Institute, Washington, DC. 378 p. (Covers all aspects of scour evaluation and determination of scour depth.) [Online] <http://www.fhwa.dot.gov/bridge>.

###### Slope Stabilization and

#### Stability of Cuts and Fills

Barrett, R.K. 1985. Geotextiles in earth reinforcement. Geotechnical Fabrics Report, March/April:15-19.

\*\*Berg, R; Christopher, B; Samtani, N. 2010. Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Volume 1 and 2. FHWA-NHI-10-024 and 025. Federal Highway Administration. US Department of Transportation, Washington, DC. 378 p.[Online] <http://www.fhwa.dot.gov/engineering/geotech/retaining/100317.cfm>

Or <http://www.fhwa.dot.gov/bridge> (Covers the design of mechanically stabilized earth walls and reinforced soil slopes.)

Collin, J.; Loehr, E.; Hung, J. 2008. Highway Slope Maintenance and Slide Restoration Reference Manual. FHWA-NHI-08-098. National Highway Institute and Federal Highway Administration. US Department of Transportation, Washington, DC. 164 p.

\*\*Fay, Laura; Akin, M.; Shi, X. 2012. Cost-effective and sustainable road slope stabilization and erosion control. NCHRP Synthesis 430 (NCHRP Project 20-5, Topic 42-09), Western Transportation Institute, Montana State University, Bozeman, Montana, and Transportation Research Board, Washington, DC. 70 p. Online at: <http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_430.pdf>

\*\*Gray, D.; Leiser, A. 1982. Biotechnical slope protection and erosion control. Melbourne, FL: Krieger Publishing Co. 288 p. (ISBN 0-442-21222-4) (Covers various biotechnical slope stabilization and erosion control techniques.)

Highland, L.; Bobrowsky, P. 2008. The Landslide Handbook- A guide to understanding landslides. USGS Circular 1325, US Department of Interior, US Geological Survey and Geological Survey of Canada. Golden, Colorado. 129 p. Available at:

[**http://pubs.usgs.gov/circ/1325/**](http://pubs.usgs.gov/circ/1325/)

Also available in Spanish and Portuguese [Online]- [**https://www.gfdrr.org/node/684**](https://www.gfdrr.org/node/684)

Hoek, E.; Bray, J. 2004. (Updated by Wyllie, D.; Mah, C. 2004. Rock Slope Engineering. Institute of Mining and Metallurgy, London, 358 p. (Older version ISBN 0-900488-573)

Keller, G.; Cummins, O. 1990. Tire retaining structures. Engineering Field Notes. 22:15-24, March/April. Washington, DC: U.S. Department of Agriculture, Forest Service.

\*Mohney, J. Retaining Wall Design Guide. 2d ed, 1994. Tech. Rep. No. EM-7170-14. Washington, DC: U.S. Department of Agriculture, Forest Service, Engineering Staff. Also Pub. No. FHWA-FLP-94-006. September. Washington, DC: Department of Transportation, Federal Highway Administration, Federal Lands Highway Program. 537 p. [Online] http://www.ntis.gov (Covers the analysis and design of a wide variety of low-cost retaining structures.) It is also available on the Association of Environmental and Engineering Geologists, Geoscience Library website under Section 5, Transportation Geology, Low -Volume Roads Collection, Slope Stability Issues and Stabilization Methods (To access this site, one must initially register with them at: [**www.geoscilibrary.org**](http://www.geoscilibrary.org)**).**

\*Turner, A.K.; Schuster, R.L. 1996. Landslides -- Investigation and Mitigation. Tech. Rep. No. TRB-SR-247. Washington, DC: National Research Council, Transportation Research Board. National Academy Press. 680 p. (ISBN 0-309-06208-X) (A comprehensive publication on all aspects of landslide hazards, investigation, their analysis, the design of unstable soil and rock slope stabilization measures, and special applications.)

\*Prellwitz, R. Editor, 1994. Slope Stability Reference Guide for National Forests in the United States, Volume 1-3, EM-7170-13, Engineering Staff , US Forest Service , Washington, DC. Available from the Government Printing Office, Phone (202) 512-1800, <http://www.bookstore.gpo.gov> and

<http://www.fs.fed.us/rm/pubs_other/wo_em7170_13/wo_em7170_13_vol1.pdf>

<http://www.fs.fed.us/rm/pubs_other/wo_em7170_13/wo_em7170_13_vol2.pdf>

<http://www.fs.fed.us/rm/pubs_other/wo_em7170_13/wo_em7170_13_vol3.pdf>

(A comprehensive 3-volume set of information on all aspects of slope stability, identification, planning and risk, analysis methods, and stabilization techniques, written by field practitioners. A practical guide for geologists and engineers dealing with slope stability problems.)

Shah, Bashir Hussan. 2008. Field Manual on Slope Stabilization, UNDP (United Nations Development Program), Environmental Recovery Program for the Earthquake Affected Areas. Islamabad, Pakistan, September, 64p. <http://preventionweb.net/english/professional/publications/v.php?id=13232>

U.S. Navy. 1986 (update). Foundations and Earth Structures. NAVFAC DM 7.02. Soils, Foundations, and Retaining Walls Design manual 7.02.Navy Facilities Engineering Command, Alexandria, VA. 241+p. Available at:

<http://www.geotechnicaldirectory.com/publications/Dm702.pdf>

Washington State Dept. of Transportation. 2013. Design Guidelines for Horizontal Drains Used for Slope Stabilization. WSDOT Research Report WA-RD 787.1. Desert Research Institute, Reno, NV and Washington State Department of Transportation, Olympia, WA. 377p.

Available at: <http://www.wsdot.wa.gov/research/reports/fullreports/787.1.pdf>

Wilson Musser, S.; Denning, C. 2005. Deep patch road embankment repair application guide. 0577 1204 - SDTDC, San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center, 21 p. Available at:

<http://www.fs.fed.us/eng/pubs/pdf/05771204.pdf>

**Roadway Materials and Materials Sources**

American Society of Civil Engineers. 2006. A Guide for the Design and Maintenance of Paved Low-Volume Roads, in cooperation with Federal Highway Administration. Prepared by Applied Pavement Technology, Inc, ASCE, Reston, VA. 174 p.

Australian Roads Research Board. 1996. Road dust control techniques – Evaluation of chemical dust suppressants’ performance. Spec. Rep. 54. Victoria, Australia**:** Australian Roads Research Board, Transport Research Ltd.[Online] <http://www.arrb.org.au> (Covers the products available, how they work, selecting the product, and the product’s environmental impacts.)

\*Bolander, P.; Marocco, D.; Kennedy, R. 1996. Earth and Aggregate Surfacing Design Guide for Low-volume Roads, EM-7170-16, USDA Forest Service, Engineering Staff, Washington, DC. And FHWA-FLP-96-001, USDOT, FHWA) 302 p. (Covers the design methodology for Surface Thickness Program, as well as an aid in selecting the type of surfacing material, and surface maintenance.) It is available on the Association of Environmental and Engineering Geologists, Geoscience Library website under Section 5, Transportation Geology, Low-Volume Roads Collection, Roadway Materials and Sources Development (To access this site, one must initially register with them at: [**www.geoscilibrary.org**](http://www.geoscilibrary.org)**).**

Bolander, P.; Yamada, A. 1999. Dust palliative selection and application guide. Technology & Development Program No. 9977 1207—SDTDC. November. Washington, DC: U.S. Department of Agriculture, Forest Service. San Dimas Technology and Development Program. 19 p. This available at:

<http://www.fs.fed.us/eng/pubs/pdf/99771207.pdf>

Bolander, P. 2005. Seal Coat Options: Taking Out the Mystery, Transportation Research Circular E-C078, First National Conference on Roadway Pavement Preservation (Oct 31-Nov 1, Kansas City, MO). Transportation Research Board, Washington, DC. pp 24-41. Available in the following publication at: <http://onlinepubs.trb.org/onlinepubs/circulars/ec078.pdf>

Dunne, T.; Collins, B. 1990. Fluvial geomorphology and river gravel mining: A guide for planners, case studies included. Special Publication SP 098**.** Sacramento, CA: California Department of Conservation, Division of Mines and Geology.29 p.

\*Federal Highway Administration, 2005. Context Sensitive Roadway Surfacing Selection Guide, Publication No. FHWA-CFL/TD-05-004, Golder & Associates under contract to the Federal Highway Administration. Lakewood, CO. 354p. <http://www.cflhd.gov/programs/techDevelopment/CompletedProjects.cfm>.

Federal Highway Administration. 1998. Problems associated with gravel roads. Publication No. FHWA-SA-98-045. May. Washington, DC. Produced through Local Technical Assistance Program. U.S. Department of Transportation, Federal Highway Administration.

\*Huntington, G.; Ksaibati, K. 2010. Gravel Roads Management (and accompanying Implementation Guide). Wyoming Technology Transfer Center (T2-LTAP) and University or Wyoming, prepared for Wyoming DOT. Laramie, WY. 16p.

Online at**:** [**http://www.ndltap.org/events/conference/downloads/2010GRMfinal.pdf**](http://www.ndltap.org/events/conference/downloads/2010GRMfinal.pdf)

\*Kestler, M. 2009. Stabilization Selection Guide for Aggregate and Native-Surfaced Low-Volume Roads, Gen. Tech. Rep. 0877 1805-SDTDC, San Dimas Technology and Development Center, USDA Forest Service. San Dimas, CA. [**http://www.fs.fed.us/eng/pubs/pdf/08771805.pdf**](http://www.fs.fed.us/eng/pubs/pdf/08771805.pdf)

Minnesota Local Technical Assistance Program (2006). To Pave or Not to Pave-Making Informed Decisions on when to Upgrade a Gravel Road. In cooperation with Minnesota Local Road Research Board and Minnesota DOT. Minneapolis, MN. 4 p. Online at: <http://www.mnltap.umn.edu/publications/factsheets/documents/paveornot/brochure.pdf>

Scholen, D.E. 1992. Non-standard stabilizers. Pub. No. FHWA FLD-92-011. July. Washington, DC: U.S. Department of Transportation, Federal Highway Administration, Office of Direct Federal Programs. (Covers the Forest Service use of various non-standard road surface stabilization products.)

\*\*Skorseth, K.; Selim, A. 2000. Gravel Roads Maintenance and Design Manual. US Department of Transportation, Federal Highway Administration and South Dakota Local Transportation Assistance Program (LTAP). (Reprint April, 2005, LTAP-02-002).[Online]

[**http://water.epa.gov/polwaste/nps/gravelroads\_index.cfm**](http://water.epa.gov/polwaste/nps/gravelroads_index.cfm)

(A useful manual on design and maintenance of gravel roads, with great photos and figures.)

Sowers, G. F. 1979. Introductory soil mechanics and foundations: Geotechnical Engineering. 4th ed. New York: Macmillan. 621 p. (ISBN 0-02-413870-3) (A basic textbook on Soil Mechanics.)

Strombom, R. 1987. Maintenance of aggregate and earth roads. WA-RD 144.1. June. Olympia, WA: Washington State Dept. of Transportation. Reprinted as Federal Highway Administration Publication No. FHWA-TS-90-035. 71 p. (A state-of-the-art manual on maintenance and management of aggregate and native earth roads.)

Yamada, A. 1999. Asphalt seal coat treatments. Technology & Development Program No. 9977 1201—SDTDC. April. Washington, DC: U.S. Department of Agriculture, Forest Service, San Dimas Technology & Development Program. 24 p.

Yoder, E.J.; Witczak, M.M. 1975. Principles of pavement design. 2d ed. New York: John Wiley & Sons. 711p. (ISBN 0-471-97780-2) ( A classic text on fundamentals of pavement design.)

Williamson, D. 1988. Unified Rock Classification System <http://www.astm.org/DIGITAL_LIBRARY/STP/SOURCE_PAGES/STP984.htm> . (Information also found in Appendix of the FS Slope Stability Guide (Prellwitz 1994))

Soil Compaction - A Basic Handbook <http://www.rentrain.com/resources/pdf/mq_soil_handbook.pdf>

Hyster Compaction Handbook—Another publication on compaction that is out of print: <http://fsweb.r6.fs.fed.us/eng/planning/AggregateRoadDesignMainGuides/HysterCompactionHandbook.pdf>

Erosion Control: Physical, Vegetative

**and Biotechnical Methods**

Association of Bay Area Governments. 1995. Manual of standards for erosion & sediment control measures, 2d ed.. May. San Fransisco, CA. 500 p. (A comprhensive field guide for controlling soil erosion in California).

Burroughs, E.; King, J. 1989. Reduction of soil erosion on forest roads. Tech. Rep. No. FSGTR-INT-264, July. Moscow, ID: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 26 p. (Covers expected reduction in surface erosion from selected treatments applied to forest road traveled ways, cutslopes, fillslopes, and ditches.)

Clackamas County Water Environment Services. 2000. Erosion prevention and sediment control: planning and design manual. Oregon: Developed in cooperation with City of West Lynn and the Unified Sewerage Agency of Washington County. Ph 503-353-4567. (Presents many erosion and sediment control Best Management Practices, with nice photos and illustrations.)

Gray, D.; Leiser, A. 1982. Biotechnical slope protection and erosion control. Melbourne, FL: Krieger Publishing Co. 288 p. (ISBN 0-442-21222-4) (A good textbook covering various biotechnical erosion control techniques, their design and construction.)

\*Gray, D.; Sotir, R. 1996. Biotechnical and soil bioengineering slope stabilization-A practical guide for erosion control. New York, NY: A Wiley-Interscience Publication, John Wiley and Sons, Inc. 378 p. (ISBN 0-471-04978-6) (Covers various biotechnical erosion control techniques and their application.)

\*Gillies, C. 2007. Erosion and sediment control practices for forest roads and stream crossings- A practical operations guide. Advantage Vol. 9 No. 9, FP Innovations, FERIC Division, Forest Engineering Research Institute of Canada, Western Region, British Colombia. 87p. Available from: [**http://www.feric.ca**](http://www.feric.ca)

Lewis, L. 2000. Soil Bioengineering- An Alternative for Roadside Management, A Practical Guide. Technology & Development Program No. 0077-1801-SDTDC, September. Washington, DC: U.S. Department of Agriculture, Forest Service, San Dimas Technology & Development Center, San Dimas, CA. 43 p.

\*Minnesota Local Road Research Board. 2003. Erosion Control Handbook for Local Roads, 2003-08. Minnesota LTAP, Minnesota Department of Transportation, and Federal Highway Administration. 122p. Available at: [www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1600](http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=1600)

Morfin, S.; Elliot, W.; Foltz, R.; Miller, S. 1996. Predicting effects of climate, soil, and topography on road erosion with the WEPP model. In: Proceedings of the 1996 American Society of Agricultural Engineers, Annual International Meeting; 1996 July 16; Phoenix, AZ. ASAE Paper No. 965016. St. Joseph, MI: ASAE. 11 p. (Use of the Water Erosion Prediction Project (WEPP) soil erosion model.)

\*Rivas, T. 2006. Erosion Control Treatment Selection Guide. Gen. Tech Rep. 0677 1203 – SDTDC. San Dimas Technology and Development Center, USDA Forest Service. San Dimas, CA.

<http://www.fs.fed.us/eng/pubs/pdf/hi_res/06771203hi.pdf>

\*Steinferld, D.; Riley, S.; Wilkinson, K.; Landis, T.; and Riley, L. 2007. Roadside Revegetation: An Integrated Approach to Establishing Native Plants. FHWA-WFL/TD-07-005, Federal Highway Administration, Vancouver, WA. and Umatilla National Forest, Pendleton, Or. 424p.

Available at: <http://www.wfl.fhwa.dot.gov/programs/td/publications/>

Truong, P.; Tan Van, T.; Pinners, E. 2008. Vetiver System Applications: Technical Reference Manual (Second Edition). The Vetiver Network International. 91 p. Available in Spanish, Portuguese, French and other languages, at the Vetiver Network: <http://www.vetiver.org/>

U.S. Department of Agriculture, Soil Conservation Service. 1978**.** Estimating sheet-rill erosion and sediment yield on rural and forest highways. WTSCTN Woodland 12. US Department of Agriculture, Soil Conservation Service, 33 p. (Basic information on use of the Universal Soil Loss Equation (USLE) to predict erosion loss on roads.)

\*U.S. Department of Agriculture, Soil Conservation Service. 1992**.** Soil bioengineering for upland slope protection and erosion reduction. In: Engineering Field Handbook, Chapter 18. October. Rep. No. EFH-650-18.Washington, DC. 62 p. (Covers biotechnical erosion control techniques and their use, with great photos and drawings.) <ftp://ftp-nhq.sc.egov.usda.gov/NHQ/pub/outgoing/jbernard/CED-Directives/efh/EFH-Ch18.pdf>

Weaver, W.; Hagans, D.; Weppner, E. 2006. Upland Erosion Inventory and Sediment Control Guidance. Part X of California Salmonid Stream Habitat Restoration Manual, Third Edition, California Department of Fish and Game, The Resource Agency, State of California. 207 p.

World Bank, The. 1993. Vetiver grass: The hedge against erosion. Washington, DC. 78 p. (ISBN 0-8213-1405) (A basic, useful pamphlet on the applications of Vetiver Grass. Spanish version first published in 1990.) [Online] http://www.vetiver.org/

Zeedyk, B.; Jansens, J. 2006. An introduction to erosion control. Second Edition. A Joint publication of Earth Works Institute, The Quivira Coalition, and Zeedyk Ecological Consulting. New Mexico Environmental Department, Watershed Protection Section, Santa Fe, NM. 26p.

Available at: (<http://www.comanchecreek.org/images/links/115-Erosion%2520Control%2520Field%2520Guide.pdf>)

Erosion Prevention and Sediment Control Manual. Available at: (<http://greshamoregon.gov/city/city-departments/environmental-services/watershed-management/template.aspx?id=20715>). Note that many counties and cities (states too) have their own erosion and sediment control manual, many deal with just temporary erosion control and some also have more long-term control measures.  This is one reference that has both.

**Stabilization of Gullies**

Gray, D.; Leiser, A. 1982. Biotechnical slope protection and erosion control. Van Nostrand Reinhold, NY. 271 p. (ISBN 0-442-21222-4) (Covers various erosion control techniques and gully stabilization measures.)

# \*Heede, B. 1976. Gully development and control: The status of our knowledge. Research Paper RM-169. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 42 p. (A basic primer on gully formation, gully stabilization techniques, and types of control structures.)

Natural Resources Conservation Service. 1972. Gully Treatment, Engineering Field Handbook, Chapter 10, US Department of Agriculture 16p.

Natural Resources Conservation Service. 2007 Gullies and Their Control. Technical Supplement 14P (210-VI-NEH). 20p. Available at: <http://www.nae.usace.army.mil/reg/nrrbs/TECHNICALSUPPLEMENTS/TS14P.pdf>