SECTION 14 – IMPLEMENTATION PLANS

MANAGEMENT MEASURES

Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA, 1993). A combination of best management practices (BMPs) and public education will be used to implement this TMDL.

A general implementation plan for activities to be established in the watershed is included in this document. The Surface Water Quality Bureau's Nonpoint Source Pollution Section will further develop the details of this plan. Implementation of recommendations in this document will be done with full participation of all interested and affected parties. During implementation, additional water quality data will be generated.

As a result, targets will be re-examined and potentially revised; this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be removed from the TMDL list.

A. pH

Introduction

The pH scale is a series of numbers that express the degree of acidity (or alkalinity) of a solution. For example, a solution of pH 1 is said to be 10 times as acidic as a solution of pH 2, because the hydrogen ion concentration at pH 1 is ten times the hydrogen ion concentration at pH 2, (Sorenson, 1909; Clark, 1920). Typically, pH ranges from 1 to 14, with a pH of 1 most acidic and pH of 14 least acidic or alkaline. The measure of pH in water is important as aquatic life has evolved around a narrow margin of pH. The suitability of an aquatic environment for fish and plant life is critically dependent on this narrow margin, usually between pH 6 and pH 9. High/low pH and fluctuations in pH can stress aquatic organisms by affecting their osmotic balance. The pH scale is a series of numbers that express the degree of acidity (or alkalinity) of a solution.

Sources contributing to low or high pH include:

- the composition of soils, surficial deposits, and bedrock,
- excessive algal growths in waterbodies can cause pH to fluctuate,
- resource extraction processes that make highly acidic soils available, and
- surface water runoff in urban areas that can carry waste residue, for example, battery acid or cleaning solvents.

Actions to be Taken
For the Jemez River Basin, one of the issues for primary focus will be control of pH.

During the TMDL process in this watershed, point sources have been reviewed and will be addressed through the permit process. The nonpoint source contributions will need to address pH exceedances through BMP implementation.

BMPs can be implemented to address pH exceedances. They include but are not limited to:

1. The use of filter strips or vegetated buffers to decrease nutrient loading. This is a good method to minimize runoff from agricultural fields and storm water drains. This BMP would also prevent sediment loading and turbidity in the river system because the vegetation filters and slows runoff. (*Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, USEPA, 1993).

2. Detention basins are effective techniques for the control of pollutant discharges from storm water runoff. The catchment basins prevent runoff into a stream by isolating and containing storm water runoff (*Urban Targeting and BMP Selection*, USEPA, 1990).

3. Using a wetland to filter runoff water and sediment from sources on the watershed. Wetlands have been effective in slowing down runoff, and in filtering out sediments, including acidic soils or materials. (*The Use of Wetlands for Improving Water Quality to Meet Established Standards*, Filas, B., and T. Wildeman, 1992.)

Additional sources of information for BMPs to address pH are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St. Francis Drive, Santa Fe, New Mexico.

Agriculture

Internet websites:

- www.nm.nrcs.usda.gov
- http://www.nhq.nrcs.usda.gov/land/env/wq7.html

- http://www.ag.ohio-state.edu/~ohioline/aex-fact/0464.html

- Cotton, Scott E. and Ann C. Cotton, Wyoming CRM: Enhancing our Environment.

- Goodloe, Sid, Watershed Restoration through Integrated Resource Management on Public and Private Rangelands.

- New Mexico State University, 1992, New Mexico Farm-A-Syst Farmstead Assessment System, College of Agriculture and Home Economics, Cooperative Extension Service, Plant Sciences Department.

Section 6, Improving household Wastewater Management

Section 7, Improving Livestock Waste Storage

Section 8, Improving Livestock Yards Management

- USEPA Region 6 and Terrene Institute, 1994, Pollution Control for Horse Stables and Backyard Livestock (handout)

- USEPA Region 4 and Tennessee Valley Authority, Animal Waste Treatment by Constructed Wetlands. (pamphlet)

- USEPA Region 5, Animal Waste Treatment by Constructed Wetlands, Water Management Division, (pamphlet).

Mining

Internet websites:

- http://www.epa.gov/region2/epd/98139.htm

- Coleman, M.W., 1996, Anoxic Alkaline Treatment of Acidic, Metal-Loaded Seeps Entering the Red River, Taos Co., NM. Paper presented at New Mexico Governor's 1996 Conference on the Environment, Albuquerque Convention Center, abstract in program. Published in NMED-NPS newsletter "Clearing the Waters", v.3, No.1, summer, Santa Fe.

- Coleman, M.W., 1999, Geology-Based Analysis of Elevated Aluminum in the Jemez River, North-Central New Mexico. Unpublished Report to USEPA Region 6 N.M. Total Maximum Daily Load (TMDL) Team, New Mexico Environment Department, Surface Water Quality Bureau, Santa Fe, 2p.

- Coleman, M.W., 2000, Rio Puerco Watershed Mining Impacts. New Mexico Environment Department, Clean Water Act Section 319(h) Grant Project Summary Report to USEPA Region 6, Dallas, New Mexico Environment Department Surface Water Quality Bureau Watershed Protection Section, Santa Fe.

- Eger, P., and K. Lapakko, 1988, Nickel and Copper Removal From Mine Drainage by a Natural Wetland. U.S. Bureau of Mines Circular 9183, pp.301-309.

- Filas, B., and T. Wildeman, 1992, The Use of Wetlands for Improving Water Quality to Meet Established Standards, Nevada Mining Association Annual Reclamation Conference, Sparks, Nevada.

- Girts, M.A., and R.L.P. Kleinmann, 1986, Constructed Wetlands for Treatment of Mine Water. American Institute of Mining Engineers Fall Meeting. St. Louis, MO.

- Holm, J.D., and T. Elmore, 1986, Passive Mine Drainage Treatment Using Artificial and Natural Wetlands. Proceedings of the High Altitude Revegetation Workshop, No. 7. pp. 41-48.

- Kleinmann, R.L.P., 1989, Acid Mine Drainage: U.S. Bureau of Mines, Research and Developments, Controlling Methods for Both Coal and Metal Mines. Engineering Mining Journal 190:16i-n.

- Machemer, S.D., 1992, Measurements and Modeling of the Chemical Processes in a Constructed Wetland Built to Treat Acid Mine Drainage. Colorado School of Mines Thesis T-4074, Golden, CO.

- Metish, J.J. and others, 1998, Treating Acid Mine Drainage From Abandoned Mines in Remote Areas. USDA Forest Service Technology and Development Program, AMD Study 7E72G71; Missoula, MT; US Govt. Printing Office: 1998-789-283/15001.

- Royer, M.D., and L. Smith,1995, Contaminants and Remedial Options at Selected Metal-Contaminated Sites. Battelle Memorial Institute-Columbus Division, under contract # 68-CO-0003-WA41 to Natl. Risk Management Lab-Office of Research and Development, USEPA; EPA/540/R-95/512.

- Slifer, D.W., 1996, Red River Groundwater Investigation. New Mexico Environment Department Surface Water Quality Bureau Nonpoint Source Pollution Section, Clean Water Act section 319 (h) Grant Project Final Report to USEPA Region 6 - Dallas.

- US EPA, 1996, Seminar Publication Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites. Office of Research and Development, EPA/625/R-95.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives, State Soil Conservation Board.

- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.

- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).

- New Mexico State University, Revegetating Southwest Riparian Areas. College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).

- State of Pennsylvania, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners. Department of Environmental Resources, Division of Scenic Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook, Nonpoint Source Water Pollution Management Program.

Stormwater/Urban

Internet website
- http://www.epa.gov/ordntrnt/ORD/WebPubs/nctuw/Pitt.pdf

- Brede, Dr. A.D., L.M. Cargill, D.P. Montgomery, and T.J. Samples, 1987, Roadside Development and Erosion Control. Oklahoma Department of Transportation; Report No. FHWA/OK 87 (5).

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program & the Environment Management Center, Brandywine Conservancy.

- Taylor, Scott, and G. Fred Lee, 2000, Stormwater Runoff Water Quality. Science/Engineering Newsletter, Urban Stormwater Runoff Water Quality Management Issues, Vol. 3, No. 2.

Miscellaneous

Internet websites:
- http://www.epa.gov/OWOW/NPS/

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health, Surface Water Quality Bureau.

- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, D., 1996, Applied River Morphology. Chapter 8. Applications (Grazing, Fish Habitat)

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook, Nonpoint Source Water Pollution Management Program.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration, Principles, Processes, and Practices.

Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook.

Section 23, Recreation Management

Section 25, Watershed Management

Section 41, Access and Transportation Systems and Facilities

- US EPA, 1993, Guidance Specifying Management Measures For Sources of Nonpoint Pollution in Coastal Waters. Office of Water, Coastal Zone Act Reauthorization Amendments of 1990, EPA840-B-92-002

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan. Section F, Specifications.

- Unknown, Selecting BMPs and other Pollution Control Measures.

- Unknown, Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for pH include:

- increase the miles of vegetative buffers between resource extraction activities and the stream.
- percentage of restored riparian buffers in the watershed
- percentage of installation of detention ponds for stormwater runoff.
- percentage reduction in nutrient sources to the watershed.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information show that changes are warranted, TMDL revisions will be made with assistance of watershed stakeholders. The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.

B. CONDUCTIVITY

Introduction

Conductivity is an indication of the number of inorganic dissolved ions in the water column. Conductivity is affected by temperature; warmer water will measure relatively higher conductivity results.

Conductivity is used as a measure of stream water quality as this measure tends to have a relatively constant range within a stream. Significant changes from baseline data can indicate that a discharge or an activity resulting in nonpoint source discharge has entered the stream system. For example, a return flow from an irrigated field may contribute a dissolved salt load from groundwater sources or from the soil. A system impacted with higher than normal conductivity levels can have a detrimental affect on the biota of a natural system. Just as an excess of soil salinity damages agricultural crops, salts in streams can be detrimental to aquatic flora and fauna.

Under natural conditions, the conductivity of the stream is generally based on the geology of the watershed. Water coming in contact with soils and erodible source rock material will dissolve salts especially when soil drainage is poor. As mentioned earlier, temperature factors in the process of dissolving salts. Naturally occurring geothermal activity can contribute to high conductivity levels. All these factors determine baseline data. Additional sources, such as point sources from failing septic systems, or drainage from confined animal operations, will change the conductivity, depending the constituents of the runoff.

Examples of sources that can cause excessive conductivity levels include but are not limited to:

- nonpoint source contributions of additional salts including agricultural field runoff or irrigation return,
- extensive use of deicing salts or dust reduction compounds on roads,
- and mining activities.

<u>Actions to be Taken</u>
For the Jemez River Basin, one of the issues for primary focus will be the control of specific conductance or the conductivity of water.

During the TMDL process in this watershed, the point sources have been reviewed and will be addressed through the permit process. The nonpoint source contributions will need to address conductivity exceedances through BMP implementation.

BMPs can be implemented to address and remediate conductivity exceedances. They include but are not limited to:

1. The use of a filter strip or vegetated buffer. This is particularly advantageous for runoff from agricultural fields, road de-icing, road erosion, stormdrains and resource extraction activities by filtering and reducing the temperature of the water. This BMP would also prevent sediment loading and turbidity in the river system. (Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, USEPA, 1993.)

2. The management of the application of fertilizers or any other field additive and the application of road salts. An over-supply of applied material in crops not used by plants will dissolve in rainwater and will become mobilized in runoff, or will be carried in irrigation return flow. In road maintenance, management of road deicers, including sodium and magnesium chlorides, is economically advantageous. Education on the application of road salts, to minimize extensive runoff should be approached immediately, especially in areas where highways and roads are adjacent to river systems. (Field Agricultural Runoff Monitoring (FARM) Manual, USEPA, 1985, and Highway Deicing, Comparing Salt & Calcium Magnesium Acetate, Transportation Research Board, National Research Council, 1991).

3. Address the placement of mine tailings and holding ponds away from potential runoff if conductivity is contributed through a resource extraction activity. Segregating easily erodible tailings and holding ponds can reduce the impacts to a river system by keeping sediments out of the runoff to a stream. (Technical Manual for the Design and Operation of a Passive Mine Drainage Treatment System, Cohen, R.R.H., and S. W. Staub, 1992.)

Additional sources of information for BMPs to address conductivity are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St. Francis Drive, Santa Fe, New Mexico.

Agriculture

Internet websites:

- http://www.nm.nrcs.usda.gov

- http://www.sci.sdsu.edu/salton/TheSalinityofRivers.html

- Bureau of Land Management, 1990, Cows, Creeks, and Cooperation: Three Colorado Success Stories. Colorado State Office.

- Cotton, Scott E. and Ann C. Cotton, Wyoming CRM: Enhancing our Environment.

- Goodloe, Sid and Susan Alexander, Watershed Restoration through Integrated Resource Management on Public and Private Rangelands.

- Grazing in New Mexico and the Rio Puerco Valley Bibliography.

- New Mexico State University, 1992, New Mexico Farm-A-Syst Farmstead Assessment System. College of Agriculture and Home Economics, Cooperative Extension Service, Plant Sciences Department.

Section 6, Improving Household Wastewater Management

Section 7, Improving Livestock Waste Storage

Section 8, Improving Livestock Yards Management.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices.
-

Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USEPA and The Northwest Resource Information Center, Inc., 1990, Livestock Grazing on Western Riparian Areas.

- USEPA and The Northwest Resource Information Center, Inc., 1993, Managing Change: Livestock Grazing on Western Riparian Areas.

Mining

- Coleman, M.W., 2000, Rio Puerco Watershed Mining Impacts. New Mexico Environment Department, Clean Water Act Section 319(h) Grant Project Summary Report to USEPA Region 6, Dallas, New Mexico Environment Department Surface Water Quality Bureau Watershed Protection Section, Santa Fe, 46 pp. plus Appendix

- Filas, B., and T. Wildeman, 1992, The Use of Wetlands for Improving Water Quality to Meet Established Standards. Nevada Mining Association Annual Reclamation Conference, Sparks, NV.

- Royer, M.D., and L. Smith, 1995, Contaminants and Remedial Options at Selected Metal-Contaminated Sites. Battelle Memorial Institute-Columbus Division, under contract # 68-CO-0003-WA41 to Natl. Risk Management Lab-Office of Research and Development, USEPA, EPA/540/R-95/512.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives. State Soil Conservation Board.

- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.
- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).
- New Mexico State University, Revegetating Southwest Riparian Areas. College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).
- State of Pennsylvania, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners. Department of Environmental Resources, Division of Scenic Rivers.
- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program.

Roads and Construction

- New Mexico Natural Resources Department, 1983, Reducing Erosion from Unpaved Rural Roads in New Mexico, A Guide to Road Construction and Maintenance Practices. Soil and Water Conservation Division.
- New Mexico Environment Department, 1993, Erosion and Sediment Control Manual. Surface Water Quality Bureau.
- State of Kentucky, 1994, Kentucky Best Management Practices for Construction Activity. Division of Conservation and Division of Water.
- State of New Mexico, 1994, Road Construction and Maintenance Practices To Reduce Erosion from Low-Volume Unpaved Rural Roads in New Mexico. Natural Resources Department, Soil & Water Conservation Division.
- Sultan, Hassan A., 1974, Soil Erosion and Dust Control on Arizona Highways, Part 1: State of the Art Review. Arizona Department of Transportation, Report ADOT-RS-10-141-1.
- Transportation Research Board, 1991, Highway Deicing, Comparing Salt & Calcium Magnesium Acetate, Special Report 235. National Research Council

Chapter 4 – Road Salt Impacts on the Environment.

- Trujillo, Delbert, 1999, Technology Transfer/Education for State and County Road Construction and Maintenance Crews. New Mexico Environment Department Surface Water Quality Bureau Nonpoint Source Pollution Section, Clean Water Act §319 (h) Grant Project Final Report to USEPA Region VI.
- USDA Forest Service Southwestern Region, 1996, Managing Roads for Wet Meadow Ecosystem Recovery. FHWA-FLP-96-016

Section V. New Construction and Reconstruction

Section VI. Remedial Treatments

Section VII. Maintenance

- USEPA, 1992, Rural Roads: Pollution Prevention and Control Measures, (handout).

Stormwater

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts From Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program and The Environment Management Center, Brandywine Conservancy.

- State of Kentucky, 1994, Kentucky Best Management Practices for Construction Activity. Division of Conservation and Division of Water.

- USEPA, 1992, Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices, Summary Guidance. EPA833-R-92-001, pgs. 7- 9

Miscellaneous

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health. Surface Water Quality Bureau.

- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, D., 1996, Applied River Morphology, Chapter 8. Applications (Grazing, Fish Habitat)

- Rosgen, D., 1997, A Geomorphological Approach to Restoration of Incised Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices.

Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook
-

Section 22, Range Management

Section 23, Recreation Management

Section 24, Timber Management

Section 25, Watershed Management

Section 26, Wildlife and Fisheries Management

Section 41, Access and Transportation Systems and Facilities

- US EPA, 1993, Guidance Specifying Management Measures For Sources of Nonpoint Pollution in Coastal Waters. Office of Water, Coastal Zone Act Reauthorization Amendments of 1990, EPA840-B-92-002

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Section F. Specifications.

- Unknown, Selecting BMPs and other Pollution Control Measures.

- Unknown, Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for metals include:

- percentage reduction of sediment into the stream.
- increased educational efforts to agencies that manage roads to promote better management of road salt dispersal.
- reduction of salts in return flow irrigation systems.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information show that changes are warranted, TMDL revisions will be made with assistance of Jemez River Basin stakeholders. The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.

C. METALS

Introduction

The uptake and transport of metals in surface waters can pose a considerable nonpoint source pollution problem. Metals such as aluminum, lead, copper, iron, zinc and others can occur naturally in watersheds in amounts ranging from trace to highly mineralized deposits. Some metals are essential to life at low concentrations but are toxic at higher concentrations. Metals such as cadmium, lead, mercury, nickel, and beryllium represent known hazards to human health. The metals are continually released into the aquatic environment through natural processes, including weathering of rocks, landscape erosion, geothermal or volcanic activity. The metals may be introduced into a waterway via headcuts, gullies or roads. Depending on the characteristics of the metal, it can be dissolved in water, deposited in the sediments or both. Metals become dissolved metals in water as a function of the pH of a water system. In urban settings, stormwater runoff can increase the mobilization of many metals into streams.

Examples of sources that can cause metals contamination:

- Activities such as resource extraction, recreation, some agricultural activities and erosion can contribute to nonpoint source pollution of surface water by metals.
- Stormwater runoff in industrial areas may have elevated metals in both sediments and the water column.

<u>Actions to be Taken</u>
For the Jemez River Basin, one of the primary focuses will be on the control of aluminum.

During the TMDL process in this watershed, point sources have been reviewed and will be addressed through the permit process. The nonpoint source contributions will need to address aluminum exceedances through BMP implementation.

BMPs can be implemented to address and remediate metal contamination. They include, but are not limited to:

1. Improving the pH in a stream. Neutral to alkaline pH waters will generally not pose a metal exceedance problem. An acidic pH will dissolve available metals. In such a case, a remedy for metals contamination could be an adjustment of the pH of runoff before it enters the water body. An approach may be the construction of an anoxic alkaline drain

   to raise the pH and precipitate the contained metals. An anoxic alkaline drain is constructed by placing a high pH material in a trench between runoff and the stream to be used as a buffer (<u>Red River Groundwater Investigation</u>- NMED-SWQB-Nonpoint

Source Pollution Section, D. Slifer, 1996).

2. Wetlands are used to filter runoff water and sediment from source areas in the watershed. Metals may be bound up in the root systems of wetlands vegetation, preventing them from entering a waterway. (The Use of Wetlands for Improving Water Quality to Meet Established Standards, Filas and Wildeman, 1992.)

3. A method for reducing metals used in controlled situations includes the use of sulfate and sulfate reducing bacteria. The sulfate, (if not already present), and the sulfate reducing bacteria are applied into the water column. This provides a mechanism for some metals to precipitate out of solution. (A Treatment of Acid Mine Water Using Sulfate-Reducing Bacteria, Wakao, Saurai, and Shiota, 1979).

4. Stormwater and construction BMPs can be used to divert flows off metal-producing areas directing them away from streams into areas where the flows may infiltrate, evaporate, or accumulate in sediment retention basins. (Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use, Delaware Department of Natural Resources and Environmental Control, Sediment and Stormwater Program & the Environment Management Center, Brandywine Conservancy, 1997.

Additional sources of information for BMPs to address metals are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St. Francis Drive, Santa Fe, New Mexico.

Mining

Internet websites:

- http://www.epa.gov/region2/epd/98139.htm
- http:www.epa.gov/OSWRCRA/hazwast/ldr/mining/docs/hhed1196.pdf
- Caruso, B.S., and R. Ward, 1998, Assessment of Nonpoint Source Pollution from Inactive Mines Using a Watershed Based Approach, Environmental Management, vol.22, No.2, Springer-Verlag New York Inc. pp.225-243.
- Cohen, R.R.H., and S. W. Staub, 1992, Technical Manual for the Design and Operation of a Passive Mine Drainage Treatment System. U.S. Bureau of Land Management and U.S. Bureau of Reclamation, Denver, CO.
- Coleman, M.W., 1996, Anoxic Alkaline Treatment of Acidic, Metal-Loaded Seeps Entering the Red River, Taos Co., NM. Paper presented at New Mexico Governor's 1996

Conference on the Environment, Albuquerque.Convention Center, abstract in program. Published in New Mexico Environment Department-NonPoint Source newsletter "Clearing the Waters", v.3, No.1, summer, Santa Fe.

- Coleman, M.W., 1999, Geology-Based Analysis of Elevated Aluminum in the Jemez River, North-Central New Mexico. Unpublished Report to USEPA Region 6, New Mexico Total Maximum Daily Load (TMDL) Team, New Mexico Environment Department Surface Water Quality Bureau, Santa Fe, 2p.

- Coleman, M.W., 2000, Rio Puerco Watershed Mining Impacts. New Mexico Environment Department, Clean Water Act (CWA) Section 319(h) Grant Project Summary Report to USEPA Region 6 Dallas, New Mexico Environment Department Surface Water Quality Bureau Watershed Protection Section, Santa Fe.

- Eger, P., and K. Lapakko, 1988, Nickel and Copper Removal From Mine Drainage by a Natural Wetland. U.S. Bureau of Mines Circular 9183. pp.301-309.

- Filas, B., and T. Wildeman, 1992, The Use of Wetlands for Improving Water Quality to Meet Established Standards, Nevada Mining Association Annual Reclamation Conference, Sparks, Nevada.

- Girts, M.A., and R.L.P. Kleinmann, 1986, Constructed Wetlands for Treatment of Mine Water. American Institute of Mining Engineers Fall Meeting. St. Louis, Missouri.

- Holm, J.D., and T. Elmore, 1986, Passive Mine Drainage Treatment Using Artificial and Natural Wetlands. Proceedings of the High Altitude Revegetation Workshop, No. 7. pp. 41-48.

- Kleinmann, R.L.P., 1989, Acid Mine Drainage: U.S. Bureau of Mines, Research and Developments, Controlling Methods for Both Coal and Metal Mines. Engineering Mining Journal 190:16i-n.

- Machemer, S.D., 1992, Measurements and Modeling of the Chemical Processes in a Constructed Wetland Built to Treat Acid Mine Drainage. Colorado School of Mines Thesis T-4074, Golden, CO.

- Metish, J.J. and others, 1998, Treating Acid Mine Drainage From Abandoned Mines in Remote Areas. USDA Forest Service Technology and Development Program, AMD Study 7E72G71, Missoula, MT, US Govt. Printing Office: 1998-789-283/15001.

- Royer, M.D., and L. Smith, 1995, Contaminants and Remedial Options at Selected Metal-Contaminated Sites: Battelle Memorial Institute-Columbus Division, under contract # 68-CO-0003-WA41 to Natl. Risk Management Lab-Office of Research and Development, USEPA. EPA/540/R-95/512.

- Slifer, D.W., 1996, Red River Groundwater Investigation- New Mexico Environment Department Surface Water Quality Bureau Nonpoint Source Pollution Section; CWA Section 319 (h) Grant Project Final Report to USEPA Region 6 - Dallas.

- US EPA, 1996, Seminar Publication Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites, Office of Research and Development, EPA/625/R-95/007.

- Wakao, N., T. Takahashi, Y. Saurai, and H. Shiota. 1979. A Treatment of Acid Mine Water Using Sulfate-reducing Bacteria. Journal of Ferment. Technology 57(5):445-452.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives, State Soil Conservation Board.

- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.

- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).

- New Mexico State University, Revegetating Southwest Riparian Areas, College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).

- State of Pennsylvania Department of Environmental Resources, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners, Division of Scenic Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook, Nonpoint Source Water Pollution Management Program.

Stormwater/Urban

Internet website

- http://www.epa.gov/ordntrnt/ORD/WebPubs/nctuw/Pitt.pdf

- Brede, A.D., L.M. Cargill, D.P. Montgomery, and T.J. Samples, 1987, Roadside Development and Erosion Control. Oklahoma Department of Transportation, Report No. FHWA/OK 87 (5).

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts from Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program & the Environment Management Center, Brandywine Conservancy.

- Taylor, Scott, and G. Fred Lee, 2000, Stormwater Runoff Water Quality Science/ Engineering Newsletter, Urban Stormwater Runoff Water Quality Management Issues, Vol. 3, No. 2. May 19.

Miscellaneous

Internet website

- http://www.epa.gov/OWOW/NPS

- Constructed Wetlands Bibliography, www.nal.usda.gov/wqic/Constructed_Wetlands_all/index.html

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health, Surface Water Quality Bureau.

- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, D., 1996, Applied River Morphology; Chapter 8. Applications (Grazing, Fish Habitat).

- State of Tennessee Nonpoint Source Water Pollution Management Program, 1995, Riparian Restoration and Streamside Erosion Control Handbook.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices; Chapter 8 – Restoration Design; Chapter 9 – Restoration implementation, Monitoring, and Management.

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook

Section 23, Recreation Management

Section 25, Watershed Management

Section 41, Access and Transportation Systems and Facilities.

- US EPA, 1993, Guidance Specifying Management Measures For Sources of Nonpoint Pollution in Coastal Waters. Office of Water, Coastal Zone Act Reauthorization Amendments of 1990. EPA840-B-92-002

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Section F. Specifications.

- Unknown; Selecting BMPs and other Pollution Control Measures.

- Unknown; Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones
Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for metals include:

- increases in wetland areas to filter associated reductions in metals concentrations found in the stream.
- increases in stabilized streambanks and enhanced riparian areas to decrease erosion and potential loading of sediment associated with metals into a stream.
- monitoring within a time frame and continued public outreach effort to educate watershed stakeholders on measures to prevent further water quality exceedances.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information show that changes are warranted, TMDL revisions will be made with assistance of Jemez River Basin stakeholders. The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.

D. TOTAL ORGANIC CARBON

Introduction

Most organic carbon in water occurs as partly degraded plant and animal materials, some of which are resistant to microbial degradation. Biochemical Oxygen Demand (BOD or BOD5) is an indirect measure of biodegradable organic compounds in water. The BOD of wastewater is a common indicator of the fraction of organic matter that may be degraded by microbial action, in a given time period, at a temperature of 20 degrees Centigrade. The test is related to the oxygen that would be required to stabilize the quantity of organic material capable of being oxidized, after discharging to a receiving body of water.

TOC measurements have been used as a method for determining pollution levels of wastewater for many years. Total organic carbon consists of two fractions: dissolved organic carbon and particulate organic carbon. TOC provides an indications of the total organic material present. It is often used as an indicator (but not a measure) of the amount of waste available for biodegradation. TOC includes the carbon both from naturally occurring organic material and organic chemical contaminants. By using TOC measurements, the number of carbon-containing compounds in a source can be determined. This is important because knowing the amount of carbon in a freshwater stream is an indicator of the organic character of the stream (Federal Remediation Technology Roundtable, 1998).

The aquatic life guidelines (HQCWF standard) is expressed in terms of total TOC concentrations.

Changes in the concentrations of TOC, and its dissolved organic carbon fraction (DOC), can cause reductions in primary productivity, system metabolism, while increasing susceptibility to toxic metals and acidifications. Increases in organic carbon concentrations can increase bacterial metabolism to the point of causing anoxic conditions. This generates a by-product of over enrichment of a receiving water body.

The production of haloforms in drinking source water, as a result of the reaction between organic carbon compounds and hypochlorous acid (chlorine disinfection), is a serious drinking water quality issue. A study with drinking water supplies in the US has shown that the probability of exceeding the trihalomethane concentration of 100 micrograms/L, following chlorination, is minimal for the finished drinking water containing total organic carbon levels of less than or equal to 2 mg/L.

The recently issued Disinfectants and Disinfection By-Products Rule by the US Environmental Protection Agency specifies maximum total organic carbon levels of 2 mg/L in treated water and 4 mg/L in source water to ensure acceptable levels of disinfection byproducts.

Through source water treatment technology, a positive correlation has been shown, that t reduction in source water turbidity produces a reduction in TOC. Turbidity removal, along with the color of the water, are key features or raw surface waters that influence the application of coagulation in treating water for drinking water purposes. For example, the flocculent dose needed in treating source water for drinking, is strongly determined by the sum of the negative surface charges of inorganic particles (clay and loam), organic particles (algal cells) and naturally occurring dissolved macromolecular organics (all potential components of a TOC measurement). The reduction in turbidity, with coagulant dosing, contrasts changes in levels/concentrations or other parameters such as TOC/DOC, UV absorbance and color. (J. van Leeuwen, et al., 1998).

The State of New Mexico has not established a drinking water quality guideline for dissolved to total organic carbon. However, it has recommended guidelines for parameters that are related to dissolved and total organic carbon. Many drinking water quality issues associated with high levels of organic carbon may be addressed through total dissolved solids standards and turbidity (maximum acceptable concentration: 10 NTU) restrictions.

Wildlife can be directly or indirectly affected by changes in organic carbon levels in aquatic systems. Studies have also shown that total organic carbon is strongly correlated with water color. For instance, abundance of loons in aquatic environments in Canada, which require clear water to sight their prey, have been negatively correlated with TOC and DOC levels which render aquatic systems highly colored. Organic carbon forms complexes with some metals (e.g., cadmium, copper, etc.), thus reducing their availability and toxicity to aquatic organisms. Conversely, mercury availability, bioaccumulation in fish and hence toxicity tend to increase in the presence of organic carbon. Indirect effects arise because organic carbon plays an important role in the productivity of aquatic systems and response of the aquatic systems to factors such as acid inputs (Water Management Branch, Environmental and Resource Management, Ministry of Environment, Lands and Parks, Canada).

Appropriate considerations must be given to these aspects when the existing water quality is assessed in an aquatic environment. Effects of organic carbon content in the aquatic environment should be assessed together with actual production of trihalomethanes after chlorination in drinking water, metal concentrations and their bioavailability, and compliance with related water quality guidelines (e.g., THM, color, turbidity, etc, in drinking and ambient waters)(Water Management Branch, Environmental and Resource Management, Ministry of Environment, Lands and Parks, Canada).

Actions to be Taken

For the Jemez River Basin, one issue of primary focus will be control of TOC.

During the TMDL process in this watershed, point sources have been reviewed and will be addressed through the permit process. The nonpoint source contributions will need to address total organic carbon exceedences through BMP implementation.

There are a number of BMPs that can be utilized to address TOC, depending on the source. Such BMPs include:

1. Protection and/or development of healthy riparian buffer strips to serve as filers for soils and potential contaminants that are transported during surface runoff. This runoff could be the result of activities in the watershed that disturb soils or cause a loss of vegetative ground cover. The riparian vegetation also helps to stabilize riverbanks with root structure which prevents excessive bank erosion and helps maintain the stability and natural morphology of the stream system. (Stream Corridor Restoration – Principles, Processes and Practices, The Federal Interagency Stream Restoration Working Group, 1998);

2. Placement of silt fences between roads and watercourses to prevent soils and contaminants, that are disturbed during road and other construction activities, from being carried into watercourses. Silt fences act as a filter to trap sediment that is carried during runoff events. When maintained properly, these silt fences are an effective erosion control measure that can be used throughout the State. (Erosion and Sediment Control Manual, Environment Department, Surface Water Quality Bureau, 1993);

3. Placement of straw mulch on soils that have lost cover from vegetative groundcover during severe forest fires. The straw mulch helps prevent erosion during rainstorms and snowmelt by holding the bare topsoil and ash in place. The mulch can also aid in the infiltration of water and replace ground litter. This method works well on gentle slopes where there is not wind. (Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Interagency Baer Team, 2000).

Additional sources of information for possible BMPs to address TOC, as resulting from organic carbon contributions, are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St. Francis Drive, Santa Fe, New Mexico.

Agriculture

Internet websites:

http://www.nm.nrcs.usda.gov/

- Bureau of Land Management, 1990, Cows, Creeks, and Cooperation: Three Colorado Success Stories. Colorado State Office.
- Cotton, Scott E. and Ann Cotton, Wyoming CRM: Enhancing our Environment.
- Goodloe, Sid and Susan Alexander, Watershed Restoration through Integrated Resource Management on Public and Private Rangelands.
- Grazing in New Mexico and the Rio Puerco Valley Bibliography.
- USEPA and The Northwest Resource Information Center, Inc., 1990, Livestock Grazing on Western Riparian Areas.
- USEPA and The Northwest Resource Information Center, Inc., 1993, Managing Change: Livestock Grazing on Western Riparian Areas.

Forestry

- New Mexico Natural Resources Department, 1983, Water Quality Protection Guidelines for Forestry Operations in New Mexico.
- New Mexico Department of Natural Resources, 1980, New Mexico Forest Practice Guidelines. Forestry Division, Timber Management Section
- State of Alabama. 1993. Alabama's Best Management Practices for Forestry.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives. State Soil Conservation Board.

- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.

- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).

- New Mexico State University, Revegetating Southwest Riparian Areas, College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).

- State of Pennsylvania, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners. Department of Environmental Resources, Division of Scenic Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program.

Roads

- Becker, Burton C. and Thomas Mills, 1972, Guidelines for Erosion and Sediment Control Planning and Implementation, Maryland Department of Water Resources, # R2-72-015.

- Bennett, Francis William, and Roy Donahue, 1975, Methods of Quickly Vegetating Soils of Low Productivity, Construction Activities, US EPA, Office of Water Planning and Standards Report # 440/9-75-006.

- Hopkins, Homer T. and others, Processes, Procedures, and Methods to control Pollution Resulting from all Construction Activity,.US EPA Office of Air and Water Programs, EPA Report 430/9-73-007.

- New Mexico Natural Resources Department, 1983, Reducing Erosion from Unpaved Rural Roads in New Mexico, A Guide to Road construction and Maintenance Practices. Soil and Water Conservation Division

- New Mexico State Highway and Transportation Department and USDA-Soil Conservation Service, Roadside Vegetation Management Handbook.

- New Mexico Environment Department, 1993, Erosion and Sediment Control Manual. Surface Water Quality Bureau.
- USDA Forest Service Southwestern Region, 1996, Managing Roads for Wet Meadow Ecosystem Recovery. FHWA-FLP-96-016.

Section V. New Construction and Reconstruction

Section VI. Remedial Treatments

Section VII. Maintenance

- USEPA, 1992, Rural Roads: Pollution Prevention and Control Measures (handout).

Storm Water

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts From Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program and The Environment Management Center, Brandywine Conservancy.

- State of Kentucky, 1994, Kentucky Best Management Practices for Construction Activity. Division of Conservation and Division of Water.

- USEPA, 1992, Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices, Summary Guidance, EPA 833-R-92-001, pgs. 7- 9.

Miscellaneous

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Section F. Specifications.

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health. Surface Water Quality Bureau.
- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, David, 1996, Applied River Morphology, Chapter 8. Applications (Grazing, Fish Habitat).

- Rosgen, David, 1997, A Geomorphological Approach to Restoration of Incised Rivers.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices.

Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook.

Section 22, Range Management

Section 23, Recreation Management

Section 24, Timber Management

Section 25, Watershed Management

Section 26, Wildlife and Fisheries Management

Section 41, Access and Transportation Systems and Facilities

- Unknown, Selecting BMPs and other Pollution Control Measures.
- Unknown, Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For these TMDLs, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for TOC include a decrease in total organic carbon measurements, erosion from streambanks, an increase in established riparian vegetation, or an increase in the miles of properly maintained roads.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information show that changes are warranted, TMDL revisions will be made with assistance of watershed stakeholders. The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.

E. TURBIDITY

Introduction

Turbidity is a measurement of the reduction of the penetration of light through natural waters and is caused by the presence of suspended particles. Turbidity is a qualitative measure of water clarity or opacity and is reported in Nephelometric turbidity units (NTU).

The turbidity standard addresses excessive sedimentation, which can lead to the formation of bottom deposits that can impact the aquatic ecosystem. Suspended solids such as clay, silt, ash, plankton, and organic materials generally cause turbidity. Some level of turbidity is a function of a stream's natural process of moving water and sediment.

Examples of sources that can cause excessive turbidity include:

- Runoff from exposed soil (such as construction sites),
- Improperly maintained roads,
- Eroded streambanks,
- Activities that occur within a stream channel (such as runoff events),
- Removal of riparian vegetation, and
- In some cases, naturally occurring situations such as runoff events.

Actions to be Taken

A combination of best management practices (BMPs) will be used to implement this TMDL. For this watershed the focus will be on sediment control. BMPs in this area will include proper road maintenance practices and drainage controls, improved grazing management practices, relocation of established recreation sites away from riparian areas, the development of defined roads, parking, and camping areas to discourage uncontrolled dispersed camping and the creation of new roads, riparian plantings, and hydrogeomorphic river restoration. The SWQB will work with the New Mexico State Highway and Transportation Department (NMSHD), the USDA Forest Service (FS), Jemez Pueblo, and private landowners in implementing these BMPs throughout the watershed.

Presently, the FS is addressing several sources of NPS pollution that originate on properties managed by the FS in this watershed. Such activities and proposals include: timber thinning and prescribed fire to prevent catastrophic wildfires and to improve groundcover and watershed conditions, improved grazing management, road closures, relocation of roads out of riparian areas, improvements to existing recreation sites to protect riparian areas, and fencing of riparian areas to exclude livestock and vehicles. The SWQB will continue coordination with the FS in implementing BMPs in this watershed.

Stakeholder and public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholder participation will include choosing and installing BMPs, as well as potential volunteer monitoring. Stakeholders in this process will include: SWQB, FS, NMSHD, local government, private landowners, tribes, environmental groups, and the general public.

Additional sources of information for BMPs to address turbidity are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St. Francis Drive, Santa Fe, New Mexico.

Agriculture

Internet websites:
http://www.nm.nrcs.usda.gov/

- Bureau of Land Management, 1990, Cows, Creeks, and Cooperation: Three Colorado Success Stories. Colorado State Office.
- Cotton, Scott E. and Ann Cotton, Wyoming CRM: Enhancing our Environment.
- Goodloe, Sid and Susan Alexander, Watershed Restoration through Integrated Resource Management on Public and Private Rangelands.
- Grazing in New Mexico and the Rio Puerco Valley Bibliography.
- USEPA and The Northwest Resource Information Center, Inc., 1990, Livestock Grazing on Western Riparian Areas.
- USEPA and The Northwest Resource Information Center, Inc., 1993, Managing Change: Livestock Grazing on Western Riparian Areas.

Forestry

- New Mexico Natural Resources Department, 1983, Water Quality Protection Guidelines for Forestry Operations in New Mexico.
- New Mexico Department of Natural Resources, 1980, New Mexico Forest Practice Guidelines. Forestry Division, Timber Management Section
- State of Alabama. 1993. Alabama's Best Management Practices for Forestry.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives. State Soil Conservation Board.
- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.
- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).
- New Mexico State University, Revegetating Southwest Riparian Areas, College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).
- State of Pennsylvania, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners. Department of Environmental Resources, Division of Scenic Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program.

Roads

- Becker, Burton C. and Thomas Mills, 1972, Guidelines for Erosion and Sediment Control Planning and Implementation, Maryland Department of Water Resources, # R2-72-015.

- Bennett, Francis William, and Roy Donahue, 1975, Methods of Quickly Vegetating Soils of Low Productivity, Construction Activities, US EPA, Office of Water Planning and Standards Report # 440/9-75-006.

- Hopkins, Homer T. and others, Processes, Procedures, and Methods to control Pollution Resulting from all Construction Activity,.US EPA Office of Air and Water Programs, EPA Report 430/9-73-007.

- New Mexico Natural Resources Department, 1983, Reducing Erosion from Unpaved Rural Roads in New Mexico, A Guide to Road construction and Maintenance Practices. Soil and Water Conservation Division

- New Mexico State Highway and Transportation Department and USDA-Soil Conservation Service, Roadside Vegetation Management Handbook.

- New Mexico Environment Department, 1993, Erosion and Sediment Control Manual. Surface Water Quality Bureau.

- USDA Forest Service Southwestern Region, 1996, Managing Roads for Wet Meadow Ecosystem Recovery. FHWA-FLP-96-016.

Section V. New Construction and Reconstruction

Section VI. Remedial Treatments

Section VII. Maintenance

- USEPA, 1992, Rural Roads: Pollution Prevention and Control Measures (handout).

Storm Water

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce

Stormwater Impacts From Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program and The Environment Management Center, Brandywine Conservancy.

- State of Kentucky, 1994, Kentucky Best Management Practices for Construction Activity. Division of Conservation and Division of Water.

- USEPA, 1992, Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices, Summary Guidance, EPA 833-R-92-001, pgs. 7- 9.

Miscellaneous

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Section F. Specifications.

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health. Surface Water Quality Bureau.

- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, David, 1996, Applied River Morphology, Chapter 8. Applications (Grazing, Fish Habitat).

- Rosgen, David, 1997, A Geomorphological Approach to Restoration of Incised Rivers.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices.

Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook.

Section 22, Range Management

Section 23, Recreation Management

Section 24, Timber Management

Section 25, Watershed Management

Section 26, Wildlife and Fisheries Management

Section 41, Access and Transportation Systems and Facilities

- Unknown, Selecting BMPs and other Pollution Control Measures.

- Unknown, Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For these TMDLs, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for turbidity include a decrease in total organic carbon measurements, erosion from streambanks, an increase in established riparian vegetation, or an increase in the miles of properly maintained roads.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information show that changes are warranted, TMDL revisions will be made with assistance of watershed stakeholders. The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.

F. STREAM BOTTOM DEPOSITS

Introduction

Stream bottom deposits in rivers are the result of excessive sediment carried either from erosion from the watershed or from eroding riverbanks. Clean stream bottom substrates are essential for optimum habitat for many fish and aquatic insect communities. Excessive sediment deposits can negatively affect aquatic life. Bottom deposits can smother eggs, choke spawning habitats, and alter invertebrate species composition. Macroinvertebrates can be affected by habitat reduction, and changes resulting in increased drift, and decreased respiration.

The following are examples of sources of sedimentation that result in stream bottom deposits:

- runoff from construction activities within floodplain and riparian areas,
- poorly constructed or maintained roads especially those located in riparian areas,

- road and trail river crossings that act as direct conduits of sediment into the river,
- removal of riparian vegetation,
- recreation areas located alongside rivers, and
- runoff from agricultural activities

Actions to be Taken

For the Jemez River Basin, one of the issues for primary focus will be control of stream bottom deposits.

During the TMDL process in this watershed, point sources have been reviewed and will be addressed through the permit process. The nonpoint source contributions will need to address stream bottom deposits through BMP implementation.

There are a number of BMPs that can be utilized to address stream bottom deposits, depending on the source of the sediment. Such BMPs include:

1. Closure of sensitive areas such as riparian areas to Off Road Vehicle (ORV) use. Vehicles in riparian areas can tear up protective ground cover and expose soils to erosion. Ruts from vehicles also channelize the flow of water causing gully formation and increased erosion and sedimentation into the adjacent river. (Soil and Water Conservation Practices Handbook, USDA Forest Service, Southwestern Region.).

2. Construction of roads away from watercourses and assurance of an adequate buffer strip of vegetation between roads and watercourses. Buffer strips are an easy and effective BMP for water quality protection. In addition to the benefits of riparian areas for shading and bank stabilization, sufficiently wide buffers act as filters to prevent sediment from reaching watercourses during runoff events. (Water Quality Protection Guidelines for Forestry Operations in New Mexico, 1983, New Mexico Natural Resources Department, Forestry Division, 1983).

3. Removal of Pinon and Juniper overgrowth in watersheds allows for the regeneration of a healthy groundcover of grasses. Without these healthy grasslands to provide a surface for water to infiltrate, watersheds can contribute large amounts of sediment that is washed from the land surface or scoured from eroding gullies into the rivers that drain the watercourses (Watershed Restoration Through Integrated Resource Management on Public and Private Rangelands, Goodloe, Sid. and Alexander, Susan).

Additional sources of information for possible BMPs to address stream bottom deposits are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St Francis Drive, Santa Fe, New Mexico.

Agriculture

Internet websites:

http://www.nm.nrcs.usda.gov

- Bureau of Land Management, 1990, Cows, Creeks, and Cooperation: Three Colorado Success Stories. Colorado State Office.

- Cotton, Scott E. and Ann Cotton, Wyoming CRM: Enhancing our Environment.

- Goodloe, Sid and Susan Alexander, Watershed Restoration through Integrated Resource Management on Public and Private Rangelands.

- Grazing in New Mexico and the Rio Puerco Valley Bibliography.

- USEPA and The Northwest Resource Information Center, Inc., 1990, Livestock Grazing on Western Riparian Areas.

- USEPA and The Northwest Resource Information Center, Inc., 1993, Managing Change: Livestock Grazing on Western Riparian Areas.

Forestry

- New Mexico Natural Resources Department, 1983, Water Quality Protection Guidelines for Forestry Operations in New Mexico.

- New Mexico Department of Natural Resources, 1980, New Mexico Forest Practice Guidelines. Forestry Division, Timber Management Section

- State of Alabama. 1993. Alabama's Best Management Practices for Forestry.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives. State Soil Conservation Board.

- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.

- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).

- New Mexico State University, Revegetating Southwest Riparian Areas, College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).

- State of Pennsylvania, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners. Department of Environmental Resources, Division of Scenic Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program.

Roads

- Becker, Burton C. and Thomas Mills, 1972, Guidelines for Erosion and Sediment Control Planning and Implementation, Maryland Department of Water Resources, # R2-72-015.

- Bennett, Francis William, and Roy Donahue, 1975, Methods of Quickly Vegetating Soils of Low Productivity, Construction Activities, US EPA, Office of Water Planning and Standards Report # 440/9-75-006.

- Hopkins, Homer T. and others, Processes, Procedures, and Methods to control Pollution Resulting from all Construction Activity,.US EPA Office of Air and Water Programs, EPA Report 430/9-73-007.

- New Mexico Natural Resources Department, 1983, Reducing Erosion from Unpaved Rural Roads in New Mexico, A Guide to Road construction and Maintenance Practices. Soil and Water Conservation Division

- New Mexico State Highway and Transportation Department and USDA-Soil Conservation Service, Roadside Vegetation Management Handbook.

- New Mexico Environment Department, 1993, Erosion and Sediment Control Manual. Surface Water Quality Bureau.

- USDA Forest Service Southwestern Region, 1996, Managing Roads for Wet Meadow Ecosystem Recovery. FHWA-FLP-96-016.

Section V. New Construction and Reconstruction

Section VI. Remedial Treatments

Section VII. Maintenance

- USEPA, 1992, Rural Roads: Pollution Prevention and Control Measures (handout).

Stormwater

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce Stormwater Impacts From Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program and The Environment Management Center, Brandywine Conservancy.

- State of Kentucky, 1994, Kentucky Best Management Practices for Construction Activity. Division of Conservation and Division of Water.

- USEPA, 1992, Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices, Summary Guidance, EPA 833-R-92-001, pgs. 7- 9.

Miscellaneous

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Section F. Specifications.

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health. Surface Water Quality Bureau.

- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, David, 1996, Applied River Morphology, Chapter 8. Applications (Grazing, Fish Habitat).

- Rosgen, David, 1997, A Geomorphological Approach to Restoration of Incised Rivers.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices.

Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook.

Section 22, Range Management

Section 23, Recreation Management

Section 24, Timber Management

Section 25, Watershed Management

Section 26, Wildlife and Fisheries Management

Section 41, Access and Transportation Systems and Facilities

- Unknown, Selecting BMPs and other Pollution Control Measures.

- Unknown, Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones
Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for stream bottom deposits include:

- a measured decrease in the percent of the bed surface covered by fines,
- a decrease in cobble embeddedness,
- removal of a poorly constructed dirt road from a riparian area,
- successful riparian plantings in a given reach of river.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information shows that changes are warranted, TMDL revisions will be made with assistance of watershed stakeholders. The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.

G. TEMPERATURE

Introduction

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms that affect fish. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. Anthropogenic impacts can lead to modifications of these natural temperature cycles, often leading to deleterious impacts on the fishery.

The following are examples of sources that can cause temperature exceedances:

- Lack of shading caused by removal of riparian vegetation,
- Streambank destabilization,

- Reduced base flows caused by such activities as removal of riparian vegetation and manipulation of flows by dams,
- Excessive turbidity,
- Alterations in stream geomorphology. This can occur when the natural scouring process leads to degradation, or excessive sediment deposition results in aggradation. Both of these processes can lead to a high width/depth ratio (wider, shallower streams)

<u>Actions to be Taken</u>
For the Jemez River Basin, one issue of primary focus will be control of temperature.

During the TMDL process in this watershed, point sources have been reviewed and will be addressed through the permit process. The nonpoint source contributions will need to address temperature exceedances through BMP implementation.

There are a number of BMPs that can be utilized to address temperature, depending on the source of the problem. Such BMPs include:

1. The planting of woody riparian species applicable to the affected area provides canopy cover and shading for temperature control and helps prevent streambank destabilization. The woody vegetation provides structure to the bank and reduces stream velocities thereby preventing excessive streambank erosion. (A Streambank Stabilization and Management Guide for Pennsylvania Landowners, State of Pennsylvania, 1986);

2. River restoration involving such actions as reconfiguration of the river's sinuosity, installation of root wads to stabilize cut banks, and riparian plantings aid in halting bank erosion and the processes of degradation and aggradation and facilitate the return of the river to a natural and stable morphology which incorporates a lower width to depth ratio. This lowered ratio means that the stream has become narrower and deeper. Thus, the stream can maintain cooler temperatures with the increased channel depth and reduced water surface exposed to solar radiation. (A Geomorphological Approach to Restoration of Incised Rivers, Rosgen, David, 1997);

3. The relocation of recreation sites out of riparian areas as well as the closure and rehabilitation of former recreation sites located in riparian areas will help restore riparian vegetation for shading and will eliminate a source of sediment, (Stream Corridor Restoration – Principles, Processes, and Practices, The Federal Interagency Stream Restoration Working Group, 1998).

Additional sources of information for possible BMPs to address temperature are listed below. Some of these documents are available for viewing at the New Mexico Environment Department, Surface Water Quality Bureau, Watershed Protection Section Library, 1190 St Francis Drive, Santa Fe, New Mexico.

Agriculture

Internet websites:

http://www.nm.nrcs.usda.gov

- Bureau of Land Management, 1990, Cows, Creeks, and Cooperation: Three Colorado Success Stories. Colorado State Office.

- Cotton, Scott E. and Ann Cotton, Wyoming CRM: Enhancing our Environment.

- Goodloe, Sid and Susan Alexander, Watershed Restoration through Integrated Resource Management on Public and Private Rangelands.

- Grazing in New Mexico and the Rio Puerco Valley Bibliography.

- USEPA and The Northwest Resource Information Center, Inc., 1990, Livestock Grazing on Western Riparian Areas.

- USEPA and The Northwest Resource Information Center, Inc., 1993, Managing Change: Livestock Grazing on Western Riparian Areas.

Forestry

- New Mexico Natural Resources Department, 1983, Water Quality Protection Guidelines for Forestry Operations in New Mexico.

- New Mexico Department of Natural Resources, 1980, New Mexico Forest Practice Guidelines. Forestry Division, Timber Management Section

- State of Alabama. 1993. Alabama's Best Management Practices for Forestry.

Riparian and Streambank Stabilization

- Colorado Department of Natural Resources, Streambank Protection Alternatives. State Soil Conservation Board.

- Meyer, Mary Elizabeth, 1989, A Low Cost Brush Deflection System for Bank Stabilization and Revegetation.

- Missouri Department of Conservation, Restoring Stream Banks With Willows, (pamphlet).

- New Mexico State University, Revegetating Southwest Riparian Areas, College of Agriculture and Home Economics, Cooperative Extension Service, (pamphlet).

- State of Pennsylvania, 1986, A Streambank Stabilization And Management Guide for Pennsylvania Landowners. Department of Environmental Resources, Division of Scenic Rivers.

- State of Tennessee, 1995, Riparian Restoration and Streamside Erosion Control Handbook. Nonpoint Source Water Pollution Management Program.

Roads

- Becker, Burton C. and Thomas Mills, 1972, Guidelines for Erosion and Sediment Control Planning and Implementation, Maryland Department of Water Resources, # R2-72-015.

- Bennett, Francis William, and Roy Donahue, 1975, Methods of Quickly Vegetating Soils of Low Productivity, Construction Activities, US EPA, Office of Water Planning and Standards Report # 440/9-75-006.

- Hopkins, Homer T. and others, Processes, Procedures, and Methods to control Pollution Resulting from all Construction Activity,.US EPA Office of Air and Water Programs, EPA Report 430/9-73-007.

- New Mexico Natural Resources Department, 1983, Reducing Erosion from Unpaved Rural Roads in New Mexico, A Guide to Road construction and Maintenance Practices. Soil and Water Conservation Division

- New Mexico State Highway and Transportation Department and USDA-Soil Conservation Service, Roadside Vegetation Management Handbook.

- New Mexico Environment Department, 1993, Erosion and Sediment Control Manual. Surface Water Quality Bureau.

- USDA Forest Service Southwestern Region, 1996, Managing Roads for Wet Meadow Ecosystem Recovery. FHWA-FLP-96-016.

Section V. New Construction and Reconstruction

Section VI. Remedial Treatments

Section VII. Maintenance

- USEPA, 1992, Rural Roads: Pollution Prevention and Control Measures (handout).

Stormwater

- Delaware Department of Natural Resources and Environmental Control, 1997, Conservation Design for Stormwater Management: A Design Approach to Reduce

Stormwater Impacts From Land Development and Achieve Multiple Objectives Related to Land Use. Sediment and Stormwater Program and The Environment Management Center, Brandywine Conservancy.

- State of Kentucky, 1994, Kentucky Best Management Practices for Construction Activity. Division of Conservation and Division of Water.

- USEPA, 1992, Storm Water Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices, Summary Guidance, EPA 833-R-92-001, pgs. 7- 9.

Miscellaneous

- Interagency Baer Team, 2000, Cerro Grande Fire Burned Area Emergency Rehabilitation (BAER) Plan, Section F. Specifications.

- New Mexico Environment Department, 2000, A Guide to Successful Watershed Health. Surface Water Quality Bureau.

- Roley, William Jr., Watershed Management and Sediment Control for Ecological Restoration.

- Rosgen, David, 1996, Applied River Morphology, Chapter 8. Applications (Grazing, Fish Habitat).

- Rosgen, David, 1997, A Geomorphological Approach to Restoration of Incised Rivers.

- The Federal Interagency Stream Restoration Working Group, 1998, Stream Corridor Restoration. Principles, Processes, and Practices.
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Chapter 8 – Restoration Design

Chapter 9 – Restoration implementation, Monitoring, and Management

- USDA Forest Service Southwestern Region, Soil and Water Conservation Practices Handbook.

Section 22, Range Management

Section 23, Recreation Management

Section 24, Timber Management

Section 25, Watershed Management

Section 26, Wildlife and Fisheries Management

Section 41, Access and Transportation Systems and Facilities

- Unknown, Selecting BMPs and other Pollution Control Measures.

- Unknown, Environmental Management. Best Management Practices.

Construction Sites

Developed Areas

Sand and Gravel Pits

Farms, Golf Courses, and Lawns

Milestones

Milestones will be used to determine if control actions are being implemented and standards attained. For this TMDL, several milestones will be established which will vary and will be determined by the BMPs implemented. Examples of milestones for temperature control include:

- percent success of riparian plantings,
- an increase in the percentage of stream canopy cover,
- a decrease in the width to depth ratio of the stream.

Milestones will be coordinated by SWQB staff and will be re-evaluated periodically, depending on which BMPs were implemented. Further implementation of this TMDL will be revised based on this reevaluation. As additional information becomes available during the implementation of the TMDL, the targets, load capacity, and allocations may need to be changed. In the event that new data or information shows that changes are warranted, TMDL revisions will be made with assistance of watershed stakeholders.

The re-examination process will involve: monitoring pollutant loading, tracking implementation and effectiveness of controls, assessing water quality trends in the waterbody, and re-evaluating the TMDL for attainment of water quality standards. Although specific targets and allocations are identified in the TMDL, the ultimate success of the TMDL is not whether these targets and allocations are met, but whether beneficial uses and water quality standards are achieved.