Acknowledgements

Arizona NEMO acknowledges the University of Arizona Cooperative Extension Service, Arizona Department of Environmental Quality (ADEQ) Water Quality Division, the Water Resources Research Center, and the University of Arizona Advanced Resource Technology Lab (ART) for their technical support in producing the Watershed Based Plans.

Funding provided by the U.S. Environmental Protection Agency under the Clean Water Act and the Arizona Department of Environmental Quality’s Water Quality Protection Division. Additional financial support is provided by the University of Arizona, Technology and Research Initiative Fund (TRIF), Water Sustainability Program through the Water Resources Research Center.

The NEMO website is www.ArizonaNEMO.org.

Written and prepared by:
Hoori Ajami, D. Phillip Guertin, Lainie R. Levick and Kristine Uhlman
University of Arizona
Tucson, Arizona
December 2005
Upper Gila Watershed
Table of Contents

Section 1: Introduction
  Background
  Purpose and Scope
  Methods
  Structure of this Report
  References

Section 2: Physical Features
  Watershed Size
  Topography
  Water Resources
    Lakes and Reservoirs
    Stream Type
    Stream Density
    Annual Stream Flow
    Water Quality
  Geology
  Soils
  Climate
    Precipitation
    Temperature
  References
  Data Sources

Section 3: Biological Resources
  Ecoregions
  Vegetation
  Habitats (Riparian and Wetland Areas)
  Major Land Resource Areas (MLRAs)
  References
  Data Sources

Section 4: Social / Economic Characteristics
  County Governments
  Council of Governments (COGs)
  Urban Areas
  Roads
  Population
    Census Population Densities in 1990
    Census Population Densities in 2000
    Population Change
  Mines
  Land Cover
Section 5: Important Resources
Upper Gila River NRA
Upper Gila River NRA Protection Needs
Animas Valley NRA
Animas Valley NRA Protection Needs
Happy Camp NRA
Happy Camp NRA Protection Needs
Cave Creek NRA
Cave Creek NRA Protection Needs
Centerfire Creek NRA
Centerfire Creek NRA Protection Needs
Upper Blue River NRA
Upper Blue River NRA Protection Needs
Cottonwood NRA
Cottonwood NRA Protection Needs
Chase Creek NRA
Chase Creek NRA Protection Needs
Mule Creek NRA
Mule Creek NRA Protection Needs

Section 6: Watershed Classification
Methods
Fuzzy Logic
Subwatershed Classifications
Water Quality Assessment Data
Metals
Water Quality Assessment Data - Metals
Location of Mining Activities
Potential Contribution of Mines to Sediment Yield
Metals Results
Sediment
Water Quality Assessment Data - Sediment
Landownership
Human Use Index – Sediment Load
Runoff
Erosion
Sediment Results
Organics
  Water Quality Assessment Data – Organic
  Human Use Index - Organics
  Land Use - Organics
  Nutrients
  pH
  Selenium
  Organics Results
Selenium
  Water Quality Assessment Data – Selenium
  Agricultural Lands
  Selenium Results
References
Data Sources

Section 7: Watershed Management
  Management Methods
    Site Management on New Development
    Monitoring and Enforcement Activities
    Water Quality Improvement and Restoration Projects
    Education
  Strategy for Addressing Existing Impairment
  Metals
    Inventory of Existing Abandoned Mines
    Revegetation
    Erosion Control
    Runoff and Sediment Capture
    Removal
    Education
  Sediment
    Grazing Management
    Filter Strips
    Fencing
    Watering Facilities
    Rock Riprap
    Erosion Control Fabric
    Toe Rock
    Water Bars
    Erosion Control on Dirt Roads
    Channel and Riparian Restoration
    Education
  Organics
    Filter Strips
    Fencing
    Watering Facilities
    Septic System Repair
Education
Selenium
Education
Luna Lake TMDL Implementation Plan
Strategy for Channel and Riparian Protection and Restoration
Education Programs
Education Needs
References
Data Sources

Section 8: Local Watershed Planning
Potential Water Quality Improvement Projects
Chase Creek – San Francisco River Subwatershed Example Project
Yuma Wash – Upper Gila River Subwatershed Example Project
Tule Wells Draw – San Simon River Subwatershed Example Project

Technical and Financial Assistance
Education and Outreach
Implementation Schedules & Milestones
Evaluation
Monitoring
References

List of Figures

1-1: Upper Gila Watershed Location Map.
1-2: Transformation of Input Data via a GIS, Fuzzy Logic Approach, and Synthesis of Results into a Watershed Classification.

2-1: Upper Gila Watershed.
2-2: Upper Gila Watershed HUCs.
2-3: Upper Gila Watershed Topography.
2-4: Upper Gila Watershed Slope Classes.
2-5: Upper Gila Watershed Major Lakes and Streams.
2-6: Upper Gila Watershed Stream Types.
2-7: Upper Gila Watershed Stream Density.
2-8: Upper Gila Watershed USGS Gages.
2-9: USGS Gage 09468500 (San Carlos River Near Peridot, AZ) Hydrograph.
2-10: USGS Gage 09448500 (Gila River at Head of Safford Valley, Near Solomon) Hydrograph.
2-11: USGS Gage 09444500 (San Francisco River at Clifton) Hydrograph.
2-12: USGS Gage 09448500 (Gila River at Head of Safford Valley, Near Solomon) Five Year Annual Moving Average Stream Flow (cfs).
2-14: Upper Gila Watershed Geology.
2-16: Upper Gila Watershed Soil Erodibility Factor.
2-17: Upper Gila Watershed Average Annual Precipitation (inches/year).
2-19: Upper Gila Watershed Annual Average Temperature (°F).

3-1: Upper Gila Watershed Ecoregions – Divisions.
3-2: Upper Gila Watershed Ecoregions – Provinces.
3-3: Upper Gila Watershed Ecoregions – Sections.
3-4: Upper Gila Watershed - Brown, Lowe and Pace Vegetation.
3-5: Upper Gila Watershed GAP Vegetation.
3-6: Upper Gila Watershed Riparian and Wetland Areas.
3-7: Upper Gila Watershed Major Land Resources Areas.

4-1: Upper Gila Watershed Counties.
4-2: Upper Gila Watershed Council of Governments.
4-3: Upper Gila Watershed Administrative Boundaries.
4-4: Upper Gila Watershed Urban Areas (Census Bureau Classification).
4-5: Upper Gila Watershed Urban Areas (1,000 persons/square mile).
4-6: Upper Gila Watershed Urban Areas Comparison of Two Approaches.
4-7: Upper Gila Watershed Road Types.
4-11: Upper Gila Watershed Mine Types.
4-12: Upper Gila Watershed Mines - Status.
4-13: Upper Gila Watershed Mines - Primary Ore.
4-14: Upper Gila Watershed Land Cover.
4-15: Upper Gila Watershed Land Ownership.
4-16: Upper Gila Watershed Preserve Areas.
4-17: Upper Gila Watershed Wilderness Areas.
4-18: Upper Gila Watershed Golf Courses.

5-1: Natural Resource Areas in the Upper Gila Watershed.

6-1: Transformation of Input Data via a GIS, Fuzzy Logic Approach, and Synthesis of Results into a Watershed Classification.
6-2: Results for the Fuzzy Logic Classification for Metals, Based on the Weighted Combination Approach.
6-3: Results for the Fuzzy Logic Classification for Sediment, Based on the Weighted Combination Approach.
6-4: Results for the Fuzzy Logic Classification for Organics, Based on the Weighted Combination Approach.
6-5: Results for the Fuzzy Logic Classification for Selenium, Based on the Weighted Combination Approach.
6-6: Results for the Fuzzy Logic Classification for Selenium, Based on the Weighted Combination Approach, Showing the Distribution of Agricultural Lands in each 10-digit HUC Subwatershed.

7-1: Upper Gila Watershed Land Ownership by Subwatershed.
7-2: Upper Gila Watershed Major Streams with HUC-10 Boundaries.

List of Tables

2-1: Upper Gila Watershed HUCs and Subwatershed Areas in Arizona.
2-2: Upper Gila Watershed Elevation Range (feet above mean sea level).
2-3: Upper Gila Watershed Slope Classes.
2-4: Upper Gila Watershed Lakes and Reservoirs.
2-5: Upper Gila Watershed Stream Type and Length.
2-6: Upper Gila Watershed Major Stream Lengths.
2-7: Upper Gila Watershed Stream Density.
2-8: Upper Gila Watershed USGS Gages.
2-9: Upper Gila Watershed Geology (percent by subwatershed).
2-10: Upper Gila Watershed – Rock Type (percent by subwatershed).
2-12: Upper Gila Watershed Soil Erodibility Factor.
2-13: Upper Gila Watershed Average Annual Precipitation (inches/year).
2-14: Summary of Temperature Data for Eight Temperature Gages in the Upper Gila Watershed.
2-15: Upper Gila Watershed Temperature.

3-1: Upper Gila Watershed Ecoregions – Divisions.
3-2: Upper Gila Watershed Ecoregions – Provinces.
3-3: Upper Gila Watershed Ecoregions – Sections.
3-4: Upper Gila Watershed - Brown, Lowe and Pace Biotic Communities.
3-5: Upper Gila Watershed - Gap Vegetation.
3-6: Upper Gila Watershed Riparian and Wetland Areas (acres).
3-7: Upper Gila Watershed Major Land Resource Areas.

4-1: Upper Gila Watershed Counties.
4-2: Upper Gila Watershed Council of Governments.
4-3: Upper Gila Watershed Urbanized Areas.
4-4: Upper Gila Watershed Urban Areas Based on Population Density Data.
4-5: Upper Gila Watershed Road Types.
4-6: Upper Gila Watershed Road Lengths by Subwatershed.
4-10: Upper Gila Watershed Mine Types.
4-11: Upper Gila Watershed Mines - Status.
4-12: Upper Gila Watershed Mines - Ore.
4-13: Upper Gila Watershed Land Cover.
4-14: Upper Gila Watershed Land Ownership.
4-15: Upper Gila Watershed Preserve Areas.
4-16: Upper Gila Watershed Wilderness Areas (acres).

6-1: HUC 10-Digit Numerical Designation and Subwatershed Name.
6-2: Fuzzy Membership Values (FMV) for HUC-10 Subwatersheds Based on ADEQ Water Quality Assessment Results.
6-3: Fuzzy Membership Values (FMV) Assigned to each 10-digit HUC Subwatershed in the Upper Gila Watershed, Based on Water Quality Assessment Results for Metals.
6-4: FMV for each Subwatershed Based on the Number and Location of Mines.
6-5: FMV Per Erosion Category.
6-6: Summary Results for Metals, Based on the Fuzzy Logic Approach – Weighted Combination Approach.
6-7: Fuzzy Membership Values for Sediment Assigned to each 10-digit HUC Subwatershed, Based on Water Quality Assessment Results.
6-8: Fuzzy Membership Values Based on Land Ownership.
6-9: Fuzzy Membership Values Based on the Human Use Index.
6-10: Fuzzy Membership Values and Runoff Categories.
6-11: Fuzzy Membership Values and Erosion Categories.
6-12: Summary Results for Sediment, Based on the Fuzzy Logic Approach – Weighted Combination Approach.
6-13: Fuzzy Membership Values Assigned to each 10-digit HUC Subwatershed - Based on Water Quality Assessment Results for Organics.
6-14: Fuzzy Membership Values for Organics, Based on the Human Use Index.
6-15: Summary Results for Organics, Based on Weighted Combination Approach.
6-16: Fuzzy Membership Values for Selenium Assigned to each Subwatershed, Based on Water Quality Assessment Results.
6-17: Fuzzy Membership Values for Selenium Assigned to each Subwatershed, Based on the Percentage of Agricultural Lands.
6-18: Weighted Combination Method Results for Selenium based on the Fuzzy Logic Approach.

7-1: Proposed Treatments for Addressing Metals from Abandoned Mines.
7-2: Proposed Treatments for Addressing Erosion and Sedimentation.
7-3: Proposed Treatments for Addressing Organics.
7-4: TMD Recommended Reductions for Nonpoint Source Pollution in Luna Lake (ADEQ, 2001).
7-5: Percentage Land Ownership by Subwatershed.

8-1: Example Project Schedule.
Appendices

Appendix A. Water Quality Data and Assessment Status, Upper Gila Watershed.

Appendix B. Suggested Readings, Upper Gila Watershed.

Appendix C: Revised Universal Soil Loss Equation (RUSLE) Modeling

Appendix D: Automated Geospatial Watersh