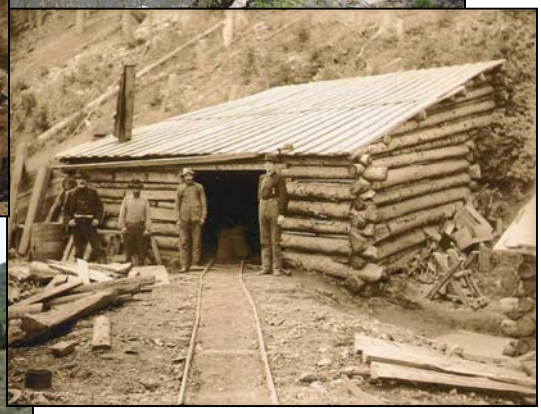
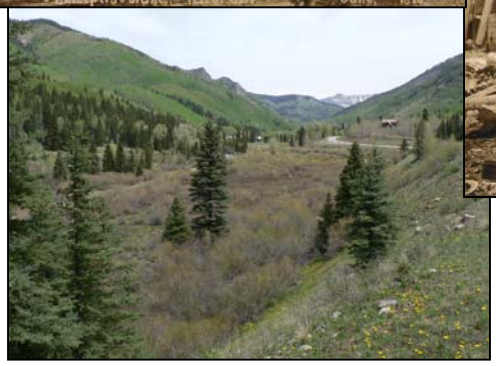
FINAL

Watershed Plan for the East Fork of the Dolores River in Dolores County

Prepared for:
The Town of Rico
August 17, 2006





Prepared by:
Grayling Environmental
18050 Rd G
Cortez, Colorado 81321
(970) 565-0278

TABLE OF CONTENTS

Tables

Figures

PHOTOGRAPHS

APPENDICES

List of Acronyms

AMD	Acid mine drainage
AMLIP	Abandoned Mined Land Inventory Project
~	Approximate value
ARD	Acid rock drainage
AWQC	Ambient Water Quality Criteria
BLM	Bureau of Land Management
BMP	Best management practice
CDNR	Colorado Department of Natural Resources
CDOLA	Colorado Department of Local Affairs
CDPHE	Colorado Department of Public Health and the Environment
CDOLA	Colorado Department of Labor
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife
CDPS	Colorado Discharge Permit System
CDWR	Colorado Division of Water Resources
CDWRM	Colorado Division of Water Resources Management
CFR	Code of Federal Regulations
Cfs	Cubic feet per second
CFAR	Citizens for Accountability and Responsibility
CGS	Colorado Geologic Survey
cm	centimeters
CO or Colo.	Colorado
CSOI	Colorado State Oil Inspector Program (Dept. within CDPHE)
CSU	Colorado State University
CWA	Clean Water Act
CWP	Center for Watershed Protection
CWCB	Colorado Water Conservation Board
CWQCA	Colorado Water Quality Control Act
CWQCC	Colorado Water Quality Control Commission
CWQCD	Colorado Water Quality Control Division
^{o}	Degree
EPA	Environmental Protection Agency
ERIR	Environmental Release and Incident Reporting (Dept. within CDPHE)
ft	foot
FR	Forest service road
FWPCA	Federal Water Pollution Control Act
gpm	Gallons per minute
GIS	Geographic Information System
GPS	Global Positioning System
>	Greater than
≥	Greater than or equal to
<	Less than
≤	Less than or equal to
LUST	Leaking Underground Storage Tank

ug/L	micrograms per liter
u	microns
uS/cm	micro Siemens per centimeter
mg/L	milligrams per liter
Mgal/d	Millions of gallons per day
MCL	Maximum contaminant level
n/a	Not applicable
NOAMS	Naturally Occurring, Acidic, Metal-rich Springs or Seeps
NPDES	National pollutant discharge elimination system
NPS	Nonpoint source
NRC	National Response Center
NRCS	Natural Resource Conservation Service
pH	A measure of the hydrogen ion concentration in water
ppb	parts per billion
ppm	parts per million
%	percent
quad	quadrangle (7.5 minute)
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act
SMCL	Secondary maximum contaminant level
STORET	U.S. Environmental Protection Agency's STOrage and RETrieval Database
SNOTEL	SNOwpack TELemetry
SOS	Scope of Services
SOW	Statement of Work
SPI	State precipitation index
SWE	Snow water equivalent
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TR	Trail
TVS	Table Value Standard
USDA	U.S. Department of Agriculture
USFS	United States Forest Service
USGS	United States Geologic Survey
UST	Underground Storage Tank
WQCD	Water Quality Control Division
WRD	Water Resources Division

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Upper Dolores River Watershed Plan is a characterization of the water quality and quantity within the sub-basin watershed defined geographically as:

> ***" the East Fork of the Dolores River in Dolores County, stretching from the county line with Montezuma County to Lizard Head pass and the county line with San Miguel County."***

This geographic area is referred to as the ***Project area*** which encompasses 68,747 acres, and serves as the focus for this effort. The *Project area* delineation is shown in **Figure EX.1.**

This plan is consistent with the requirements of Section 208 of the Clean Water Act, as well as the CWA nonpoint source (NPS) funds requirements. The main goals of this plan are to characterize water quality concerns and provide recommendations for the maintenance of high quality water within the *Project area*.

This document includes summaries of;

- watershed characteristics (hydrology, geomorphology, geology, climate)
- population and land use
- stream classifications and standards
- water quality characteristics
- point and nonpoint source discharges
- watershed management recommendations

The purpose of this document is to describe the watershed features within the area, determine the point and nonpoint sources of pollution to the watershed, summarize the existing data which characterizes water quality issues and finally, identify those areas requiring further information in order to complete the watershed plan, and identify those projects the Town of Rico can address themselves and begin the process of improving water quality conditions. This document represents the 'Watershed Plan' which will be presented to the *Project area* Watershed Stakeholders Group, for review and comment. Once the plan is completed it will be integrated into the Town of Rico regional plan (refer to subsection 7.2.4 Rico Regional Master Plan).

This document does NOT represent a regulatory document, nor does it serve to replace any ongoing water quality documentation efforts that are being conducted by others as part of a regulatory process. It is simply, a culmination of available information that was compiled for the Town of Rico for their interests and to achieve their goals. This plan was designed to document water quality concerns and provide for the maintenance of high quality water in the *Project area*.

The Town of Rico has an intense amount of recreator activity, is on the cusp of significant development opportunities and is associated with an historic mining district. As such it has impacts from recreator use, development activities and mining era characteristic issues such as remnant mine waste piles, mine adits and other historic features. An aggressive effort has been put forth to address many of the water quality issues associated with the mine-related concerns, however there remains certain issues creating water quality concerns. This document helps to identify the additional data needs required to thoroughly characterize the watershed as well as an evaluation of features (associated with recreator use, development and mine-related features) that may yet remain and may still require further remediation activity.

The completion of this document represents a goal achieved by the Town of Rico, needed in order to complete the next steps in their Master Plan for the Town. This document will help the Town of Rico achieve the following specific goals;

1. As the Town grows, this document will serve as the 'baseline' watershed characterization report that characterizes current water quality and quantity conditions. As the Town grows, this document will also grow and begin to integrate the effects of growth into the watershed condition so that the Town can Track, and proactively plan for their water resource needs.

2. This document represents a first step towards the eventual accomplishment of pro-active water quality project completion. A watershed plan is required and integral to the pursuit of grant opportunities (i.e. through the State/USEPA 319 process and others) which would enable the Town to pursue project funds for on-the-ground work whether it be for data collection or actual remedy development,

3. This plan is a written testament to the Town's dedication to improve water quality conditions within the area. This document will provide an identification of project the Town can tackle and begin the process of remediation.

This document was formatted based upon standard Watershed Plan components (USEPA, 2005) as well as the Nonpoint Source Funds Watershed Plan requirements (CFR, October 23, 2003). In order for the Town of Rico to be able to qualify for nonpoint source funds, the following information must be described within this plan;

- ✓ An identification of the causes and sources of nonpoint pollution,
- ✓ An estimate of the load reductions expected with the control or remediation of the nonpoint sources,
- ✓ A description of the NPS management measures to be implemented to achieve load reductions,
- ✓ An estimate of the amounts of technical and financial assistance needed,
- ✓ An information/education component that will be used to enhance public understanding of the project,
- ✓ A schedule for implementing the NPS management measures,

- ✓ A description of interim, measurable milestones for determining whether NPS management measures are being implemented
- ✓ A set of criteria that can be used to determine whether loading reductions are being achieved, and
- ✓ A monitoring component to evaluate the effectiveness of the implementation efforts over time

This document represents a compilation of existing resources that describe the Project area. **Table EX.1** summarizes the availability of information pertinent to the Watershed Plan and links (or references) to the information. This Table summarizes the typical Watershed Plan information components as described by the U.S. Department of Agriculture (USDA), U.S. Environmental Protection Agency (USEPA) and Colorado Department of Public Health and the Environment (CDPHE), and identifies any data gaps that may exist.

As shown within **Table EX.1** there are data gaps associated with the characterization of point and nonpoint sources of pollution. There have been no watershed planning efforts completed to-date for this area with an exception of a cursory Dolores River –wide plan developed in 1987 (BLM, 1987) that did not focus upon the water quality issues, nor the project area in particular. This Plan is organized into eight Sections and supporting appendices, as follows.

- **Section 1.0** – Introduction: This section describes the project background, scope and general organization of the Upper Dolores River Plan. General information regarding the planning process, hydrology, water quality and planning concerns is provided in a format as an educational overview.

- **Section 2.0** – Regional Overview of the Watershed: This section presents a brief description of the watershed, noting the key tributaries and lakes in the basin. It also contains general descriptive information regarding geography, hydrology, land use, and water quality management. In addition, this section describes general water quality issues identified in the basin.

- **Section 3.0** – Population Projections: This section documents population figures for the Town of Rico. Census data for 1980, 1990 and 2000 are presented.

- **Section 4.0** – Water Quality Assessment: This section discusses Upper Dolores River stream classifications and standards. It includes an assessment of available water quality data to determine if there are water quality or related watershed concerns. Water quality data are assessed to determine if applicable standards are being met. Recommendations pertaining to the continued collection of water quality data and the development of a comprehensive upper-basin water quality database are summarized.

- **Section 5.0** – Water and Wastewater Facilities: This section includes an inventory of public water systems and domestic wastewater facilities (proposed as of 2005). Recommendations pertaining to basin facilities are presented.

- **Section 6.0** – Nonpoint Source Pollution: this section assesses current sources of nonpoint pollution, using existing information. It includes a brief description of current ordinances and criteria used by local governments for erosion control and stormwater management Also described are the historic mine related nonpoint sources controls put in place and managed as part of cleanup efforts throughout the area. Recommendations are presented for continued evaluation of existing nonpoint sources and practices to control nonpoint sources.

- **Section 7.0** – Water Quality Management Designations: This section identifies management considerations when implementing the plan. A description of the stakeholders to be involved with the management process is provided.

- **Section 8.0** – Draft Feasibility Analysis and Recommendations: This section describes the proposed next steps for the Town of Rico in regards to potential projects to accomplish their goal of improving water quality in the basin. A cursory feasibility assessment of the projects was completed in order to rank them by priority and economic feasibility.

- **Section 9.0** – Summary of Conclusions and Next Steps: This section provides a bullet list of recommended next steps to accomplish in order to achieve the Town of Rico's goals for water quality improvement.

- **Section 10** - References: This section lists references cited in the Plan.

- **Appendices:** A list of **Definitions** for the terms applied within this document is provided within **Appendix A**. **Appendix B** provides a list of Points of Contact and Additional Resources for referral in regards to additional information to support methods and data resources. The remaining appendices include relevant information, such as the applicable water quality standards for the area, copies of relevant data and their sources etc.

This plan documented the information which describes the water quality and quantity characteristics of the *Project area*. As a result of compiling and interpreting this information, recommended projects that would assist with addressing ongoing concerns were formulated. The primary areas requiring further attention are related to;

1. The continuation of watershed planning by maintaining an active, dedicated Project area watershed stakeholders group, by becoming an active stakeholder to other – overlapping watershed groups and land-management projects, and by integration of this plan into the Town of Rico Regional Master Plan,

2. The further characterization of the watershed water quality, sediment quality and aquatic life in order to more fully understand water quality concern sources and impacts,

3. Control of nonpoint sources of stormwater and mine-related water quality issues, and the

4. Control of potential future point sources associated with the Wastewater Treatment plant, St. Louis tunnel, other development-related sources etc..

The management and preservation of sensitive stream-side (and River-side) riparian areas is key and integral to the above recommendations.

The **first category** of recommended projects is referred to as Watershed Coordination and Continued Planning. There are projects that fall within this category as follows;

1. Stakeholder Group Development, Meetings and Coordination,
    a) Presentation of this plan
    b) Assign a group coordinator
    c) Formalize the group structure and goals
    d) Develop a memorandum of understanding between stakeholder members
    e) Determine a strategy to accomplish monitoring
    f) Develop an electronic database
    g) Conduct meetings
    h) Use the stakeholder group as a resource to educate and reach the public
2. Integration into the Town of Rico Regional Master Plan

The **second category** of recommendations formulated by this plan is Monitoring to Address Data Gaps. Very specific areas of informational gaps exist for the Project area and include;

1. Comprehensive project area data
2. Aquatic life monitoring data
3. Metals loading and synoptic sampling
4. Sediment data

Prior to the implementation of any data collection effort, it is recommended that the proposed sampling strategy be thoroughly documented within a Field Sampling Plan (FSP). This FSP should be described, presented and provided for review and approval by the Town and the Watershed stakeholders.

The **third category** of recommendations formulated by this plan is for the completion of an Aquatic Ecological Risk Assessment and Regulatory Documentation that can be completed from the data collected from the second category of recommendations (Monitoring to Address Data Gaps).

The information gained from the previously described sampling efforts can serve a number of purposes. First and foremost, it will help to answer any questions regarding water quality characteristics and the potential sources of any contaminant load. If the sampling efforts are appropriately designed, reviewed and approved of by regulatory agencies (i.e. USEPA, CDPHE) then the information can also support an 'Ecological Risk Assessment' and regulatory documents such as the TMDL, the WWTP NPDES and for the CWQB mitigation of injury reports. The information can also be documented as part of grand-funding requirements etc..

The **fourth category** of recommendations formulated by this plan is for the completion of various Nonpoint Source Controls. The specific recommendations associated with nonpoint source controls include the monitoring of potential and known nonpoint source areas (as previously described in **Section 6**), and additional recommendations of;

1. Pro-active planning of riverwalk/river corridor features in order to blend potential nonpoint source control best management practices into the design. There are BMPs suitable for the control of Stormwater and for the control of mine waste that may add unique features to the proposed design.

Specifically for stormwater,

2. To document and implement a Stormwater management plan as part of the Town of Rico Regional Master Plan, and

3. To become pro-actively involved with Stormwater management as development occurs (especially in regards to the riverwalk/river corridor development), and to control existing Stormwater issues related to recreator activity and existing development.

Specifically for mine-site related nonpoint sources,

4. Become actively involved in all mine-site related closures/cleanups and integrate concepts of watershed issues into the design,

5. Re-evaluate existing remedy efforts for the Columbia and Argentine to determine if existing remedies are suitable for the contaminant releases once additional monitoring data become available

6. Upon completion of the monitoring data obtained from the proposed monitoring efforts (in subsection 7.4), identify suitable mine-sites that can be pro-actively remedied in order to control nonpoint sources of metals load. Current information indicates the need to evaluate sites within Horse Creek, Aztec Gulch, the Mountain Spring Mine and others.

The Town of Rico is in a unique position to pro-actively plan for both stormwater and mine-related nonpoint source controls in coordination with other ongoing activities. The Town is on the cusp of building a Wastewater Treatment Plant to service the residential and industrial settings within the town limits. The 'products' of the WWTP could be of beneficial use to the mine-related nonpoint source control process. The biosolids sludge could also be used as 'cap' or mine-waste treatment material for tailings left in place. Biosolids also have useful application as fertilizer which may serve Town purposes in other areas (proposed community green house, reclamation of developed lands etc.). There is also the potential for using passive wetlands for the treatment of mine drainage (and Stormwater issues as previously discussed). The possibility of using constructed wetlands to assist with the mine-related nonpoint sources should also be evaluated as a viable remedy alternative since this alternative is conducive with Town goals and possible Riverwalk/River corridor enhancement.

There are very strategic steps that need to be taken, and engineered analysis needed to determine the potential of these remedy strategies. There are environmental concerns, permitting issues and regulatory constraints that surround these proposed ideas. Consultation with professional water permitting and engineering personnel is required for these efforts.

The **fifth category** of recommended projects is referred to as Point Source Control. There are currently four point source releases associated with the Project area;

1. the St. Louis tunnel and associated outfall,
2. the combined flows from the Santa Cruz and Rico Boy Adits,
3. the discharge from the Silver Swan Tunnel, and
4. the seep from the Argentine tailings.

There is also, the potential of a point source from an unnamed adit located below the overhead tramway along Silver Creek, and the Mountain Spring Mine seep. Both of these point sources have been documented by others, and there are other potential point sources mentioned by CGS during their AML inventory that need review (CGS, 1989). The lack of specific information pertaining to these potential point sources represents a significant data gap in the understanding of water quality conditions within the *Project area*. This data gap was addressed with the proposed comprehensive watershed monitoring strategy presented in the second recommendation category above. For the remaining point sources with 'known' information, the Town is in a unique position in regards to being able to address/assist with these concerns. The point sources have all been addressed from a remediation perspective during VCUP actions by AR. These VCUP efforts have addressed a significant amount of contamination associated with the mine-site, yet point sources of water discharge remain. These point sources are to be a component of the proposed TMDL for the Upper Dolores and may capture the attention of the regulatory entities if they are found to be of significant concern and load.

Currently, review of the existing data identifies significant uncertainties in the data itself. The first and foremost recommendation in regards to these point sources is to capture a comprehensive watershed-scale monitoring program. The following specific recommendations were formulated for each point source;

1. **For the St. Louis Tunnel and discharge outfall:** The Town should continue their relationship with Atlantic Richfield and Rico Renaissance – particularly through the formation and operation of the North Rico non-profit organization – in moving towards an effective treatment strategy for the tunnel and associated ponds system. As treatment and solids management technologies are implemented, further investigations should be performed in accordance with CDPHE recommendations or requirements to confirm their effectiveness in diminishing metals loading to the Dolores River. The data interpretation results indicates that the ponds do not capture and control all the flows released by the tunnel which presents a concern, and pending risk to the Dolores River. This Plan does however, have limited data available from which to draw further conclusions. There is also a significant data gap in the understanding of the geothermal spring influences to the water quality. There have been numerous ideas posed in regards to treatment of the tunnel water. AR recently submitted a Technical memorandum describing "the Proposed Approach to Complete the Water Quality Assessment for the St. Louis Ponds" describing their next steps in a strategy to study the St. Louis Ponds water quality. It is apparent, that any treatment of the water will benefit the overall metals load within the *Project area*.

2. **For the Santa Cruz/Rico Boy Adits**: Review of the historic conditions of this point source indicates the potential need for control of the water and possible treatment. The settling pond associated with these point releases historically had a singular outfall into a wetlands area that is linked directly to the Dolores River. However, erosion and the collapse of the settling pond berm have lead to additional point discharges that exist currently. It appears that this pond requires maintenance and perhaps additional footprint area to assist with the passive treatment of the water. It appears that the existing passive treatment procedures for these combined flows are not sufficient to address the water quality concerns. Significant amounts of metals are possibly being released to the Dolores River as a result of these flows. It is recommended that these flows be further studied to identify a more aggressive, suitable remedy.

3. **For the Silver Swan Adit**: Review of the current conditions of this point source indicates the need for continued study and possible control or treatment of the water. There are two 'flowing' features associated with the Silver Swan Site, the flows from the adit provide a significant metals load to the receiving wetlands. There is also, flow associated with the captured nonpoint waste rock seep and stormwater collection system. These flows are routed to a settling pond and released at a distinct point to the Dolores River. The water quality associated

with this point release does not appear to have been studied. The amount of metals contribution associated with the Silver Swan site needs further evaluation. Cursory information gained from the water quality analysis does indicate that there is a concern and the need for additional remedy efforts. It is recommended that the Town further study this site, become involved with decision process in regards to its fate and endorse further action once additional information becomes available.

4. **Other Point Sources (both private and federally owned)–as yet to be identified:** There are other potential point sources including the unnamed adit associated with the overhead tramway along Silver Creek, the Mountain Spring Mine and others. It appears that a significant amount of investigation has been completed that delineates the 'privately owned' contaminant sources. However, further review of private sites (e.g. such as those along Horse Creek) may require further evaluation. These potential sources were not visually verified during the course of this plan's production. In addition, there is little information available to characterize the Mountain Spring Mine (and other CGS identified mine sites [CGS, 1989]) in order to determine if a flow pathway is complete. SEH has studied the unnamed adit and results indicate that it is a potentially significant contributor of metals load to Silver creek. Given the uncertainties associated with the data sets however, it is recommended that further study be completed before any definitive action were to be taken in regards to these sites.

The **sixth and final recommendation** that was formulated from this Plan, is a one that has already been folded into the previous recommendations yet has tremendous value and merit as its own strategy. The preservation and possible enhancement of riparian/wetlands is key to the strategies presented within the Nonpoint and Point Source Control recommendations. Many of the recommendations discussed within this Plan, present the opportunity to develop the Riverwalk/river corridor so as to accommodate BMPs for both stormwater and mine-site related sources. This would entail the protection and possible enhancement of riparian/wetland settings. The Town of Rico already has enacted wetland protection regulations that incorporate a 25-foot development setback. This is a tremendous stride forward towards the protection of these resources. The protection of wetlands in order to achieve watershed goals is a current trend and strongly endorsed by watershed protection entities, and it is suggested that wetland/riparian areas be enhanced in order to address nonpoint pollution concerns.

As per review and comment from Atlantic Richfield it is recognized that this document contains an evaluation of water quality based upon a data set with 'recent' data gaps. As such, there are uncertainties with the conclusions drawn herein. The readers are referred to Appendix H for a listing of review comments and their suggested changes. This plan recommends that there is a need for further studies to be conducted. However it should be noted that there are ongoing studies being completed by AR for the Water Quality Assessment of the St. Louis Ponds (SEH, 2005). Therefore, any future studies should be performed in coordination with these efforts. It should also be recognized that AR (as a

member of the NorthRico Non-profit) intends to address the St. Louis Tunnel discharge with appropriate treatment upgrades to meet discharge permit standards ultimately established by CDPHE. AR believes that the the analysis performed as part of the CDPHE's ongoing WQA support the position that appropriate and protective permit limits can be established for the St. Louis Tunnel discharge without specifically accounting for, or requiring mitigation of, the other point sources noted within this plan.

Table EX.2 summarizes the proposed next steps for the Town of Rico in regards to achieving their goals towards water quality improvement. As per USEPA and CDPHE watershed planning requirements, this Table outlines the projects, their components, budget and technical needs, timeline for completion and the goals. This information is cursory and DRAFT for stakeholder review. Once this document has been reviewed and discussed, these goals and their associated components can be refined.

Figure EX.2 depicts a schematic diagram of the identified data gaps that need fulfilled prior to next steps towards completion of watershed projects. As identified within this document, there are a number of studies that have been completed, however they represent small portions of information that reflect conditions for a given location and a distinct point in time. There is the need for a comprehensive watershed water quality study that folds in components of water quality, sediment quality and aquatic life studies. **Figure EX.3** provides a proposed strategy for the completion of various studies in order to obtain the needed information for the Project area.

Based upon available information, there were certain types of projects (not studies) that were recommended in order for the Town of Rico to maintain an active role in planning processes and regulatory process, and to control nonpoint and point sources of pollution. **Figure EX.4** highlights the features within the *Project area* that are a part of these recommendations and the types of activities that are recommended within the plan.

Securing funds for these projects will definitely vary by type. A considerable amount of effort can be accomplished by the contributed efforts of stakeholders. It is strongly recommended that each project be thoroughly presented and reviewed to the community so that as many interested parties can become involved. Community involvement and education is laced throughout all of the recommendations of this plan, and is key to the success of the proposed projects.

There are a number of funding mechanisms available that would support the recommended projects within this plan. Securing funds is a timely process and needs to be accommodated within the time-line for the completion of these efforts. The watershed stakeholders group can become responsible for tracking funding opportunities and being held responsible for process of identifying funding sources, their requirements, seeking community review and approval, submission of funding requirements etc.. This document provides a review of available, relevant grant funding sources that qualify for the recommended projects. This review extends only to grant funds, and is subject to

change in response to funding directives. Results of the review indicate that there are a number of funding resources that support the recommended projects from this Plan.

In summary, this Plan characterized the setting of the Project area and identified possible projects that the Town of Rico can embark upon in order to improve water quality conditions. The next steps would entail the strengthening of a Watershed Stakeholder group that can take the lead on securing funding, begin monitoring and eventually take on projects with the nonpoint and point sources of contamination. This plan will in-turn begin to be updated and evolve as water quality conditions improve, and further next steps are identified.

Table EX.1 Project Area Information Summary of Sources and Data Gaps. Pg 1 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Meteorology			
Precipitation	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. CSU : http://waterknowledge.colostate.edu/precip.htm Colorado Climate Center : http://ccc.atmos.colostate.edu
Air Temperature	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. Colorado Climate Center : http://ccc.atmos.colostate.edu
Evaporation	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. Colorado Climate Center : http://ccc.atmos.colostate.edu
Wind	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. Colorado Climate Center : http://ccc.atmos.colostate.edu

Table EX.1 Project Area Information Summary of Sources and Data Gaps. Pg 2 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Surface Water			
Quality	Watershed –scale information lacking	Narrative, GIS Coverages, Tabulated Data	Potable Supply Water Quality: EPA Safe Drinking Water Information system – http://oaspub.epa.gov/enviro/sdw_ National Water Information System : http://waterdata.usgs.gov/nwis USEPA STORET http://www.epa.gov/storet/dw_home.html
Quantity	Baseline –above Rico area information lacking	Narrative, Tabulated Data	Gauging station hydrographs: http://waterdata.usgs.gov; or waterinform.program: http://web.frontier.net/SCAN Estimates of water use: http://water.usgs.gov/watuse/spread95
Water Rights and Permits	None	Narrative, GIS Coverages, Tabulated Data	NPDES: www.epa.gov/enviro/html/ Water quality use designation and TMDL: www.epa.gov/owow/tmdl/links.html Stormwater : www.epa.gov/npdes/stormwater CDWR databases (refer to Section 10 of this Report)
Groundwater			
Springs	Project area information lacking	Narrative some tabulated	USEPA, Walsh, 1995 and others (refer to Section 10)
Quality	Project area information lacking	Narrative, Tabulated data	USGS Water Quality : http://water.usgs.gov/osw/programs/nffpubs.html CGS, 2003 and 2004 (refer to Section 10 of this Report) USEPA STORET http://www.epa.gov/storet/dw_home.html, Refer to Section 4
Aquifers	Project area information lacking	Narrative, with some mapping	Potable Supply Water Quality: EPA Safe Drinking Water Information system – http://oaspub.epa.gov/enviro/sdw_ CGS, 2003 and 2004 (refer to Section 10 of this Report) Estimates of water use: http://water.usgs.gov/watuse/spread95
Wells, Permits and Water Rights	None	Narrative, mapping	CDWR databases (refer to Section 10 of this Report)

Table EX.1 Project Area Information Summary of Sources and Data Gaps. Pg 3 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Sediment			
Quality	Project area information lacking	Narrative with some database info	Sediment quality : www.epa.gov/waterscience/cs/nsidbas.html Refer to Section 4 of this Report
Drainage Basin Characteristics			
Watershed Morphology	None	Narrative, GIS Coverages, Tabulated Data	HUC and Watershed coverages: http://water.usgs.gov/GIS/HUC.html; www.ncgc.nrcs.usda.gov/products/ or www.epa.gov/ost/basins, CDPHE status of watersheds http://www.cdphe.state.co.us/op/wqcc/waterstatus2002/305(b) CWCB – flood plain delineations : www.CWCB
Wetlands/Riparian Areas	None	Narrative, GIS Coverages,	National wetlands inventory. www.nwi.fws.gov Drew, P. 2005 (refer to Section 10 reference list)
Terrestrial Setting	None	Narrative	Natural resource inventory : www.nrcs.usda.gov/technical/NRI, text within numerous documents describes the terrestrial setting including various SJNF documents (refer to Section 10 of this Report)
Aquatic Setting	Project area information lacking	Narrative with some database info	Aquatic Life monitoring : http://water.usgs.gov/nawqa and http://infotrek.er.usgs.gov/doc/nawqa_www/bio/bio_communitysamples.html Some data available through CDOW and others (i.e. C. Derfus, refer to Section 10 of this Report)
Soils	None	Hard copy and some GIS info.	NRCS info. www.nrcs.usda.gov/partners
Geology	None	Mostly narrative, some mapping	CGS, 2000, 2003, 2004 and others (refer to Section 10 of this Report)

Table EX.1 Project Area Information Summary of Sources and Data Gaps. Pg 4 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Human Influence			
Land Use Management	None	Narrative, GIS Coverages	Mineral Use Records : www.geocommunicatorgov/Geocomm/Isis_home/home/index.html, BLM planning : www.blm.gov/planning/plans.html and http://www.co.blm.gov/sjra/sjoutfitters.htm Estimates of water use: http://water.usgs.gov/watuse/spread95
Property Ownership	None	GIS Coverages	Census US Census Bureau : http://quickfacts.census.gov, Department of Labor population projections: http://dola.colorado.gov/demog/QuickTables.cfm CDOT, COGCC and County web pages
Point Sources of Pollution	Some information available, there is need for additional characterization	Narrative listing of permits held	NPDES: www.epa.gov/enviro/html/ Stormwater : www.epa.gov/npdes/stormwater CDPHE CDPS http://www.cdphe.state.co.us/wq
Nonpoint Sources of Pollution	Some information available, there is need for additional characterization	Narrative	US Census of Agricultural use: www.nass.usda.gov/census (and livestock/crops) Agricultural chemical application rates: www.nass.usda.gov/census/research/cropland/SARSIa.htm Septic systems : www.nexc.wvu.edu/nsfc/nsfc_index.htm Colo. State Oil Inspection : http://www.epa.gov.swerust1/states/co.htm

Table EX.2 Summary of the Watershed Plan Recommendations. Pg. 1 of 3.						
Watershed Plan Recommended Projects	Components of the Project	Amount of Financial Assistance Needed	Amount of Technical Assistance Needed	Schedule	Milestones	Goals – Criteria for Achievement
Watershed Coordination and Continued Planning	1. Stakeholder Group – formulation and coordination, integration to federal, state and regional watershed efforts	15,000/year	Low	Ongoing → future	Stakeholder involvement, quarterly meetings	Stakeholder MOU
	2. Integration of Watershed Plan into Rico Regional Master Plan, and Rico Planning efforts	2,000/year[1]	Medium	Ongoing → Future	Integration into the Regional Plan	Integration into the Regional Plan
Monitoring	1. Documentation – Field Sampling Plan : for Stakeholder review and Approval.	3,500/total	Low	2007	FSP development	FSP approval
	2. Comprehensive Project Area Monitoring (for the sampling of water quality, aquatic life, metals load, and sediment)	20,000/year	Low	2008 → Future	Monitoring	Monitoring
	3. Ecological Risk Assessment and TMDL, updating the Watershed plan etc.	8,000/total	Low	2008	ERA development	ERA approval

Table EX.2 Summary of the Watershed Plan Recommendations. Pg. 2 of 3.						
Watershed Plan Recommended Projects	Components of the Project	Amount of Financial Assistance Needed	Amount of Technical Assistance Needed	Schedule	Milestones	Goals – Criteria for Achievement
Nonpoint Source Controls	1. Stormwater Management – Planning Riverwalk/river corridor.	5,000[1]/total	Medium	ASAP → Future	Proactive planning	Completed design
	2. Stormwater Management – Stormwater Plan	8,000[2]/total	Medium	ASAP → Future	Documentation of the Plan	Approval of the Plan
	3. Stormwater Management – Control existing issues	10,000[2]/total	Medium	ASAP → Future	Planning	Implementation
	4. Mine-related Management – Involvement with ongoing efforts and coordinate Watershed Issues	3,000[1]/total	Medium	2008 → Future	Involvement	Coordination
	5. Mine-related Management – Re-evaluate Existing Remedies	3,000[1]/total	Medium	2008 → Future	Re-evaluate existing plans	Implement new controls
	6. Mine-related Management – Identify Suitable Sites for Pro-active Remedy Efforts.	3,500[1]/total	Medium	2008 → Future	Evaluate Sites	Remedy Sites
Point Source Controls	1. WWTP Innovative technologies	3,000[1]/total	Medium	2007 → Future	Evaluate technologies	Implement technologies
	2. St. Louis Adit, Rico Boy/Santa Cruz, Silver Swan	-	High[3]	ASAP → Future	Evaluate technologies	Implement technologies
Riparian/Wetland Management	1. Protect, maintain and enhance existing riparian/wetland areas	-	High[3]	ASAP → Future	Plan for protection	Implement

Table EX.2 Footnotes:

1 – The level of effort for these projects involves Town of Rico administration and staff. An approximate budget based upon anticipated hours with average hourly rates was presented for these categories. Since there are existing personnel available who are able to accomplish these tasks, a 'low' level of additional technical assistance was identified.

2- These projects would require input from professional design engineers. Therefore the estimated costs have a 'medium' level of technical assistance required and the cost estimate would have to be reviewed by others.

3- These projects have a high uncertainty associated with any cost projection since the technology used, scope of project, footprint of area are all largely unknown. Since there is such a significant amount of uncertainty, there was no prepared cost estimate provided and the level of technical assistance would be high..

FIGURES

Figure EX.1

Delineation of Project Area Watershed Boundary

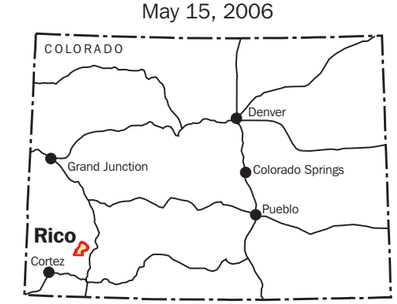
LEGEND

- Rico Watershed
- County Line
- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment

Prepared By:

K. King
Aquatic Toxicologist

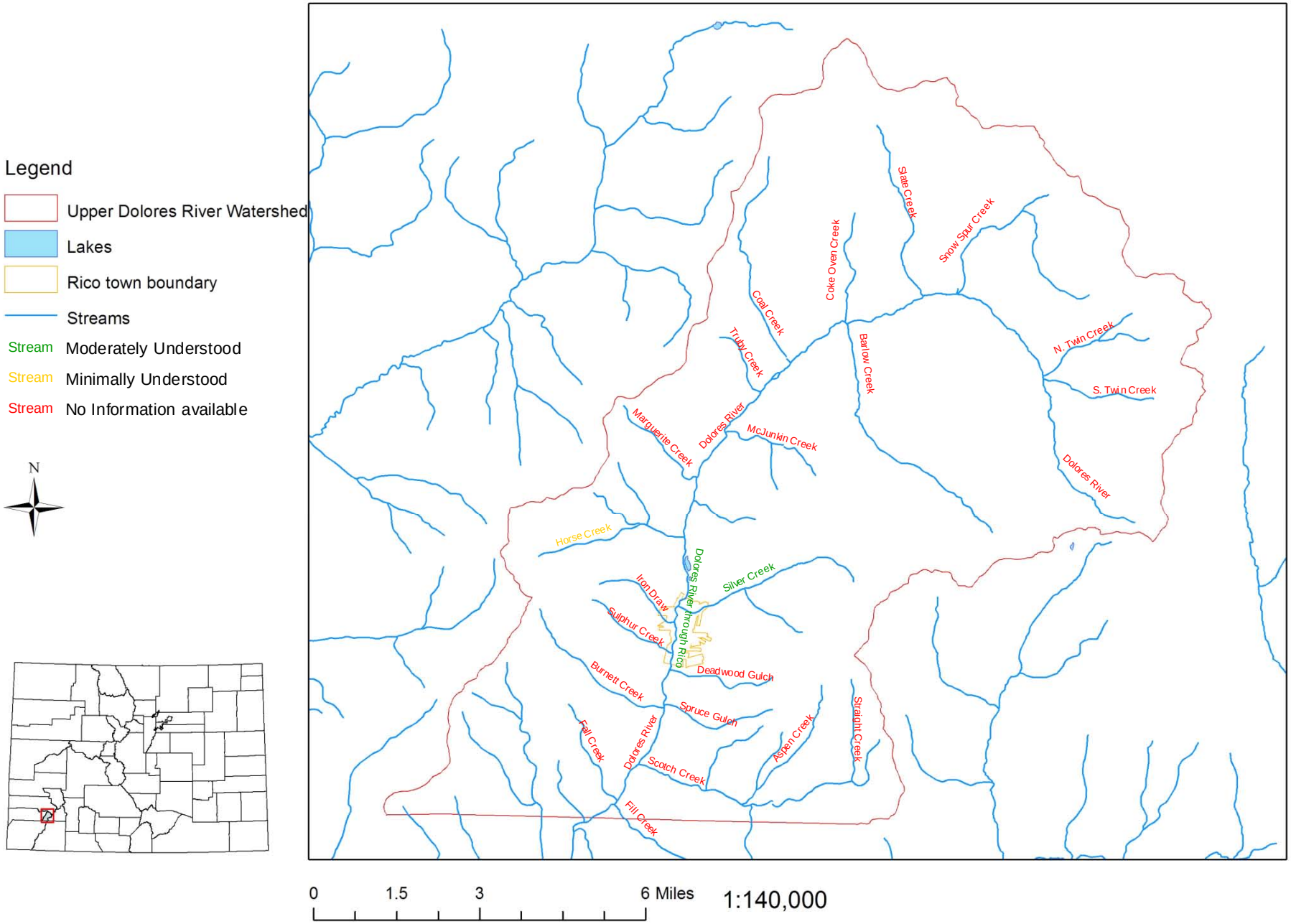
May 15, 2006



N

0 1 2 3 4 5 Miles

Figure EX.2. Areas Identified as Having Data Gaps



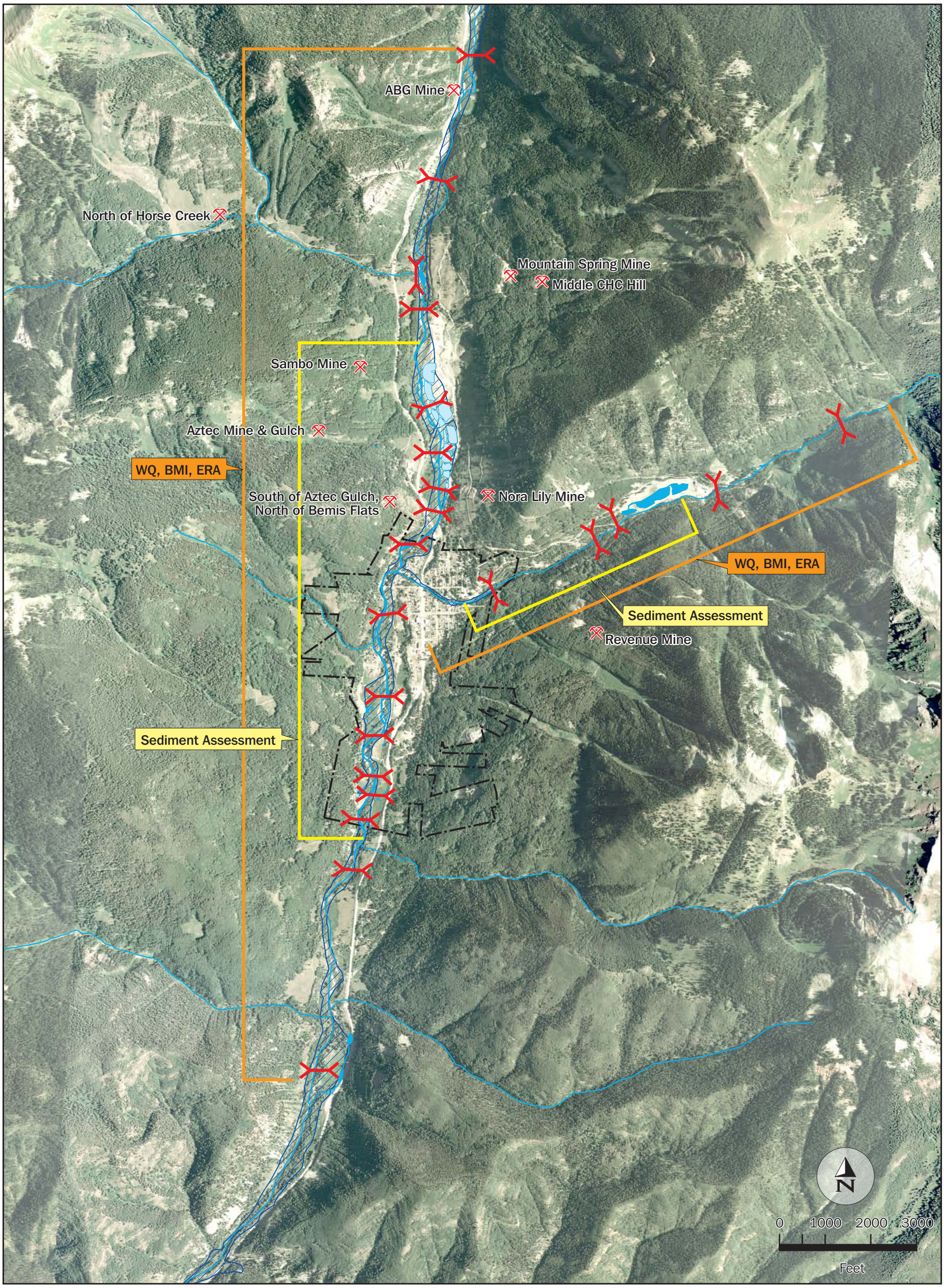


Figure EX.3

Proposed Next Steps for Studies by Area

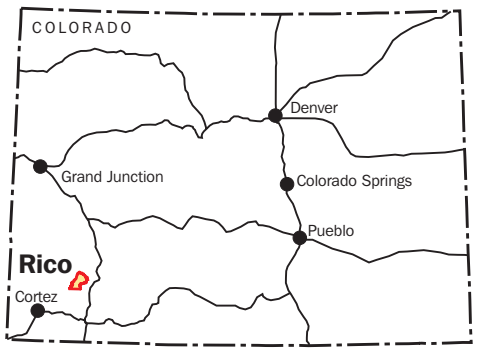
July 27, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- 100 Year Flood Plain
- USFS AML Site
- Sediment Assessment
- Water Quality (WQ), Biological Monitoring and Inventory (BMI) & Ecological Risk Assessment (ERA)
- Metals Loading Analysis Sites & WQ, BMI, ERA Analysis Sites

Prepared By:

K. King
Aquatic Toxicologist



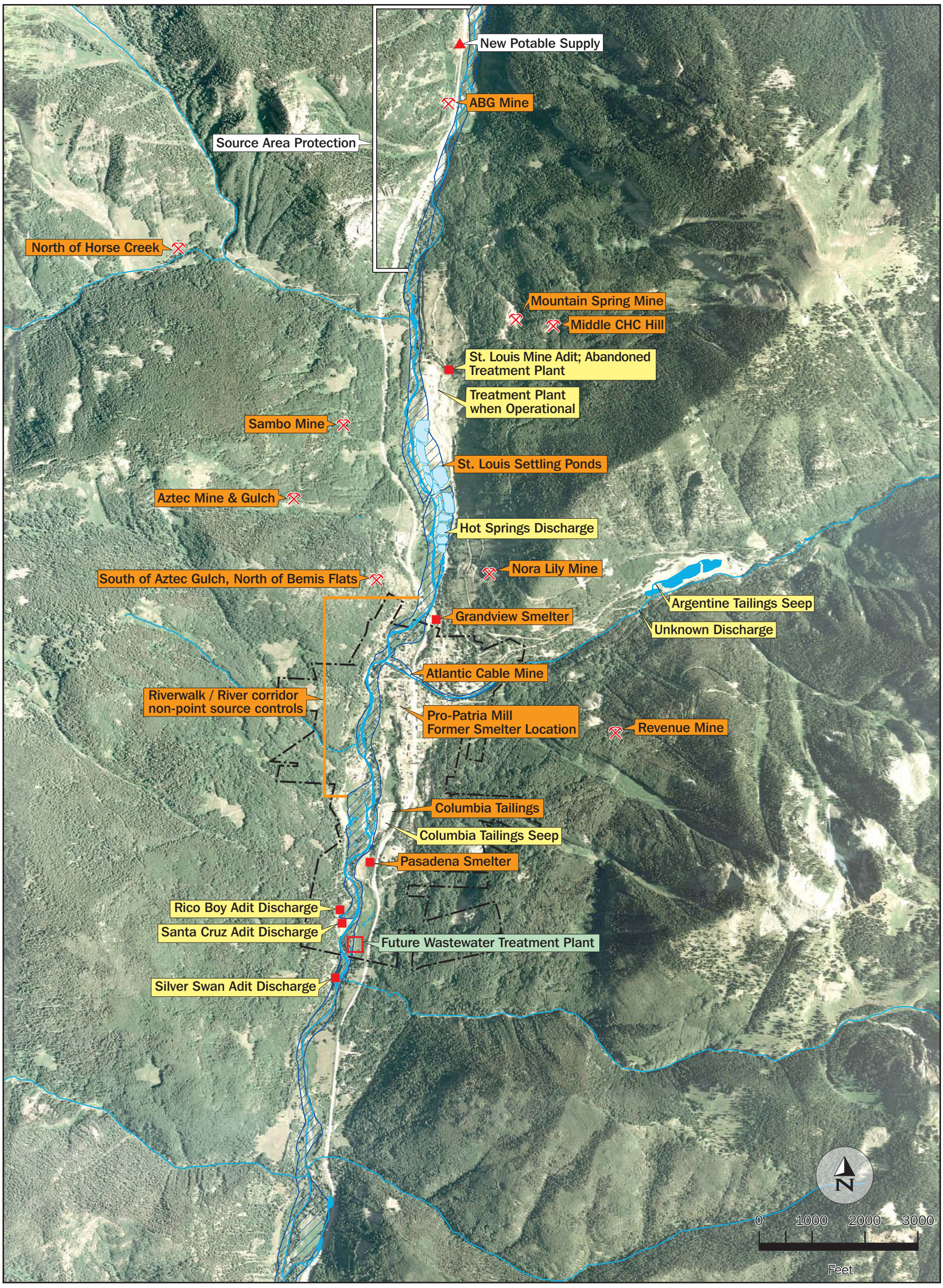


Figure EX.4

Recommended Activities by Project Area Feature

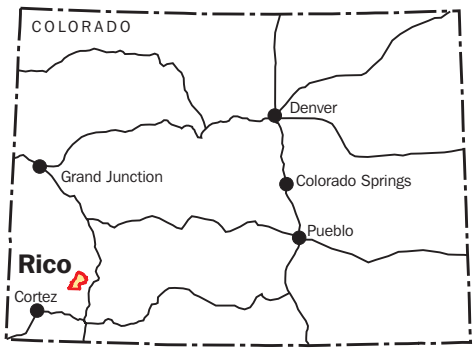
July 27, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- 100 Year Flood Plain
- USFS AML Site
- Potable Supply Area
- Point Source Study and Possible Control
- Proposed Point Source - Possible use for Remedies
- Nonpoint Source Study and Possible Control

Prepared By:

K. King
Aquatic Toxicologist



SECTION 1

1.0 INTRODUCTION

This document provides the Watershed Plan for the Town of Rico associated with the *Project area* watershed of interest which occurs within Dolores County, capturing the East Fork of the Dolores River (**Figure 1.1**). This document follows the guidance for watershed plan completion as described by others (CWP, 2001; CDPHE, 2005) and follows the Scope of Work (SOW) provided to Grayling Environmental for the Scope of Services (SOS) described in the Watershed Planning Request For Proposal (RFP) for the Town of Rico (Town of Rico, 2005). There are numerous watershed methodology handbooks available; from which this document follows (e.g. SCS, 2006; CWP, 2001 and others) however, the scope follows the objectives outlined within the Town of Rico SOW explicitly.

This Section provides cursory, educational information in order to bring reviewers and interested parties up to speed in regards to terminology and concepts applied with planning. Much of this information is expanded in detail as related to the *Project area* in the following Sections. The readers are referred to the list of **Definitions** provided within **Appendix A** for additional referral.

1.1 General

Watershed planning is simply a process to get watershed stakeholders and the community to make better choices about future growth (CWP, 2001). This document is a culmination of available scientific information that describes the watershed setting. The results of the setting characterization help identify the necessary next steps to enhance water quality conditions within the setting. These next steps involve monitoring, gathering information needed to fill data gaps, and actual on-the-ground work alternatives to address known issues. It also describes the essential watershed considerations the Town of Rico should fold into their future economic development efforts.

This document is a <u>working</u> document and represents <u>suggestions</u> for the watershed stakeholders to decide whether or not to pursue. In order for this document to be effective, the stakeholders need to understand the information presented within this document and be able to come to a decision themselves as to the next, most effective steps to take to achieve their watershed goals.

The first step to watershed planning is to delineate the watershed to be evaluated. A watershed can be defined as the land area that contributes runoff to a particular point along a waterway. A typical watershed can cover tens to hundreds of square miles and several jurisdictions. Such is the case of the 'Dolores River' watershed which begins at Lizard head pass and ultimately travels to a final confluence point with the Colorado River in Utah. This expansive watershed covers of 95 river miles in length (**Figure 1.2**).

Watersheds are broken down into smaller geographic units called subwatersheds. Streams within watersheds are often 'ordered' with headwaters having an order of '1', and segments below headwaters have orders of 2,3,4, etc. depending upon the number of tributaries ultimately feeding the stream (**Figure 1.3**) . A 'subwatershed' is typically a drainage area of 2 to 15 square miles with boundaries that include the land area draining to a point at or below the confluence of two second order streams, or can be designated by 'management' strategies which is the case for this project. This project deals with a subwatershed within the Dolores River watershed that encapsulates the Town of Rico footprint of influence. The purpose of this document is to help define the characteristics of the watershed that the Town of Rico relies upon and can potentially impact. Therefore, this subwatershed includes;

> ***" the East Fork of the Dolores River in Dolores County, stretching from the county line with Montezuma County to Lizard Head pass and the county line with San Miguel County. "***

This description encompasses the planning area and is referred to as the ***Project area*** for the duration of this document. The *Project area* would be described as a 'sub-basin or sub-watershed' within the Dolores River Watershed (refer to **Figure 1.2**). The *Project area* is bounded by Dolores County boundaries to San Miguel County to the North, San Juan County to the East, and Montezuma and La Plata Counties to the South. The western boundary of the *Project area* is a defined topographic ridge which separates the upper Dolores Watershed from its neighboring West Dolores River Watershed.

Within subwatersheds are catchments, which are the smallest units in a watershed and is defined as the area that drains an individual site to its first intersection with a stream. There are several 'catchments' described within this document for purposes of management next steps. The Silver Creek area is referred to as a catchment and is focused upon given its heightened concern and contribution to the watershed water quality. The delineated area of the Silver Creek catchment is shown in **Figure 1.4**. The various types of aquatic corridors (perennial, intermittent or ephemeral, and standing water bodies) are mapped within both the *Project area* (refer to **Figure 1.3**) and the Silver Creek Catchment (**Figure 1.4**) maps.

1.2 Project Background

This project was initiated as a result of watershed interests and concerns expressed by the Town of Rico. The Town has taken steps over the past years to try and deal with an affected economy, mining-industry impacts from historic activities and the issues associated with pending growth and development. As the Town of Rico has grown, water quality and quantity issues have become apparent. The need for infrastructure improvements such as a combined-sewer system, and a more stable potable supply have became apparent. In addition, the residents and Town administration recognized a need to better understand their own water quality and quantity issues. This document represents the result of years of planning and strategizing by the Town, to obtain a

watershed tool that will help them with their watershed planning and watershed rehabilitation in the years to come.

This document also serves the purpose of various CWA compliance procedures including Sections 208 and 319 which are described herein. This document represents a compilation of existing resources that describe the *Project area*. There have been no watershed planning efforts completed to-date for this area with an exception of a cursory Dolores River –wide plan developed in 1987 (BLM, 1987) that did not focus upon the water quality issues, nor the project area in particular.

1.2.1 Section 208 – Clean Water Act

The legislative background that has lead to the need for communities to complete watershed plans begins in 1972,when Congress overrode a presidential veto to pass the Federal Water Pollution Control Act (FWPCA) amendments of 1972, also known as the Clean Water Act. The CWA was further amended with significant changes in 1977 and 1987. The CWA states that the ultimate objective of the Act is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters". In beginning the process to improve water quality, the CWA identified a number of planning programs to be initiated at various levels of government, outlined in Section 208 of the CWA.

To maximize efficient use of resources and provide regional coordination, Section 208 of the CWA established an area-wide approach to planning for the abatement of pollution. Section 208 (titled "Area-wide Waste Treatment Plans") provides criteria to design local plans, based on an integrated and comprehensive planning process. The *Continuing Planning Process for Water Quality Management in Colorado*, adopted by the Colorado Water Quality Control Commission (CWQCC) in 1983, requires annual updates of the *Area-wide Water Quality Management Plans* prepared under Section 208 of the CWA. The main objectives of 208 plans are to;

1) update the previous plans to reflect the progress that has been made in plan implementation, and

2) address the region's shift in focus to a watershed perspective.

Under Section 208 of the Federal CWA, planning regions within each state are required to develop and update water quality management plans. Based on the regions designated by the Governor in 1973, the *Project area* is a part of Region 7 which includes the entire Dolores River and San Miguel river basins. These basins traverse portions of San Miguel, Montrose, Dolores, Montezuma and LaPlata Counties. The Region does not have a complete 208 Plan. This document was designed to address the standard 208 plan requirements but contains the information only pertinent to the *Project area*.

1.2.2 Section 319 – Clean Water Act

This document also serves other purposes such as those described in Section 319 of the CWA which requires a Watershed Plan for the inventory, evaluation and recommendations towards recovery of nonpoint pollution sources. Specifically, this document follows the format of the "Colorado's Watershed Cookbook: Recipe for a Watershed Plan" (CDPHE, 2005). This document goes through the process of identification of causes and sources of nonpoint pollution, it also estimates the load associated with the nonpoint sources (having metals load issues) and provides a list of projects associated with the further study and possible actions towards abatement of the nonpoint source issues. As such, this document can serve as the Town of Rico's first step towards the pursuit of USEPA-319 grant funds that are made available on an annual basis and serve to support nonpoint source planning, investigation and best management practice development.

1.3 An Overview of Watershed Planning

Water is central to many community planning processes. In the arid west, these processes are exacerbated by the fact that we have a limited water resource. This document helps define the characteristics of water quantity and quality within the *Project area*. In turn, this information can be used by the Town of Rico for their planning. In order to be able to accommodate anticipated population growth, land-use change etc., it is imperative to have a basic understanding of the water resource that is to be required for these eventual changes. This subsection introduces some basic concepts that are discussed throughout this Watershed Plan. It provides an introductory primer on hydrology terms and their application. It also describes how the information obtained through the watershed planning process eventually folds together to formulate a plan for next steps to address existing or potential concerns related to water quality. Subsection 1.3.1 describes the planning process, subsection 1.3.2 defines the hydrologic cycle components evaluated within the plan, subsection 1.3.3 describes the components of a water 'balance' which affect communities trying to plan for the future and their water needs, and subsection 1.3.5 provides an overview of the watershed plan goals. This Section as a whole provides introductory information that leads into the next Sections which provide a thorough evaluation of each watershed plan component. There is a '**Definitions'** list provided within **Appendix A** for reader referral.

1.3.1 The Planning Process

Watershed management is to plan and work toward an environmentally and economically healthy watershed that benefits all who have a stake in it. Watershed planning is a collaborative process and requires the input of multiple types of stakeholders in order to be able to accomplish the watershed goals (**Figure 1.5**). Once the basic information that characterizes a watershed is pulled together, planning can begin. This process can be broken into three stages:

- **The first stage** includes identifying concerns, gathering and analyzing information and data, defining challenges/opportunities, developing objectives, and documenting data and decisions.
- **The second stage** includes developing a plan for addressing the objectives, selecting the best watershed management alternative(s), listing ways (strategies) for implementing the selected alternative(s), and determining how to measure progress.
- **The third stage** includes implementing and evaluating efforts.

The actual watershed planning efforts will be based on the best available assessment of the natural, economic, and social features of the watershed to be evaluated. It is unrealistic to hope to have all the information needed at the onset. Missing information represents a **data gap**, and filling this data gap can become a next step in the planning process. Through the process of planning, the following considerations need to be addressed:

- **Identify Concerns**
  Trustees to the watershed should identify and address concerns. These concerns may combine water and other natural resources issues, the local economy, and social matters. Since it is sometimes difficult to separate perceived from actual problems, and environmental from non-environmental issues, all concerns need to be heard. When identifying possible water quality concerns, it is necessary to check with the state water quality agency to determine the designated water uses for the watershed. The goals the trustees have for the watershed need to be cohesive with the state designated uses of the watershed.
- **Identify Valued Watershed Features**
  There may be natural features that help give the watershed a sense of identity and value. For example, they may include landscape traits that symbolize the watershed, such as a mining heritage, or mixed recreational and woodland settings. These valued features should be identified and weighed against the problems and concerns that are brought to the trustees attention. The risk of negative impacts upon a valued feature of the watershed is a good basis for evaluating the concerns that are brought to the watershed trustees and, later in planning, for setting priorities for action.
- **Seek and Analyze Data**
  Once all the concerns have been identified, information which describes the magnitude of these concerns need to be gathered and interpreted. Existing data (e.g. water quality data, land use/cover information, point source data, etc.) needs to be reviewed for completeness and then interpreted to determine the magnitude of a perceived problem
- **Prioritize Challenges/Opportunities**
  After listing concerns and exploring them by gathering and analyzing data, challenges and opportunities will surface. Unfortunately, there are usually not

enough funds or time to address all potential watershed management needs. Priorities must be set that target efforts to the most critical problems or opportunities. This is why the trustees will need to strive for consensus on prioritizing which problems/opportunities to pursue. Many groups begin prioritizing problems by establishing criteria. This might include:

- ***Determine the relationship of the problem to the watershed goals and valued features.*** If the problem is affecting the valued features of the watershed, then it is a worthy project. If the problem does not pose a concern to the values, then perhaps this problem can be ranked lower in priority.
- ***Determine if there is an ability to bring about change.*** Determine if tackling the problem is a realistic goal.
- ***Determine if correcting the problem is achievable in the time-frame allowed.*** For example, it may take decades to see results from changes on the land that ultimately affect a deep aquifer, but changes near a stream bank may quickly affect the quality of the stream's water and the surrounding habitats.
- ***Is there a willingness to tackle the issues.*** Only when the reasons are strong enough to motivate those who may need to change, then the project is likely to be achievable.
- ***Cost/benefit ratio.*** The benefits of tackling an issue need to outweigh the costs in order for a project to be successful.

This document had the benefit of knowing some of the issues identified by the *Project area* trustees, which then gave focus to the types of information needed in order to characterize the concerns. This document takes the available information and attempts to characterize those concerns. At times, information is lacking and 'data gaps' were identified. At the end, the document provides a list of recommended project for the trustees to the *Project area* to review and consider. Some of these projects include data collection efforts in order to address data gaps that characterize a concern. Other projects are planning in nature, while yet others involve pro-active involvement for actual remedy development. These projects are suggestions for the trustees to review and blend with their goals for the watershed. They need to be prioritized and planned and will require additional effort on the trustee's behalf.

1.3.2 The Hydrologic Cycle

It is useful to understand a conceptual framework within which to analyze environmental problems that have arisen, or to anticipate the consequences of population growth and development. Such a framework in regards to water resources is provided by the ***hydrologic cycle***. The hydrologic cycle, represented in **Figure 1.6**, describes the ways in which water moves around the earth. During its endless circulation from ocean to

atmosphere to earth and back to ocean, the water is stored temporarily in streams, lakes, the soil, or groundwater and becomes available for use.

In the cycle, solar energy evaporates water from the ocean. This water is carried by winds over the continents, and when atmospheric conditions are favorable, a portion of the water is precipitated, generally as rain or snow. If cold conditions prevail at the ground surface, snow will be stored there until enough energy is available for melting. The snow-melt water will follow the same pathways as rain water (Dunne, T. and L.B. Leopold, 1998).

Before reaching the surface of the earth, most rain is caught by vegetation. Some of the water is stored upon leaf surfaces during wetting, and the remainder falls to the ground from leaves and branches, or runs down trunks and stems. A small amount of water never reaches the ground, but is evaporated back to the atmosphere from vegetation during and after the rainstorm. The process by which water is short-circuited back to the atmosphere in this way is known as ***interception*** (Dunne, T. and L.B. Leopold, 1998).

Upon reaching the ground surface, a portion of the rain is absorbed by the soil. Rain that is not absorbed remains on the surface of the ground, fills small depressions, and eventually spills over and runs quickly down-slope into streams as overland flow, which can generate flood conditions. The absorbed rain water seeps into the soil by the process of ***infiltration***, and is held there as soil moisture by capillary forces. If the soil moisture content is raised sufficiently, infiltrating water will displace older soil water, which may percolate laterally through the topsoil into streams as ***stormwater runoff*** or vertically to the groundwater zone where the pores of the soil or rock are completely filled with water. Groundwater moves slowly intro streams, swamps, or lakes providing surface runoff during dry weather.

Not all the infiltrated water reaches a stream, however. Some of it remains in the topsoil after rain and is returned to the atmosphere by ***evaporation*** from the soil surface or by transpiration from the leaves of plants. Other water evaporates from streams, lakes and swamps (Dunne, T. and L.B. Leopold, 1998).

The concept of the hydrologic cycle can be extended to include the movement of sediment, chemicals, heat and biological organisms contained in the water. This extended definition enhances the value of the cycle as a framework for the analysis of many problems (i.e. water quality issues, biological resource issues etc.) in planning (Dunne, T. and L.B. Leopold, 1998). Some key hydrologic cycle considerations that are pertinent to the *Project area* are summarized as follows;

- ***Precipitation*** is the major factor controlling the hydrologic cycle of a region. Precipitation can take two forms; 1) rain fall and 2) snow. Precipitation has many characteristics that affect water resource planning including the relative amounts of rain and show, their seasonal timing, and the sizes and intensities of individual storms. These characteristics affect planning activities such as snow removal,

storm sewer design, runoff forecasting, stormwater best management practice planning, the sizing of flood-control structures, culverts and bridges.

- ***Interception*** of precipitation by vegetation can be a very influential factor to the hydrologic cycle within a small region. The amount of water stored by vegetation is dependent upon the density and type of vegetation present. For instance, water droplets on coniferous trees and typically held apart and will not overcome surface tension. There is a tendency for more water to be lost from coniferous forests due to evaporation/interception. Many areas within the State of Colorado are managing interception by changing the density and diversity of vegetation in drought prone areas. Interactive management of vegetation resources (i.e. timber thinning by USFS and others) with watershed management is a common strategy in arid west settings (Hibbert, 1967, and 1971: Lewis, 1968).

- ***Infiltration*** of water into the soil surface is affected by qualities of the soil, and the intensity of the rainfall. There are times when the infiltration capacity of a soil is exceeded by the amount of rainfall. This in turn causes stormwater runoff, often in terms of 'sheet flow' meaning the water runs off as sheets over the ground surface. The water quality of the infiltrated and runoff water is affected by the soil it comes in contact with. For instance, if the soils have a loose and small particle size, the runoff will have a high particle load. This particle load can then be transported to receiving water systems such as streams and lakes. If the soil has a waste characteristic (i.e. mine waste) then the water can pick up water quality characteristics of the waste (such as acids or metals). Vegetative cover is a very important characteristic that will affect infiltration rates. The lack of vegetative cover creates a lack of infiltration capacity (Dils, 1953). As a result, water will become run-off and will not be a benefit to subsurface soil, vegetation, and groundwater recharge.

1.3.3 The Water Balance

This subsection introduces the concept of a ***water balance*** while **Section 2** describes the variables that affect a water balance in detail for the *Project area*. A region's 'water balance' is a measure of the sources of water input as compared to the sources of water output (**Figure 1.7**). Ideally, there would be an abundance of input as compared to output. However in areas such as the arid west, there can be more water demand than there is resource available, which leads to the concept of a ***water budget***. A water budget is an estimate of the natural available amounts and types of water as compared to the water demands. It is a useful tool for planning and is dependent upon the human population making demands upon the resource.

The *Project area* 'water budget' is shown within **Figure 1.8** which depicts the water balance throughout the State of Colorado. The CGS has used available regional information to understand the sources of inputs and outputs and has classified the entire state of Colorado. Results indicate that the *Project area* occurs within an area with a

balance of '0' indicating that all natural inputs are accounted for by natural outputs. This indicates that there is no excess and that any artificial or introduced use would result in a net loss to the system.

A water balance is typically estimated from regional meteorological, soils and geology and other available water resource information. The information is useful when determining whether the area in question has resources capable to support a new need such as irrigation supply, residential development or other. It is also useful for predicting impacts over time.

Figure 1.7 demonstrates the different components that are used to estimate a region's water balance which is shown in **Figure 1.8**. The interaction of these components is expressed in the following equation (Dunne, T., and L.B. Leopold, 1998):

Eq. 1.1 $$P = I + AET + OF + \Delta SM + \Delta GWS + GWR$$

Where;

P	= Precipitation
I	= Interception
AET	= actual evapotranspiration
OF	= overland flow
Δ SM	= change in soil moisture
Δ GWS	= change in groundwater storage
GWR	= groundwater runoff

The following describes general characteristics of water balance considerations by the type of water resource. There are two broad categories of water resources; 1) surface water, and 2) groundwater. ***Surface waters*** include all those sources and supplies of water that are visible at the surface. These can include creeks, streams, rivers, ponds, lakes and oceans. ***Groundwater*** includes all those resources that occur subsurface and within the soils and geologic layers below ground.

Understanding the balance for surface water resources is relatively straight forward as compared to understanding groundwater resource budgets. Surface water quantity measurements are relatively simple to gather, and can be collected in such a manner so as to characterize all the inputs and outputs to an area with ease. With the strategic placement of gauges or stream flow measurement devices, a quick schematic of the flow change over time and distance can be constructed. Inputs can take the form of groundwater recharge of a surface water system, rainfall, snow melt, and point source discharges. Outputs can include uses such as drinking water, irrigation, agricultural uses and others, as well as hydrologic cycle processes of evaporation, transpiration, and infiltration. Uses of a surface water system are defined and allocated through the water rights appropriations. In addition, the water balance of an area is determined by

combining an estimate of the water/soil moisture evaporation with vegetative transpiration to determine a total loss of water called ***evapotranspiration***.

Evapotranspiration is dependent upon climate, elevation, ground cover and type of vegetation. Statewide averages show that approximately 81 percent of the precipitation that falls in Colorado returns to the atmosphere through evapotranspiration (Litkey and Evans, 1987). Using the equation of subtracting the average annual potential evapotranspiration from the average annual precipitation (Waltman, 1997), CGS has estimated that the Upper Dolores area falls within a range of 4 to -4 inches of year indicating that it is on the border of gaining as much as it loses (as shown in **Figure 1.8**). The overall balance of the area is about '0'.

Groundwater is the water contained within subsurface soil and rock pore spaces. This saturated subsurface zone, or phreatic zone is the predominant source of freshwater drinking water in Colorado. The relationship of groundwater to the landscape (including surface water resources) is shown in **Figure 1.9**. If a groundwater body provides a good supply of water to wells for use, the soil or rock that contains the water is called an aquifer.

Groundwater is not a limitless resource. It is tied to recharge and discharge from surface water bodies as well as other factors. When planning the management of a groundwater system, one needs to know the limits to which water can be drawn without depleting the resource. In such plans the concept of safe yield of the aquifer is often introduced. Safe yield is usually defined as the annual draft of water that can be withdrawn without producing some undesirable result. The difficulty rests in being able to determine or define the undesirable result before it is too late. The standard equation to determine safe yield is:

Eq. 1.2 **Input – Output = Change in Storage**

Where;

Input = Deep percolation of rainwater and snow melt + seepage from streams + artificial recharge (i.e. septic tanks)

Output = Evapotranspiration from plants with roots drawing on the saturated zone + seepage to streams, lakes and marshes + well pumpage

Storage capacity = the change of water table elevation and its specific yield

The variables that fold into the groundwater budget equation can be measured and can vary drastically over time as areas are developed. For instance, alterations of ground

surface with the onset of building and development can reduce infiltration and thereby cause a reduction of groundwater recharge. As paving and compacted ground area increases, summer streamflow (which is largely fed by groundwater recharge) can decrease (Franke, O.L. and N.E, McClymonds, 1972). These are subtle changes that can occur over time as a result of human factors, and should be monitored and planned pro-actively.

Evaporation is the dominant mechanism of water loss in the state of Colorado. The abundance of sunshine, clear skies, low relative humidity, wind and moderate temperature result in large rates of evaporation. The rate of evaporation is dependent upon the water temperature and the temperature and humidity of the overlying air, as well as the amount of wind within the area. The rate of evaporation loss for the Upper Dolores area is 35-40 inches per year (CGS, 2003). Potential evaporation rates that are in excess of precipitation will remove most surface water and soil moisture before the water can infiltrate the subsurface to recharge an underlying aquifer.

1.3.4 Water Quality Issues

Water quality characteristics of natural waters are a result of natural processes of weathering of rock, contact with the atmosphere. Rocks exposed at the surface of the earth combine with water, various gases (especially oxygen and carbon dioxide), and organic acids by a set of geologic processes known as weathering. Some rocks contain minerals that are very soluble while others are resistant (Hem, 1985). The products of these reactions are soil and chemical solutions. The chemical solutions flow through the soil and the groundwater to streams, determining the chemical properties of each water resource and its suitability for use (irrigation, washing, drinking etc.) (Dunne, T. and L.B. Leopold, 1998).

Surface water chemistry is more complex than groundwater chemistry because runoff consists of a variable mixture of waters that have reached the channel by various routes. Groundwater remains in contact with weathering rock and soil minerals for periods of time ranging from a few days to hundreds of years. Groundwater quality tends to have a more stable water quality character which lends to the desired use for potable supply (Hem, 1985).

There are natural water quality characteristics that give water the characteristics to support aquatic life and support human uses. There are also, natural enrichment processes and pollution sources that create adverse water quality conditions that can limit the water's use. The water quality of a surface water or groundwater resource can be 'degraded' with natural constituents such as metals as a result of the geology (NASH, 2000; and Neubert, 2002). It is important to recognize these natural limits to the water quality characteristics.

Water quality can also be impaired by various sources of man-made, or anthropogenic pollution sources. These sources in regards to surface water and groundwater releases,

are referred to as either 'point' or 'nonpoint' sources. Point sources come from distinct points of release such as an industrial effluent or a water/wastewater treatment plant discharge. Nonpoint sources are more diffuse and do not have definable releases. Examples include agricultural/irrigation return flows, stormwater releases, septic tank releases etc (Spellman, F.R., 1998).. Both sources can carry a variety of types of pollutants inclusive or organic, and inorganic chemicals. Certain chemicals within these can be toxic and thus, detrimental to the receiving system. Once mixed within a receiving system such as a surface water body or a groundwater aquifer, the degraded water quality can limit the 'use' since harm can come to those who are exposed to the pollutant (aquatic life, wildlife and public health. The water quality concerns particular to the *Project area* are described in detail by source (point vs nonpoint) in **Sections 6 and 7** of this document.

1.3.5 Watershed Planning Goals

Watershed plans can be written to achieve different types of goals. Watershed resource planning is becoming a critical component to any communities' planning efforts since water resources are critical for all types of land-use and growth. The general goal of any watershed plan is to thoroughly characterize the water resources and determine their limitations for use due to quality and/or quantity concerns. If there is adequate information, then the plan can be used for a diversity of goals including planning for development, flood hazard planning, evaluation of water quality and quantity change over time, management of water supply and use, etc.. The goals for this plan are described in subsection 1.5.

1.4 Town of Rico Planning Goals and Objectives

The Town of Rico Regional Master Plan, Section III. Goals and Objectives, Environmental Protection, Objective 3. States that is an objective of the Town to, "Ensure all water in the Rico Region, both ground and surface, meet water quality standards capable of supporting aquatic life at a level comparable to other natural mountain streams; and that these waters do not pose a human or other environmental health threat in the valley;" (Town of Rico, 2004). Some of the major aspects of the next-steps to be taken within the Town of Rico Master Plan are shown in **Figure 1.10.** The following describes the goals and objectives within the Master Plan that overlap with this Watershed plan.

Section V. Environmental Protection, of the Rico Regional Master Plan addresses community issues related to environmental considerations. Of particular relevance are the following goals:

"Goal A deals with the quality of the human environment, stating:
Protect and enhance the natural environment to ensure the health and safety of the present population and future generations."

The Objectives include:

1. Prevent any degradation to the environment that presents a measurable human health risk.
2. Abate any existing or natural environmental conditions that present a measurable human health threat.

"Goal B seeks protection of natural resources, stating:
Protect and enhance natural environmental resources."

The Objectives include:

1. Minimize degradation to, or loss of, natural environmental resources.
2. Restore degraded natural environmental resources and enhance existing natural environmental resources.
3. Reduce or eliminate non-sustainable consumption of natural resources.

"Goal C intends to prevent natural hazard damage, indicating:
Prevent damage caused by natural hazards."

The Objectives include:

1. Eliminate or minimize the potential for personal injury and property damage presented by natural hazards.

1.5 The Watershed Plan Goals and Objectives

This Watershed Plan is consistent with the requirements of Sections 208 and 319 of the CWA, administered by the Water Quality Control Division (WQCD) of the Colorado Department of Public Health and the Environment (CDPHE). It follows the SOW described in the services agreement between the Town of Rico and Grayling Environmental. It specifically serves to address the following goals;

- ✓ As the Town grows, this document will serve as the 'baseline' watershed characterization report that characterizes current water quality and quantity conditions. This document will be updated in order to integrate the effects of growth into the watershed condition so that the Town can Track, and proactively plan for their water resource needs.

- ✓ This document represents a first step towards the eventual accomplishment of pro-active water quality project completion. A watershed plan is required and integral to the pursuit of grant opportunities (i.e. through the State/USEPA 319 process and others) which would enable the Town to pursue project funds for on-the-ground work whether it be for data collection or actual remedy development,

- ✓ This plan is a written testament to the Town's dedication to improve water quality conditions within the area. This document will identify projects the Town can tackle and begin the process of evaluation or actual remediation.

This document addresses the standard major watershed planning goals and objectives as follows;

- ✓ **Water Resources**: To prepare an overview of the *Project area*, describing major water bodies and waterways, as well as land use, and population characteristics.

- ✓ **Water Quality**: To review existing water quality data and assess the location and extent of water quality and watershed concerns. To evaluate issues such as impacts to aquatic habitat, erosion, and sediment load and provide recommendations for further study or possible action if needed.

- ✓ **Facility Planning/Design**: To describe proposed public water systems and wastewater facilities in terms of impacts or considerations to the watershed water quality/quantity characteristics.

This document was formatted based upon standard Watershed Plan components as well as the Nonpoint Source Funds Watershed Plan requirements (CFR, October 23, 2003; CDPHE, 2005). In order for the Town of Rico to be able to qualify for nonpoint source funds, the following information was described within this plan;

- ✓ An identification of the causes and sources of nonpoint pollution
- ✓ An estimate of the load reductions expected with the control or remediation of the nonpoint sources
- ✓ A description of the nonpoint source (NPS) management measures to be implemented to achieve load reductions,
- ✓ An estimate of the amounts of technical and financial assistance needed,
- ✓ An information/education component that will be used to enhance public understanding of the project,
- ✓ A schedule for implementing the NPS management measures,
- ✓ A description of interim, measurable milestones for determining whether NPS management measures are being implemented
- ✓ A set of criteria that can be used to determine whether loading reductions are being achieved, and
- ✓ A monitoring component to evaluate the effectiveness of the implementation efforts over time

This document does NOT represent a regulatory document, nor does it serve to replace any ongoing water quality documentation efforts that are being conducted by others as part of a regulatory process. It is simply, a culmination of available information that was compiled for the Town of Rico for their interests and to achieve their goals. This plan

was designed to document water quality concerns and provide for the maintenance of high quality water in the *Project area*.

1.6 Watershed Description

The planning area (referred to as the *Project area*) addressed within this document, includes the East Fork of the Dolores River in Dolores County, stretching from the county line with Montezuma County to Lizard Head pass and the county line with San Miguel County. A majority of the watershed planning issues will focus on the Town of Rico and adjacent areas impacted by past mining activities.

The *Project area* is bounded by Dolores County boundaries to San Miguel County to the North, San Juan County to the East, and Montezuma and La Plata Counties to the South. The western boundary of the *Project area* is a defined 'topographic ridge' which separates the Upper Dolores Watershed from its neighboring West Dolores River Watershed (refer to **Figure 1.2**).

The ultimate headwaters location of the *Project area* occurs at Bolam Pass (adjacent to Hermosa Peak at 12,579 ft) where the mainstem of the East Fork of the Dolores River headwaters are identified. The terminus of the watershed (down-gradient end-point) occurs where the Dolores River crosses the Montezuma County line (T 39N, R 11W, S 15).

Figure 1.11 depicts the various types of aquatic habitat features within the *Project area*. These include perennial systems (year-round flow), intermittent systems (seasonal or rain-event flows) and standing water (lakes and ponds). Approximately 21- Dolores River miles (within the mainstem of the River) are captured by the *Project area*. There are approximately 22 tributary creeks that are either perennial or ephemeral and reach a confluence and contribute to the Dolores River flows within the *Project area* (**Table 1.1**). The sum total of tributary miles was estimated as 96 miles (USFS, 2001). Of the 96 tributary miles, approximately 70 miles are perennial (with year-round flows) and 26 would be considered ephemeral or intermittent (dependent upon groundwater levels and precipitation events). There is very little information regarding annual flow rates for the *Project area*. There exists only one gauging station (USGS gauging station No.# 09165000) which is located just below the Town of Rico.

The *Project area* is bounded topographically by the ridges created by the surrounding Rico Mountains. The topographical ridgeline which delineates the *Project area* watershed basin is outlined within **Figure 1.2, with the Silver Creek Catchment shown in Figure 1.4**. This ridge line identifies the land surface which captures all surface water sources (rain and snow) that ultimately contribute to the instream flows associated with the *Project area*. It is assumed, that the subsurface of this same delineated footprint would represent an approximation of the groundwater aquifer setting for the *Project area*. Although it should be noted, that it is possible for 'trans-basin' groundwater sources via faults, mine workings or geologic feature to communicate with the *Project area*.

The distinct types of aquatic settings (perennial streams or stream segments, ephemeral/intermittent streams or stream segments and standing water bodies) within the *Project area* are shown in **Figure 1.11.** Silver Creek is focused upon within this document for a variety of reasons. It poses as a significant contributor to nonpoint contaminant concerns and is currently serving as the Town of Rico's municipal supply. Further, more comprehensive characterization of the *Project area* is provided in **Section 2.**

1.7 The Watershed Plan Scope and Organization

This document follows the CWA 208 and 319 guidance for watershed plans. It addresses the watershed characteristics and concerns associated with the *Project area* defined in the previous subsection and outlined within **Figure 1.2**. The document is organized into eight sections and supporting appendices, as follows.

- **Section 1.0** – Introduction: This section describes the project background, scope and general organization of the Watershed Plan.

- **Section 2.0** – Regional Overview of the Watershed: This section presents a brief description of the watershed, noting the key tributaries and lakes in the basin. It also contains general descriptive information regarding geography, hydrology, land use, and water quality management. In addition, this section describes general water quality issues identified in the basin.

- **Section 3.0** – Population Projections and Land Use Patterns: This section documents population figures for the Town of Rico. Census data for 1980, 1990 and 2000 are presented. In addition, the land uses are described in terms of current conditions and projected future changes.

- **Section 4.0** – Water Quality Assessment: This section discusses Upper Dolores River stream classifications and standards. It includes an assessment of available water quality data to determine if there are water quality concerns. Water quality data are assessed to determine if applicable standards are being met. Recommendations pertaining to the continued collection of water quality data and the development of a comprehensive *Project area* water quality database are summarized.

- **Section 5.0** – Water and Wastewater Facilities: This section includes an inventory of public water systems and domestic wastewater facilities (proposed as of 2005). Recommendations pertaining to basin facilities are presented.

- **Section 6.0** – Nonpoint Source Pollution: this section assesses current sources of nonpoint source pollution to the *Project area*, using existing information. It includes a brief description of current ordinances and criteria used by local

governments for erosion control and stormwater management. Also described are the historic mine related nonpoint sources controls put in place and managed as part of cleanup efforts throughout the area. Recommendations are presented for continued evaluation of existing nonpoint sources and practices to control nonpoint sources.

- **Section 7.0** – Water Quality Management Designations: This section identifies management considerations when implementing the plan. A description of the stakeholders to be involved with the management process is provided.

- **Section 8.0** – Draft Feasibility Analysis and Recommendations: This section describes the proposed next steps for the Town of Rico in regards to potential projects to accomplish their goal of improving water quality in the basin. A cursory feasibility assessment of the projects was completed in order to rank them by priority and economic feasibility.

- **Section 9.0** – Summary of Conclusions and Next Steps: This section provides a bullet list of recommended next steps to accomplish in order to achieve the Town of Rico's goals for water quality improvement.

- **Section 10** - References: This section lists references cited in the Plan.

- **Appendices:** A list of Definitions is provided within **Appendix A**. The remaining appendices include relevant information, such as copies of relevant data and their sources, a glossary of terms and a summary of correspondence records.

TABLES

Table 1.1 Summary of Project Area Tributary Stream Characteristics.					
Tributary	Tributary Miles			Location	
	Perennial	Ephemeral or Intermittent	Total	Headwaters[1]	Terminus[2]
North Twin Creek	3.5	2.25	5.75	T41N, R9W S32	T40N, R9W S1
South Twin Creek	2.5	0.75	3.25	T40N, R9W S8	T40N, R9W S1
Snow Spring Creek	3.0	3.0	6.0	T41N, R10W S24	T41N, R10W S26
Lizard Head Creek[3]	0	2.5	2.5	T41N, R10W S18	T41N, R10W S23
Slate Creek	3.5	2.0	5.5	T41N, R10W S9	T41N, R10W S27
Coke Oven Creek	3.25	1.0	4.25	T41N, R10W S21	T41N, R10W S33
Coal Creek	4.0	0.5	4.5	T41N, R10W S18	T40N, R10W S5
Truby Creek	1.0	0	1.0	T40N, R10W S31	T40N, R10W S6
McJunkin Creek	4.5	0	4.5	T40N, R10W S17	T40N, R10W S18
Marguerite Creek	2.75	1.0	3.75	T40N, R11W S11	T40N, R11W S13
Horse Creek	3.75	3.0	6.75	T40N, R11W S28	T40N, R11W S23
Iron Draw	2.0	0	2.0	T40N, R11W S27	T40N, R11W S35
Sulphur Creek	2.5	0	2.5	T40N, R11W S27	T40N, R11W S35
Barlow Creek	5.25	2.5	7.75	T40N, R10W S23	T41N, R10W S33
Silver Creek	3.75	3.75	7.5	T40N, R10W S28	T40N, R11W S25
Dead Gulch	3.0	0.25	3.25	T39N, R10W S5	T39N, R11W S1
Spruce Creek	3.0	0.5	3.5	T39N, R11W S2	T39N, R10W S7
Scotch Creek	7.5	3.0	10.5	T39N, R10W S16	T39N, R11W S11
Straight Creek[4]	2.5	0	2.5	T39N, R10W S4	T39N, R10W S16
Aspen Creek[4]	4.0	0	4.0	T39N, R10W S5	T39N, R10W S18
Fall Creek	2.5	0	2.5	T39N, R11W S4	T39N, R11W S15
Fill Gulch	2.25	0	2.25	T39N, R11W S18	T39N, R11W S15

1 - Defined as the point where surface water occurs and begins to flow
2 - Defined as the point where the tributary flow joins with the Upper Dolores River.
3 – Lizard Head Creek is a tributary to Snow Spring Creek
4 – Straight Creek and Aspen Creek are tributaries to Scotch Creek

FIGURES

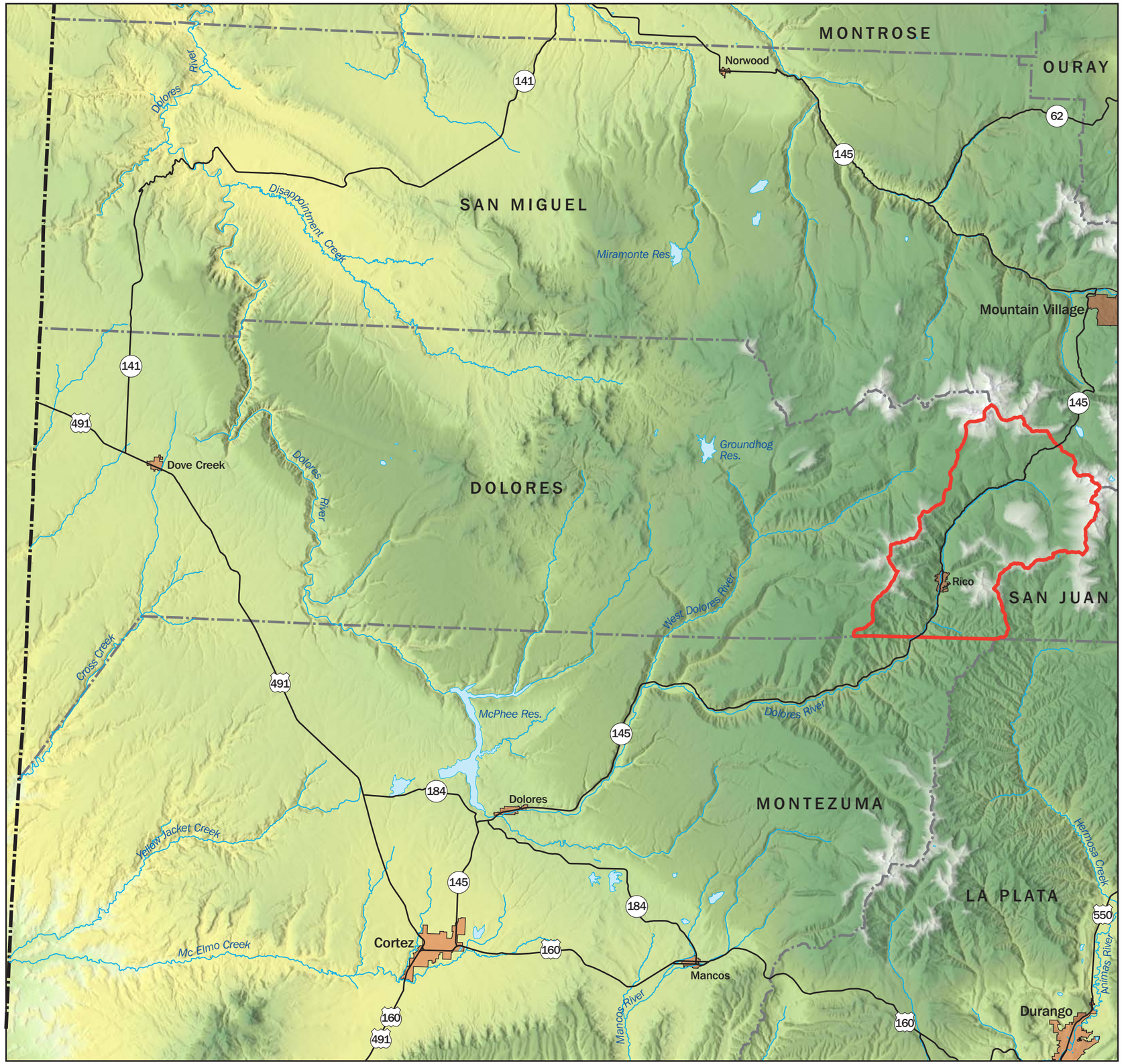


Figure 1.1

Location of Project Area within Dolores County

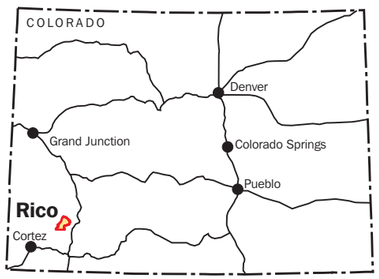
LEGEND

- Rico Watershed
- County Line
- Municipal Boundary
- Rivers & Streams
- Lakes

Prepared By:

K. King
Aquatic Toxicologist

May 15, 2006



N

0 2 4 6 8 10

Miles

Figure 1.2

Delineation of Project Area Watershed Boundary

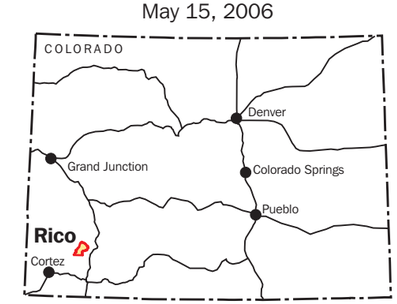
LEGEND

- Rico Watershed
- County Line
- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment

Prepared By:

K. King
Aquatic Toxicologist

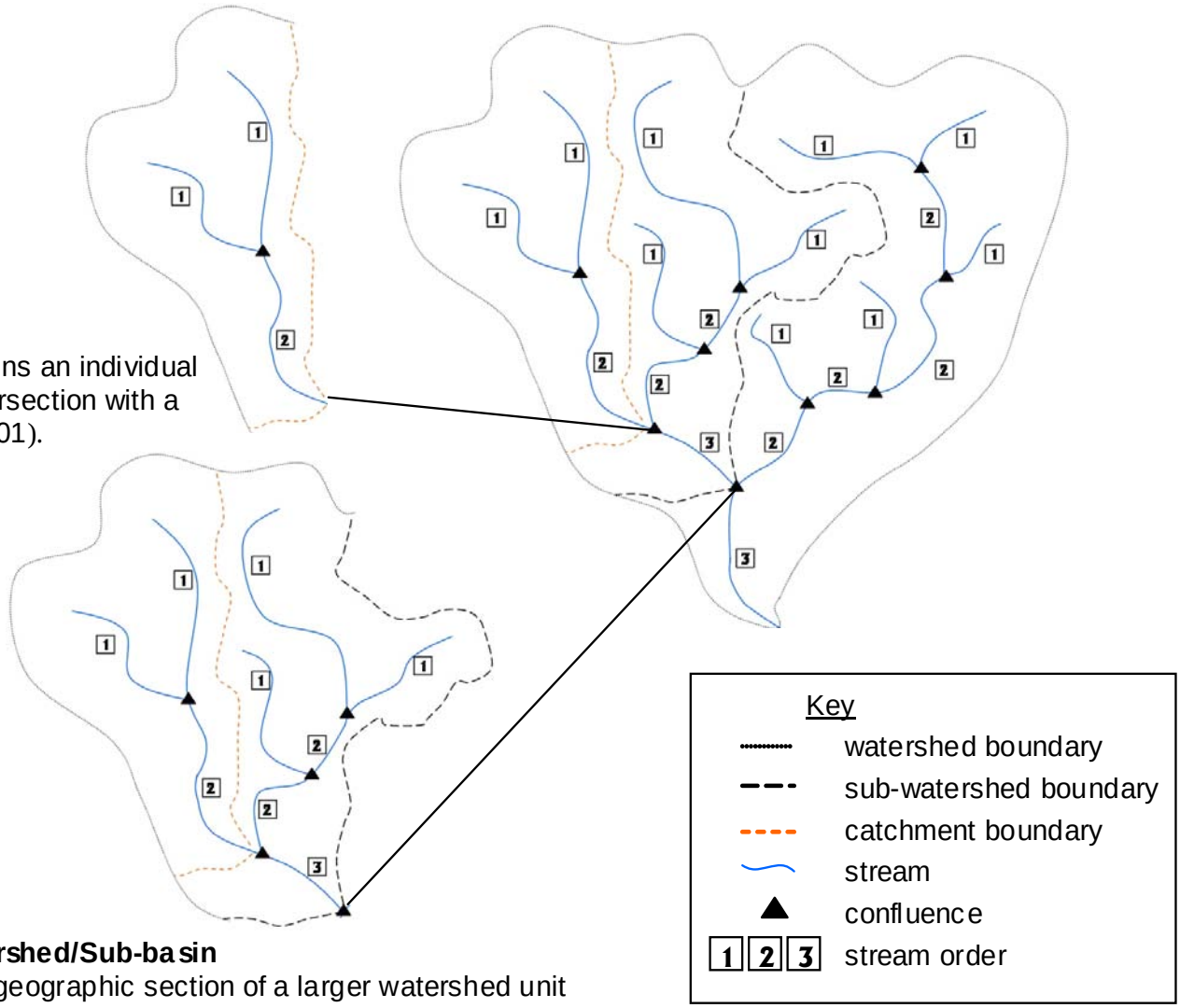
May 15, 2006



N

0 1 2 3 4 5 Miles

Figure 1.3. Types of Watershed Features



Catchment
The area that drains an individual site to its first intersection with a stream (CWP, 2001).

Sub-watershed/Sub-basin
A smaller geographic section of a larger watershed unit with a drainage area between 2 and 15 square miles and whose boundaries include all the land area draining to a point where two second order streams combine to form a third stream (CWP, 2001).

Figure 1.4

Delineation of Silver Creek Catchment

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment / Lake
- Hydrologic Unit Code (12 digit) Boundary

Prepared By:

Aquatic Toxicologist

July 26, 2006

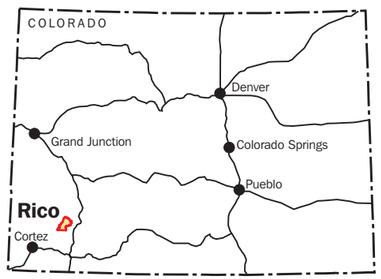


Figure 1.5 The Watershed Planning Process (source; NRCS, 2006).

USDA NRCS
Natural Resources Conservation Service

Figure 1.6. The Hydrologic Cycle (source; USGS)

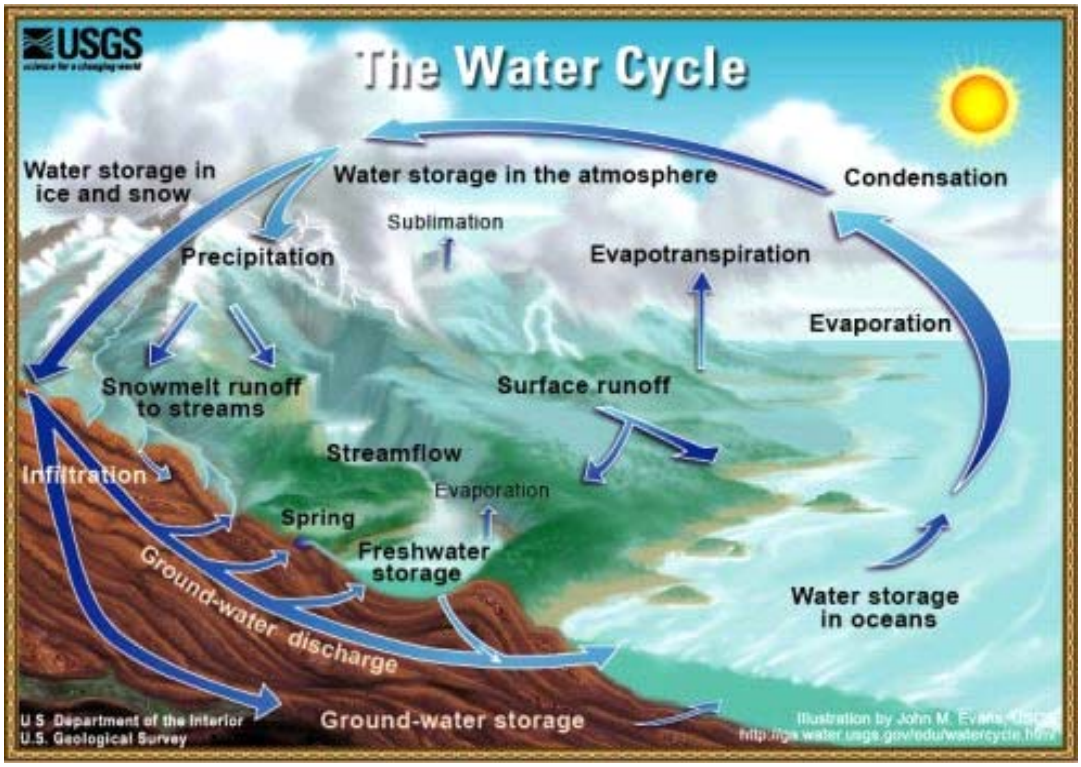


Figure 1.7. Components of Water Balance (CGS, 2004).

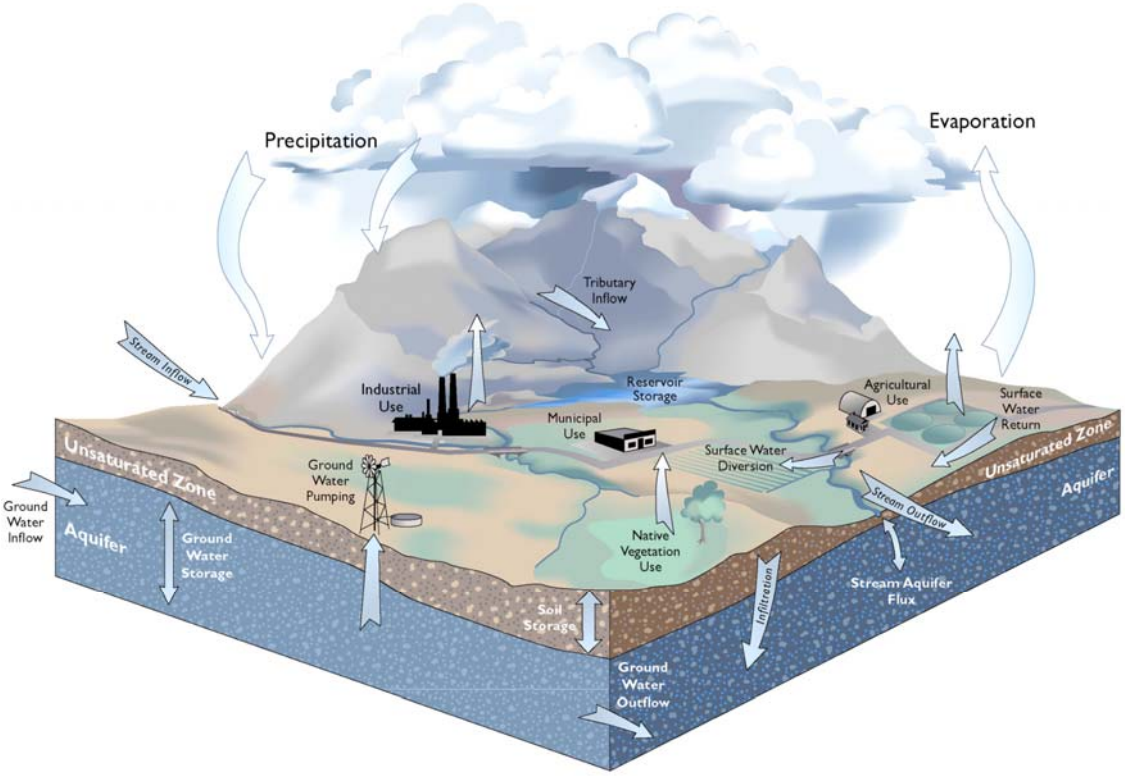


Figure 1.8. Average Annual Water Balance in Colorado (source; CGS, 2004).

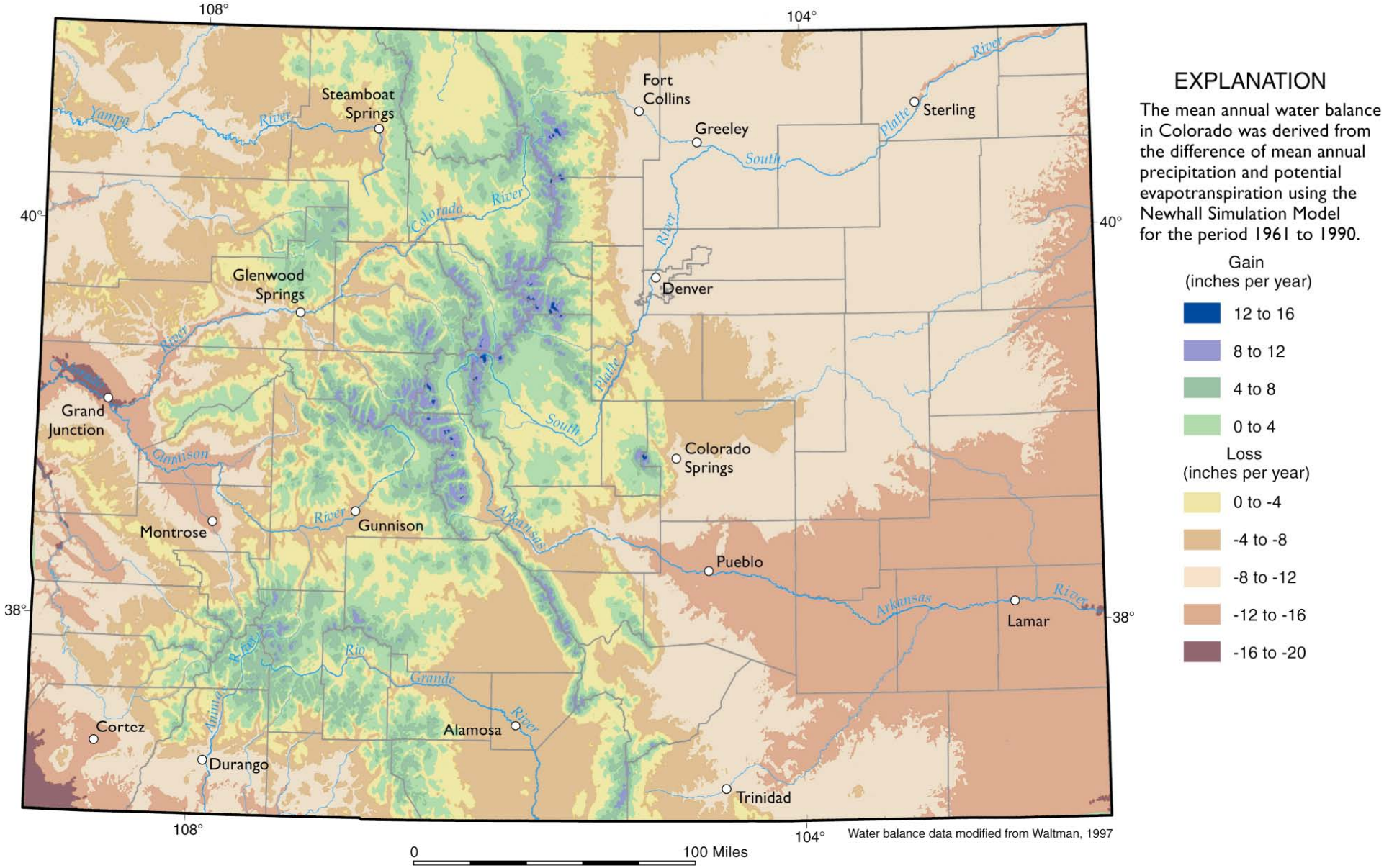
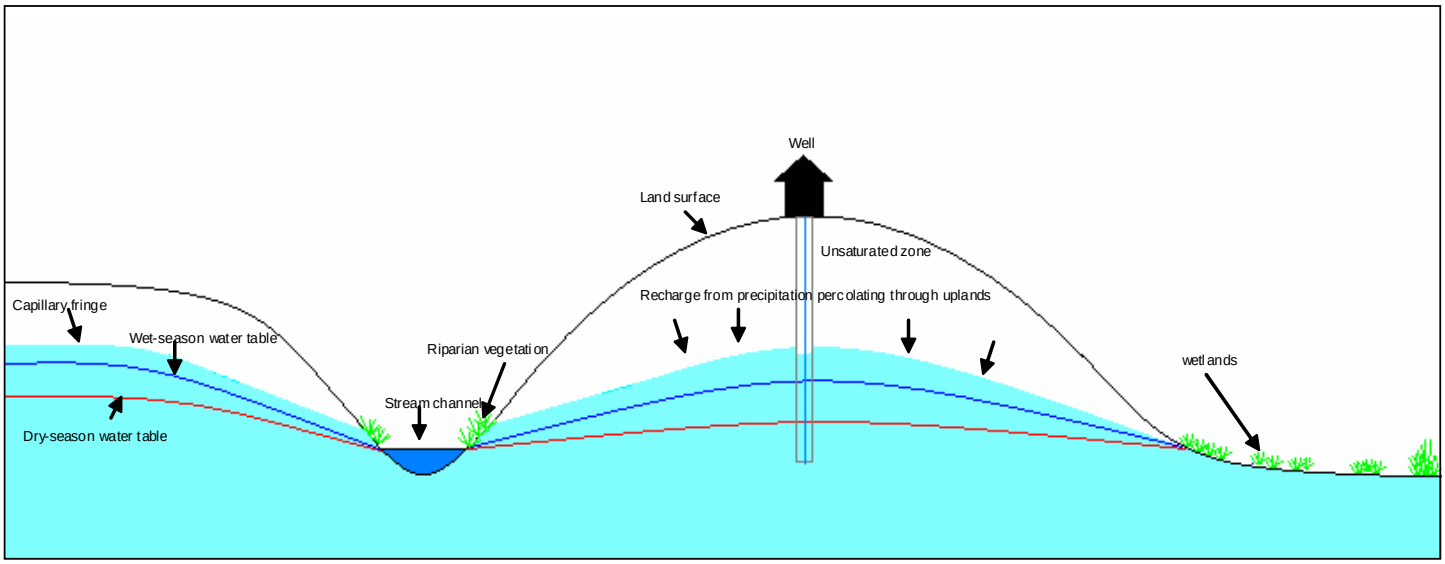


Figure 1.9. Diagram of an Unconfined Groundwater System (source: Dunne and Leopold, 1978).



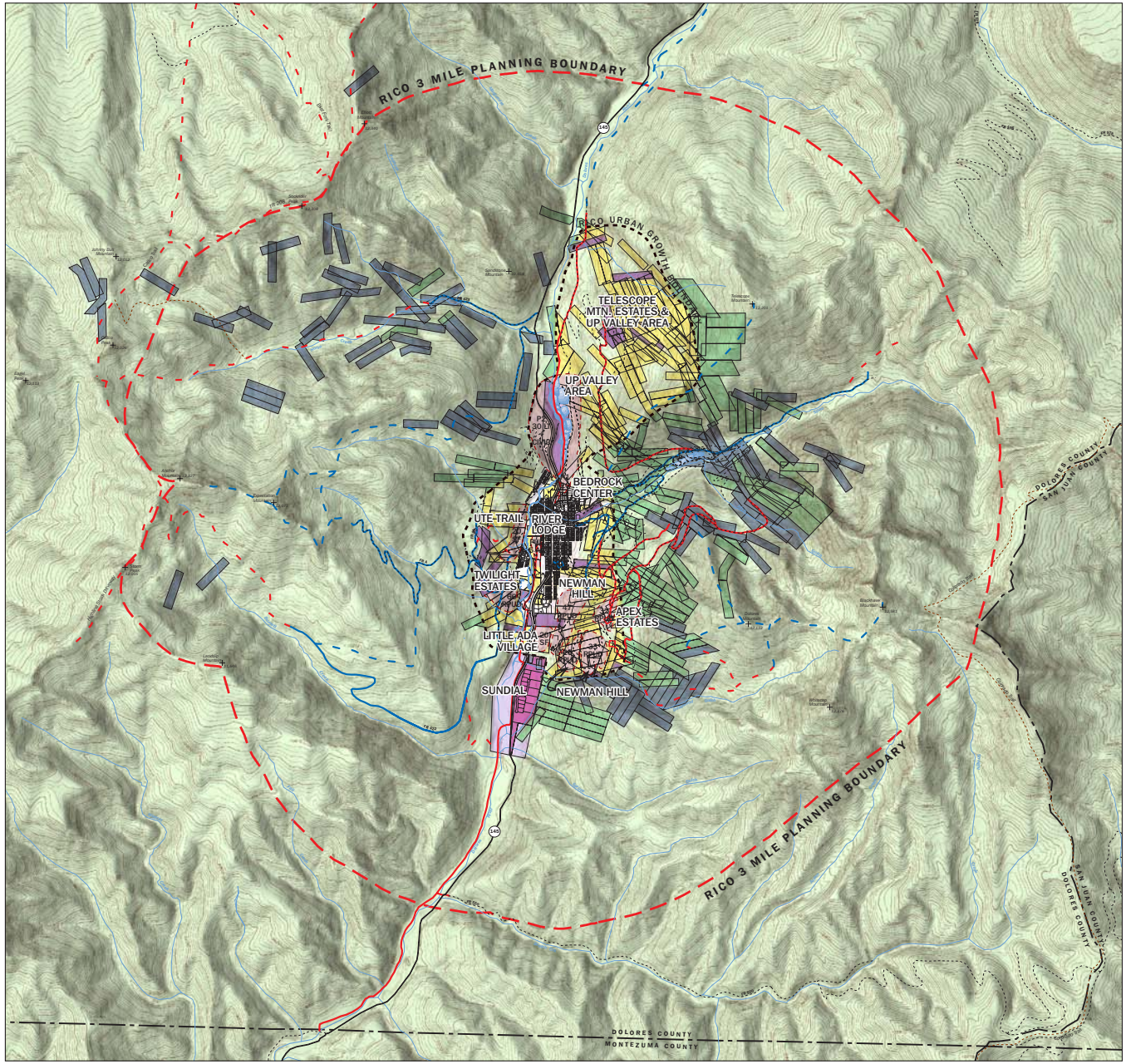


Figure 1.10

Official Rico Regional Master Plan

Adopted by the Rico Planning Commission on Jun 29th, 2004.

By: _____
Tom Bennett, Chairperson

Attest: _____
Linda Yellowman, Planning Commission Secretary

Adopted by the Board of Trustees as the Official Rico on August 18th, 2004

By: _____
Thomas A Clark, Mayor

Attest: _____
Linda Yellowman, Town Clerk

Rico, Colorado

LEGEND

- Rico Renaissance RPUD areas
- Rico Renaissance Open Space
- Rico Renaissance (within the Urban Growth Boundary)
- Other Property Owners (within the Urban Growth Boundary)
- Sundial PUD Area
- Single Family Residential (1 residence per 3 acres)
- Single Family Residential (1 residence per 10 acres)
- Forest Service Lands
- Rico 3 Mile Planning Boundary
- Rico Urban Growth Boundary
- Rico Renaissance PUD
- Motorized Multi-use Jeep Trail
- Non-motorized Multi-use Wide Trail
- Non-motorized Single Track Trail
- Future Non-motorized Single Track Trail
- Trail Connections
- County Line
- Existing Town Boundary
- Asphalt Roads
- Gravel Roads
- Forest Service Trail
- Streams
- Lakes

August 27,2004

0 1000 2000 3000 4000 6000 FT

0 0.2 0.4 0.6 0.8 1.0 MI

Prepared By:
Computer Terrain Mapping, Inc.
Boulder, Colorado

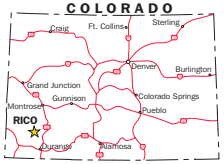


Figure 1.11

Aquatic Habitat Features Within the Project Area

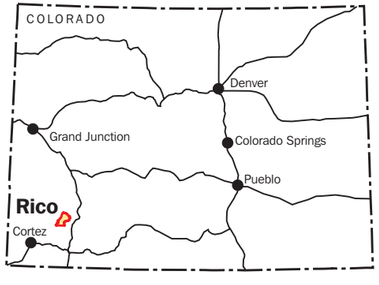
LEGEND

- Rivers & Streams
- Intermittent Streams
- Lakes and Ponds
- 12 Digit Hydrologic Unit Boundary
- Rico Watershed
- Rico Municipal Boundary

Prepared By:

K. King
Aquatic Toxicologist

August 8, 2006



0 1 2 3 4 5 Miles

SECTION 2

2.0 REGIONAL OVERVIEW OF THE DOLORES WATERSHED

2.1 Introduction

This Section presents a brief description of the *Project area* watershed, noting the key tributaries and aquatic features in the basin. It also provides a general description of the geography, geology, hydrology, land use and water quality management of the area. In addition, this Section describes the general water quality issues identified in the area.

The upper East Fork of the Dolores River which comprises the *Project area* is shown in **Figure 1.2**. The *Project area* addressed within this document is defined as ***" the East Fork of the Dolores River in Dolores County, stretching from the county line with Montezuma County to Lizard Head pass and the county line with San Miguel County."*** The *Project area* is encompassed by the "Rico, Dolores Peak, Hermosa Peak and Mt. Wilson US Geological Survey quandrangle maps..

The general aquatic characteristics of the *Project area* were shown in **Figure 1.9** and characterized below. Of particular interest, is the tributary Silver Creek which is a catchment to the *Project area* basin and a significant water quality/quantity issue to the *Project area*. The specific setting characteristics to this catchment were shown in **Figure 1.4.**

The *Project area* occurs within the 'Upper Dolores Watershed and has the Hydrologic Unit Code (HUC) of 14030002. . This 8-digit code was determined by the USEPA and is used as a standard method for watershed identification throughout the United States. The US was divided and sub-divided into successively smaller hydrologic units which were classified into four levels: regions, sub-regions, accounting units, and cataloging units (**Figure 2.1**). The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions).

The Colorado Division of Water Resources (CDWR), also known as the State Engineer's Office, is empowered to administer all surface and groundwater rights throughout the state and to ensure that the doctrine of prior appropriation is enforced. The State of Colorado is divided into seven Water Divisions which are separated by topographic divides creating the seven major river basins (**Figure 2.2**):

- South Platte,
- Arkansas,
- Rio Grande,
- Gunnison
- Colorado
- White-Yampa, and
- Dolores-San Juan.

The *Project area* occurs within the Dolores-San Juan basin – Water Division 7 (**Figure 2.3**). The oversight and management of water resources is addressed in terms of these Divisions. Information regarding basic water rights, water use rates and water balance is described by Division and posted annually on Colorado Water Conservation Board (CWCB) and NRCS web pages. For the duration of this document, 'Division 7 'information was used and relied upon to characterize the *Project area*.

For the purposes of this watershed plan, it is important to have a basic understanding of site setting characteristics. Ultimately, the plan provides guidance for the next steps that could be taken towards water quality improvement and management. These next steps can not be feasible without at least a cursory understanding of the setting and natural features which affect and can control the water resource itself. This Section provides a summary of the natural setting features which need to be considered prior to watershed management.

2.2 Geography, Soils and Geology

The watershed characteristics of a basin are influenced by factors of its geography, soils and geology. These factors influence each other and in turn affect the water quality and quantity characteristics ('hydrology') of a basin. A review of literature-derived information describing the site setting of the *Project area* is provided in the following subsections.

2.2.1 Geography

The occurrence and distribution of water resources are linked to the geography and underlying geology. The geographic variation is expressed in three major physiographic provinces including the Great Plains the Southern Rocky Mountains and the Colorado Plateau. The Upper Dolores watershed occurs within the Southern Rocky Mountains which encompasses the center of the state and runs its entire north-south length. It is characterized by mountain ranges with elevations ranging from 6,000 to over 14,000 feet. The Continental Divide occurs within this region and separates river basins flowing west into the Gulf of California from those flowing east into the Gulf of Mexico. The *Project area* specifically encompasses 68,747 acres. The headwaters of four of the West's major river systems (The Colorado, the Platte, the Arkansas, and the Rio Grande) are within this region (CGS, 2003).

The *Project area* resides within Dolores County, Colorado in the Rico Mountains, a subsidiary group of peaks on the southwest fringe of the San Juan Mountains. Although the peaks are high relative to the plateau country on the west and southwest, they are low relative to the San Juan Mountains. The highest point is Blackhawk Peak at 12,677 feet, approximately 2.5 miles east of the town of Rico. Other peaks that more closely overlook the town all more than 12,000 ft in altitude are Dolores Mountain to the southeast, Telescope Mountain to the northeast, and Expectation Mountain across the river to the west. There are six mountains within the immediate vicinity of Rico that reach over 12,000 feet in altitude (Blackhawk – 12,681; Telescope – 12,201; Flattop – 12,098; Johnny Bull – 12,012; Eagle Peak – 12,113 and Storm – 12,095). There are numerous

'peaks' within the area and include; Harts, White cap mountain, Dolores mountain, Sheep mountain, Elliot mountain, Sandstone mountain, Papoose peak, Expectation mountain, anchor mountain and Landslip mountain (USFS, 2001).

The headwaters of the Dolores River flow south through the heart of the Rico mining district. The Rico mining district is on its east bank at the confluence of Silver Creek. Silver Creek comes from the northeast between Telescope Mountain and high spurs, including Harts Peak, that extend out from Blackhawk peak (McKnight, 1974).

2.2.2 Soils

A soil survey for the *Project area* has not been published. However, preliminary maps and soil characteristics have been summarized and were made available by the Dove Creek United States Department of Agriculture/Natural Resource Conservation Service (USDA/NRCS) office (source John Lestino/Dove Cr/USDA NRCS). Copies of the original information are in the Grayling Env. project files and are cited as NRCS, no date. It is anticipated that a finalized soil survey will be available by 2008. Dolores County has similar soil characteristics to neighboring counties, therefore the County as a whole, has information summarized in several USDA NRCS publications (NRCS, 1997a; and 1997b).

An understanding of soils and their properties is of importance to watershed planning since soil characteristics affect land uses and water management strategies (i.e. the possibility of storage etc). The soil types for the *Project area* are shown in **Figures 2.4 and 2.5** (source: NRCS, 2006). The types of soils are coded by numbers using a standard USDA NRCS nomenclature system. **Table 2.1** provides a summary of the types of soils within the *Project area*, the approximate number of acres they encompass, and key characteristics useful for planning considerations.

Soil scientists within NRCS compile data that characterizes the soil and use it to infer or predict soil behavior for particular land uses and water uses. Within **Table 2.1** are descriptions of permeability, water capacity (referred to as available water capacity), rooting depth, runoff potential and water erosion potential. These parameters define a soils' drainage class and hydrologic group which describe how a soil behaves in the presence of excess water. As shown within **Table 2.1**, most of the soils within the *Project area* have a high runoff potential with a predominately moderate to severe hazard for water erosion. This is largely due to the fact that most of the soils have little ability to 'retain' water (as measured by water capacity), therefore water comes off the soil readily as runoff. This is an important consideration in regards to land use planning for the *Project area* since it appears that the soil condition itself is a contributing cause to erosion and erosion related nonpoint concerns (further discussion is provided in **Section 6**).

The NRCS also provides recommendations for types of land uses the soils can sustain with minimal to low damage. For the *Project area*, a range of uses including livestock

grazing, wildlife, timber and recreation are considered appropriate uses. The distinction between the acceptability of a land use within a given soil type is often related to the vegetation present. For instance, if palatable grasses and forbs are missing, then livestock grazing may not be a recommended land use practice.

The soils within the *Project area* are limited in depth and organic content which is typical for soils in 'soil forming' geographical settings. High altitude, high exposure regions such as the *Project area* are characterized as having exposed rock. The weathering of the rock, along with other forces of nature will eventually form the thin layer of soils found at such extreme settings. These soils are typically lacking nutrients and unstable. They lack water retention capabilities and tend to have a loose texture. These characteristics lend to their potential for erosion and stormwater carriage to receiving surface water bodies, which can contribute to degraded water quality.

2.2.3 Geology

Geology plays an important role in water quality. Some water quality issues in Colorado have their beginning and foundation in natural interaction between water and rock. This interaction can produce poor water quality independent of other influences (Nash, 2002, CGS, 2000). Prior assessment of the geology and associated water quality is necessary in proposed development areas in order to identify pre-development, or 'baseline' conditions and inform planners about potential problems. The Horse Creek – Silver Creek area of the *Project area* was characterized by the Colorado Geologic Survey (CGS) as having a 'naturally degraded water quality' characteristic due to the mineralization associated with the area geology (CGS, 2000). This information is further summarized in the 'baseline characterization' provided in **Section 4.**

A basic understanding of the geology of the area is essential to understanding the nature and occurrence of surface and groundwater. The rock layers form the aquifers in which water is stored, and affect the water quality characteristics of both surface and groundwater. Rock layers are of three basic types; igneous, sedimentary, and metamorphic. Igneous rocks are the cooled, crystallized product of molten magma and volcanic eruptions. They are the source material for both sedimentary and metamorphic rocks. Sedimentary rocks are formed from the material (sediments) derived from the erosion and subsequent deposition of pre-existing rocks, together with material of organic origin. Metamorphic rocks are formed when either igneous or sedimentary rocks are subjected to sufficient heat and pressure to recrystallize them (CGS, 2003).

The Southern Rocky Mountain geographic province is comprised of a structurally complex assortment of igneous, metamorphic, and sedimentary rocks, with the igneous and metamorphic predominating in the Upper Dolores watershed area (**Figure 2.6**). More specifically, the Upper Dolores has a combination of undifferentiated volcanic and intrusive igneous rocks of the Cenozoic Era, sedimentary rocks of the Mesozoic Era and unconsolidated deposits of the Quaternary Period (CGS, 2003).

Project area Geology

The geology of the Rico Mountains which border the *Project area* is extremely complex, with the dominant structure of the district as a faulted dome centered near a monzonite stock. A central faulted horse block of Precambrian rock has been uplifted about 6,000 feet. The lower slopes of the Rico district are generally covered by debris from the hillsides from wash, talus and landslide processes (CGS, 1975). The geologic environment in the immediate surroundings of Town of Rico has been historically characterized for the purposes of primarily understanding the mining ore bodies. A list of relevant references includes;

- Farish (1892) who characterized deposits of Newman Hill,
- Rickard (1897) who wrote of the Enterprise mine,
- Ransome (1901) who characterized the general setting,
- Cross and Spencer (1900) who published a geologic map with their report,
- Cross and Ransome (1905) who published the "Geologic Atlas of the United States, Rico Folio', and
- McKnight, 1974 who consolidated the information from these previous reports and conducted his own ground-truthing investigation.

The geologic environment of the *Project area* consists mainly of Paleozoic sedimentary rocks including limestones, shales, sandstones, and arkoses overlain by quaternary deposits of talus and slope wash, torrential fan deposits, land-slide deposits, and alluvial gravel. The relationship of the *Project area* surface water features to these deposits is shown in **Figure 2.7.** The sedimentary units dip gently to the south and are cut by many east-west striking faults **(Figure 2.8)** (CGS, 1994). The bedrock in the area ranges from Precambrian to Permian. Precambrian rocks include older greenstone and metadiorite and later Uncompaghre Quartzite which is at least 1,000 feet thick. Overlying the Precambrian is the Devonian age Ouray Limestone succeeded by Mississippian Leadville Limestone with a combined thickness of approximately 169 feet (USEPA, 1994).

Quaternary alluvial deposits are coarse in texture and confined to the Dolores River valley. Landslide deposits thought to be on the order of several-hundred feet thick and containing many large blocks, encroach onto the alluvial deposits and have forced the river westward against Sandstone Mountain. The torrential debris fans are found at the mouths of Silver Creek, Horse Creek, Aztec Gulch and Deadwood Gulch. This fan material covers much of the Town of Rico (CGS, 1994). Talus and slope wash cover the lower slopes of the mountains surrounding the area and have been measured to be 300- to

400-ft thick in places where mining access was required. Calcareous tuft has been identified on the slopes south of Iron Draw on the west side of the Dolores River and are shown to overlap with fan debris (CGS, 1994).

Bedrock in the vicinity of Rico ranges in age from Precambrian to Permian. The Precambrian rocks include greenstone, metadiorite and the Uncompahgre Quartzite. The quartzite is overlain by the Devonian Ouray Limestone which is succeeded by the Mississippian Leadville Limestone. These formations have a combined thickness of 160 ft. The Leadville dips between 23 and 40 degrees to the south. A thin quartzite thought to be equivalent to the Molas formation and identified as Larson Quartzite overlies the older Paleozoic sedimentary units. The Pennsylvanian Hermosa Formation is the most widespread in the area and is composed of arkoses, sandstones, shales and conglomerates. Minor interbedded limestones occur through the 2,800 ft thick Hermosa Formation, but are for the most part located in the middle of the formation. The limestones of the Hermosa Formation host much of the ore which was mined from the historic district. The conglomeratic units occupy the upper third of the formation. The Pennsylvanian Rico Formation overlies the Hermosa and is composed of approximately 300 ft of sandstones and arkosic conglomerates. The Cutler Formation overlying the Rico consists of 2,800 ft of sandstones, conglomerates, shales and thin limestones (CGS, 1994).

Intrusive rocks in the Rico area include sills and dikes of hornblende latite porphyry, alaskite porphyry, and lamprophyre. A monzonite stock which crops out west of the Dolores River has metamorphosed the adjacent strata for up to 1.7-miles east of the contact. One of the main structural features of the area is a 10-mile diameter dome centered just east of the monzonite intrusive. Faults are plentiful in the area and generally strike easterly and dip steeply to either the north or south. A large horse block trends easterly from the intrusive. Most of the downtown mining has occurred within this horst (CGS, 1994).

Intrusion of the igneous rocks formed a structural dome about 6,000 feet high and 5 to 10 miles in diameter. The doming event was accompanied by faulting, folding and tilting of the sedimentary rocks in the Rico area. Some of these faults provided channels for mineralizing fluids to replace adjacent sedimentary rocks and form vein deposits. Large quantities of silver, lead, zinc, and sulfuric acid (from pyrite) were produced from replacement and vein-type deposits in the Rico area. Gold and copper were byproducts. At least one deeply buried, sub-economic stockwork molybdenum deposit exists (Neubert et al., 1992).

The ore deposits of the district consist of (Ransomme, 1905; and McKnight, 1974);

- Massive sulfide replacement deposits in the limestones of the Hermosa Formation,
- Contact metamorphic deposits of sulfides and iron oxides in limestones of Ouray, Leadville and Hermosa Formations,

- Veins on fractures and small faults in Hermosa sandstones and arkoses, and
- Replacement deposits in residual debris in lower Hermosa formation (the rich blanket deposits) (USEPA, 1994).

Groundwater Geology Units

Colorado's groundwater aquifers are categorized by their geologic unit. Geologic units consist of either unconsolidated sediments or consolidated rock. The groundwater geologic units associated with the *Project area* are shown in **Figure 2.9**. Groundwater is simply water filling the pore spaces between rock grains in sedimentary rocks or in crevices such as fractures and faults in crystalline rocks. A geologic unit's ability to store and transmit water is dependent on the amount of pore space, and the degree of interconnection between pores.

The *Project area* occurs within the 'Paradox' sedimentary rock aquifer and structural basin, and also within a tertiary volcanic and intrusive igneous rock mountains region aquifer (**Figure 2.10**) (CGS, 2003). The Paradox sedimentary basin is al elliptical shaped basin that covers approximately 14,000 square miles, of which 5,600 square miles are located in Colorado. The Paradox Basin is the unit underlying the *Project area* aquifer which is comprised of Precambrian crystalline and tertiary igneous rock aquifers. The major hydrogeologic unites in the region consist of an upper Mesozoic sandstone aquifer and a lower Paleozoic carbonate aquifer that are separated by a thick sequence of confining salt beds. Both natural gas and oil are produced from the lower Paleozoic aquifer and the groundwater is typically saline (CGS, 2003). The lower reaches of the Dolores River (outside of the *Project area* and below McPhee reservoir) picks up an estimated 205,000 tons of salt annually as it crosses Paradox Valley, primarily from the surfacing of natural brine groundwater associated with the Paradox Unit (CWCB, 2005). This brine is disposed of via deep well injection as managed by the Bureau of Reclamation outside of Bedrock, Colorado (CWCB, 2005).

Crystalline rocks represent a unique and expansive aquifer system. Unlike the sedimentary rock aquifer (such as the Paradox), igneous and metamorphic crystalline rocks have no primary porosity; water is stored in fractures within the rocks. In turn, the water storage capability of these rocks is low.

The *Project area* is primary comprised of this type of hydrogeologic characteristic. In general. groundwater within the fractured crystalline rock aquifers is unconfined with water levels fluctuating seasonally and correlating with precipitation events. The predominant recharge is from snowmelt occurring between the middle of May and the first part of July. Water levels can fluctuate up to 10 feet or more depending on the season as well as on yearly variations in precipitation. Typically, water levels are highest in the spring or early summer when there is high runoff, and lowest in the winter when frozen ground and precipitation in the form of snow rather than rain inhibit recharge. Regionally, the water table mimics the surface topography. The general flow direction is down-slope and toward surface drainages. Water quality in Precambrian crystalline-rock

aquifers is generally good, except in areas of mineralization where acidic or metallic waters may be found. Due to the thin surficial soil cover and direct fracture connection to the water table, bacterial contamination from leach fields can be a concern. Radon can also be a concern in wells completed in Precambrian rocks because of the presence of naturally occurring uranium and radium which decay into radon (CGS, 2003).

2.3 Hydrology

The Dolores River basin is about 95 miles long from northwest to southeast and encompasses an area of just over 5,300 square miles. The river eventually meets the Colorado River near Cisco, Utah. Formation of the Dolores River was complex. It flows southwest down the side of the Rico Mountains before turning abruptly north. It is hypothesized that the Dolores River originally continued towards the southwest and that geologic processes acted to re-route the river to the north (Weir et al., 1983).

The Dolores River watershed is highly erosive and can move water, sediment, and large debris by flowing water and avalanches. Peak flows are normally associated with spring snow melt or heavy rain fall (typically in the fall season). Channel substrate is course alluvial material, mostly cobble and rubble. Valley slope is approximately 1.3%. The river had a moderate gradient and follows a meandering pattern. Historically, the river valley within the area of Rico was relatively un-confined, in that the channel could meander and migrate across the valley to a greater extent than it can currently. Activities such as roads, railroads, mining, and urban development have imposed physical changes to the valley and the river channel.

The *Project area* is encompassed by the CDWR's Division 7 (the San Juan/Dolores River Basin) and occurs within District 71; the West Dolores Creek/Tributaries. The rivers in Division 7 drain the west and central portion of the San Juan Mountains and parts west, stretching from the continental divide to the state line of both Utah and New Mexico (refer to **Figure 2.3**) (CWCB, no date; CWCB, 2000). Specifically, the *Project area* is a part of the 'Dolores River Subregion which is bounded as follows;

- On the north by the Dolores River – Colorado River basin divide
- On the east by the Dolores River – Gunnison River basin divide,
- On the south by the Dolores River- San Juan River basin divide; and
- On the west by the Colorado – Utah state line

The *Project area* specifically encompasses an area referred to as the upper reach of the mainstem of the Dolores river. It begins at the headwaters of the Dolores river and progresses down-gradient to the Montezuma County line which is immediately prior to the confluence with the West Fork of the Dolores River. The following subsections describe the *Project area* groundwater and surface water characteristics.

2.3.1 Groundwater

As previously described within the Groundwater geology Unit discussion, groundwater within the *Project area* is predominantly associated with the crystalline rock and some alluvial rock aquifers. It is unconfined with water levels fluctuating seasonally and with precipitation events. The predominant recharge is from snowmelt occurring between the middle of May and the first part of July. Typically, water levels are highest in the spring or early summer when there is high runoff, and lowest in the winter when frozen ground and precipitation in the form of snow rather than rain inhibit recharge. Regionally, the water table mimics the surface topography. The general flow direction is down-slope and toward surface drainages. Water quality in crystalline-rock aquifers is generally good, except in areas of mineralization where acidic or metallic waters may be found.

Alluvium within the Dolores basin is comprised of typical Quaternary alluvial valley fill. These deposits consist of gravel, sand, silts, clay and various mixtures. In the *Project area*, some glacial deposits are present. The alluvial extent is limited to areas near the river and its tributaries and disappears entirely in areas where active canyon down-cutting is occurring.

Little data is available for the Dolores alluvial aquifer. The shallow unconfined aquifer associated with the alluvium is assumed to have a fairly high conductivity and estimated to flow south along the Dolores River and southwest along Silver Creek (USEPA, 1994). It is suspected that this shallow aquifer is heavily mineralized (USEPA, 1994) as was verified by the State of Colorado, Division of Highways who had drilled a well on the south end of the Town for water supply for a maintenance shop but had to abandon it after a couple of years due to heavy mineralization in the pipes (USEPA, 1994).

Deeper bedrock aquifers within the limestone formations were evaluated with historic drill holes, which were later capped (USEPA, 1994). This groundwater resources reaches the surface in the form of several seeps and springs found in the area, that appear to be geothermal in nature. One historic drill hole is used by locals to supply hot water to a pool used to soak in (USEPA, 1994). Many of the springs contain carbonic acid gas and sulphurated hydrogen (Cross and Ransomme, 1905). Some springs are calcareous due to the high carbonate of lime contained by many of the geologic formations and several springs are iron-bearing and have left local deposits of iron oxide (Cross and Spencer, 1900).

The groundwater within the *Project area* portion of the Dolores River basin is administered by the Office of the State Engineer's Water Division 7 (CDWR). The CDWR well permit database was reviewed in order to characterize the groundwater in the *Project area*. Copies of well records and permitted well locations are provided in **Appendix C** to this document. A summary of findings from the records review is as follows;

- There are 8 wells permitted within the *Project area* as per review of existing CDWR records (Mancos Office of Division 7) (**Figure 2.11**)

- The depths of the wells of record range from 8 to 400 feet below ground surface (bgs).

- Reported well yields varied from 3.5 to 400 gallons per minute (gpm) with the highest yield associated with a monitoring hole series used by the USFS and Dolores Water Conservancy District (refer to **Appendix C**).

Typically, where present, the Dolores River alluvium is only capable of yielding low to moderate quantities of groundwater (CGS, 2003). CGS inventoried the alluvial wells throughout the entire Dolores Basin and found that 90% of these wells yield less than 50 gpm with the average well yielding only 22 gpm. However, CGS notes that the reported yield values within the CDWR well permits may not be indicative of the hydraulic characteristics of the aquifer, but rather due to having to report the statutory pumping limitation of 15 gpm for domestic or stock-watering wells (CGS, 2003).

Personnel communication (SEH, and others) has indicated that there are 'geologic pinch points' in the basin that control aquifer characteristics and flow. These pinch points can be envision as creating a value at the terminus of an aquifer, thereby controlling flow out of the basin and mingling of the groundwater with adjacent settings. As per communication information these pinch points occur just below the St. Louis ponds and below the Town of Rico.

2.3.2 Surface Water

The *Project area* begins with surface water features that are referred to as 'headwaters' streams. The headwaters represent the first collection points of runoff from a watershed into a defined channel. Headwater streams are exceptionally vulnerable to watershed development. They are typically short in length and drain relatively small areas.

Headwater streams are referred to as streams having an order of '1', meaning they contain the primary source of water (refer to **Figure 1.3**). As the stream progresses down gradient, and combines with another stream order one stream the confluence becomes a stream order 2. This numeric succession or ordering is a useful tool for watershed management because management strategies differ significantly for streams by their order (Rosgen, 1998).

Stream flow measurements of the *Project area* have been gathered by the USGS and others for a variety of purposes. The USGS maintains a gauging station below the Town of Rico referred to as USGS gauging station 09165000 (hydrologic unit code 14030002 http://waterdata.usgs.gov/co/nwis/annual/calendar_year?). This gauging station represents the mid-point of the *Project area*. Readily available information regarding current flow conditions can be found on the Water Information Program web site (http://web.frontier.net/SCAN/wip/wiphome.html, or by calling the Southwester Water Conservation District via email: water@frontier.net (or by phone: 970-247-1302) (Colorado Outdoors, 2006).

Review of *Project area* flow information indicates that the upper area is a 'gaining' stream (gains flows over distance) within the upper area, with losses ('losing' stream) due to surface water recharge of the groundwater, beginning at the alluvial fan aquifer areas, and depending upon the time of year. There appears to be little man-made effects attributable to draw-down activities such as the potable supply use of Silver Creek flows.

The stream flow has marked seasonal variations. As shown in **Figure 2.12** which depicts the annual hydrographs for water years 2000 through 2005, the annual flows are marked by significant spring melt runoff periods with low flow fall/winter periods with occasional high flows from significant summer rain events. Historic records of 'peak' flows indicate that high flow periods occur in the mid-summer when snow melt is at its highest. A summary of historic peak flow records is provided in **Table 2.2**, while a summary of monthly stream flow values from 2000 through 2005 are provided in **Table 2.3.**

Bankfull flow is referred to as the 'flow volume that fills the normal channel' and is an important parameter of channel geometry and maintenance. The bankfull stage corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forms or changes bends and meanders, and generally does work that results in the average morphologic character of channels (Dunne, T. and L.B. Leopold, 1978). When flows exceed the bankfull stage, flooding can occur. Statistical analysis of river flows show the bankfull discharge to occur on average, every 1.5 years. Typical bankfull discharge (at a the USGS gauging station below Rico) was determined to be in the range of 980 cubic feet per second (cfs). This value was calculated using USGS data from the gauge at the Montelores Bridge (Derfus, C., 2001).

Flooding within the *Project area* was evaluated by Matrix Design Group (2004) using the above referenced hydrographs. Their interpretation of the USGS flow data identified flooding has occurred on the Dolores River in the years 1952, 1957, 1958, 1973, 1980, and 1984. Droughts were recorded for 1977 and 2002. The largest flood events occurred in June 1884 and October 1911.

The Dolores River floodplain through Rico was first studied by Chris Wilbur, PE in September 1995 in a report titled, 'Documentation for Hazard and Constraint Maps, Town of Rico Colorado. The CWCB completed an evaluation of the floodplain study in September 2000 titled, "Floodplain Information Report" which adopted the Wilber report. The recommended 100-year hydrology for the floodplains in Rico is as follows:

- Dolores River at Rico – 2,800 cfs
- Silver Creek – 700 cfs

These basin floodplain projections were calculated using basin-specific regression equations as developed by the CWCB (2000) as follows;

Eqn. 2.1 $$\mathbf{Q = 213.8(A)^{0.601}}$$

Where:

A = Drainage Area, square miles (given $2 < A < 1{,}080$)
Q = 100 year peak flow in cfs

Other studies regarding flood plain characteristics and flood hydrographs were also studied in the Rico mining districts in order to better understand flood impacts (Dames & Moore, 1981). These estimates appear to have been folded into the more current evaluations presented by CWCB and others. CWCB maintains a 'virtual Water Resources Information Center' which contains a record of all floodplain analysis by watershed (CWCB, 2006: http://cwcb.viis.state.co.us/FloodplainDocs.htm). Specific files for this *Project area* are located on http://cwcb.viis.state.co.us/cgi-bin/openwb.EXE?ID=71839688&WBID=Q6APRJE3PNJO....)

Water quality is discussed in detail in **Section 4** of this report. The water quality within the *Project area* has been described by various entities over the years, for a variety of reasons. Included within this group of historic studies are the Colorado Geological Survey (CGS) who evaluated the Horse Creek tributary and identified this setting as a 'naturally occurring, acidic, metal-rich spring or seep area' (NOAMS) (Neubert, 2000). The area as a whole has geologic characteristics that lend to mineral rich environments (thus the mining presence) and geothermal conditions. These types of settings can in turn lead to naturally mineral rich environments. In addition, being located at headwaters settings, other water quality characteristics such as alkalinity are typically low (due to low buffering capacity and the lack of carbon content) and hardness being high (elevated magnesium, calcium and iron due to mineral weathering). These conditions are not atypical to Colorado mountain/headwaters systems. These characteristics in combination control the amount and types of aquatic life that can be sustained. These characteristics would be considered harsh and in-turn limit the amount of life sustainable by the system.

2.3.3 Hydrology of Silver Creek

The Silver Creek drainage basin was treated as its' own area for planning purposes. A thorough understanding of this catchment is essential to the next steps in the *Project area* water planning. The Silver creek area lies to the east of town, encompasses approximately 5 sq miles and is flanked on the south by Blackhawk Mountain, the highest peak in the area with an elevation of 12,677 ft. Many small tributaries drain the

steep slopes and flow into Silver Creek which is 3.5 miles long and the principle drainage in the basin. Except for the first mile of very steep headwater length and the last 0.5 miles of gentle gradient slopes approaching the Dolores River Valley, the gradient is uniformly ten horizontal to one vertical (10 percent) (CGS, 1994).

Silver Creek flows westward past the Van Winkle Mine, under State Highway 145 through a concrete box culvert roughly 4-ft high by 6-ft wide and then goes northwest to the Dolores River. Stream velocity is between 5 and 10 ft per second. The channel is about 6-ft deep by 6- to 8-ft wide as it progresses past the concrete wall at the head-frame. Bed-load (bottom substrate) is not embedded (loose) and consists of cobbles and boulders from 4 to 18 in. in diameter (CGS, 1994).

The creek is very steep (approximate gradient of 13%), confined, has high flow energy and is relatively unstable. Substrate is course as a result of debris from slides and avalanches. Man made alterations (roads, culverts and berms) have added to some of the instability (i.e. especially from Hwy 145 to the mouth there is confinement due to berms) (Derfus, C., 2001).

Although, the creek is a small area it can contribute large flow volumes, avalanches and debris flows. The mouth of the creek is a debris fan as a result of these debris flows. C. Wilber (1995) estimated the 100 year flow event to be approximately 350 cfs. More recent estimates of the Silver Creek 100-year floodplain (of 750 cfs) are contradictory to this information. Matrix Design Group summarized available information from these and other previous works (FEMA, 1986 and 1989) and has provided recommendations regarding the Silver Creek floodplain condition (Matrix Design Group, 2004).

C. Wilbur (1995) stated that the section between Hwy 145 and the mouth would be able to hold a 100 year event, but that the culverts at Hwy 145 could easily become plugged (Wilbur, C., 1995). Division of Water Resources personnel analyzed the Silver Creek basin for a flood event with a 1- year return period. They used the computer program HEC-1, and the spillways method to size a culvert for installation in Silver Creek. Using a roughness coefficient of n=0.022 yielded approximately 3 ft as the required diameter. Any pipe of greater diameter would suffice and would provide a larger factor of safety. A final design for the culvert was 6-ft in diameter (CGS, 1994).

2.4 Climate

The climate of an area will ultimately control its water resources because the source of surface and groundwater is ultimately precipitation. In Colorado's semi-arid climate, most of the precipitation that falls on the land surface is lost through evaporation, and most of the precipitation occurs as snowfall during the winter and early spring. Precipitation varies tremendously with altitude and topography. Approximately 45% of the *Project area* is above timberline, and occurs in the high mountain region which lends to its high amount of snow accumulation (Dames & Moore, 1981).

Snowfall data was obtained from the Natural Resource Conservation Service (and historic Soil Conservation Service sources), which maintains two snow course data stations within the proximity of the *Project area*;

- Lizard Head Pass – Site No. 586, Station ID 07m29s (Lat 37.799256, long. -107.924260 elevation 10,200), and

- Scotch Creek – Site No. 739, Station ID 08m08s (lat. 37.645555, Long. -108.007859, elevation 9,100)

These stations provide snow depth and water content measurements, as well as total precipitation rates by location. **Table 2.4** provides a summary of the total precipitation for the Lizard Head Pass SNOTEL site which most closely estimates precipitation conditions for the *Project area*. **Table 2.5** provides the annual and monthly SNOTEL precipitation rates for the Scotch Creek site which is down-gradient of the *Project area*. The results from these two locations 'bracket' the *Project area*. Within **Tables 2.4 and 2.5** the 'monthly accumulation' and 'total accumulation' rates are shown. The total rates are calculated by summing the monthly rates as time progresses. **Figures 2.13 through 2.16** depict the annual and monthly precipitation accumulation for the Lizard Head and Scotch Creek locations. As summarized within these Figures, 2002 was a severe drought year. The months of May through July are typically characterized with low precipitation rates. Snow melt can begin as early as January and continues through to April. Fall rain and snow storms contribute to the recovery of precipitation after the summer months.

The average annual precipitation in the state is 17 inches (CSU, 2002). The Upper Dolores watershed area receives an range of 25 – 48 inches per year (CSU, 2002), with a mean annual precipitation within the *Project area* of 27 inches. Precipitation conditions are shown on **Figure 2.17**. These standard precipitation maps (SPI) were developed by McKee et al (1993) for the purpose of defining and monitoring drought. The images allow a person to determine the rarity of a drought or an anomalously wet event as compared to regional typical characteristics.

Sufficient precipitation records exist in order to determine the drought periods within the area since 1898. Recent droughts in the Division 7 area occurred in 1899-1905 (extreme), 1918 – 1919, 1931 – 1936, 1945 – 1947, 1951 – 1952, 1954 – 1957, 1976 – 1978, and 1989 – 1991. the most sustained drought in the tree-ring record for the river basin occurred in 1273 – 1289. Many archaeologist believe this period of severe sustained drought coincided with the abandonment of Mesa Verde by the Anasazi (CWCB, 2004)

2.5 Ecological Setting

Photo 2.1 depicts an historic image of Horse Gulch captured in the late 1800s by Thomas McKee [source:DPL,no date]. As shown within this photo, the historic setting looks much like today's features within the *Project area*. The ecological setting of the *Project*

area is controlled by many factors of the environmental setting. The geology of an area underlies and often dictates the environmental pattern. Climatic patterns describe the distribution and periodicity of precipitation and temperature. Vegetation provides the layers that affect landforms, moderates the climate and dictates the presence of animal species. Colorado environments are described in terms of eight ecosystem types which are described by their classical life-zones within them (Fitzgerald et al., 1994). The *Project area* contains areas having alpine tundra and subalpine forest. The aquatic systems are confined largely to narrow flowing streams that either have year-round (perennial) or sporadic (ephemeral/intermittent) flows. Descriptions of the terrestrial and aquatic ecosystem settings are provided in the following subsections. A comprehensive evaluation of vegetation, wildlife and sensitive species was previously conducted by Cedar Creek Associates (Cedar Creek Associates, 1995. Ecological Characterization: Vegetation Communities/Wildlife Habitats and Sensitive Species, Rico, Colorado. September, 1995), but the report was not available at the time of this document production.

2.5.1 Terrestrial

The terrestrial setting within the *Project area* is comprised of a diverse environmental community. The elevation and climate control the floral and faunal species to those hearty enough to withstand seasonal extremes. The hills have a discontinuous forest cover in which aspen, Colorado blue spruce, and Engelmann spruce at higher levels are dominant types. Valley slopes are dominated by aspen stands intermixed with conifers such as Blue spruce, and Douglas fir. The timberline is at about 11,500 feet (McKnight, 1974). The subalpine meadows are dominated by grasses and forbs. The drainage areas tend to be dominated by thickets of willows and species of alder. River corridors contain a diverse riparian community often dominated by cottonwood, alder, snowberry and willow. Associated wetland areas offer patches of willows, rushes and sedges.

The riparian areas within the Dolores River corridor near Rico have been defined as valuable vegetative communities (C. Wilbur, 1995). These areas have characteristics of the Montane Riparian forest ecosystem type. This plant community is listed as imperiled statewide (CNHP, 1995).

Riparian areas are valuable habitats in that they provide a diverse environment of flora and fauna. Wildlife depend on these areas for providing food and cover as well as a means for protective travel corridors (Bookhout, T., 1994). Up to 70% of the vertebrate species of a region will use a riparian corridor in some significant way, and maintaining this unique community will help maintain the aesthetic and wildlife values of the Dolores River (Naiman, R., 1993).

Given the great diversity of habitat types, there is also a diversity of wildlife species including birds, mammals, reptiles and amphibians. A list of observed species was collected by C. Derfus, 2001. In addition a summary of the possible threatened and endangered species that may utilize the area was also gathered. There have been no

observations of these species within the *Project area*, however the habitats present could support their activity. **Table 2.6** provides a summary of the potentially occurring threatened and endangered species, and their status.

The *Project area* supports habitat conducive for amphibians (Western toad, striped chorus frog, Northern leopard frog, western boreal toad, wood frog and tiger salamander), reptiles (western terrestrial garter snake and possibly the smooth green snake) potential elk calving and forage areas, and avian habitat (American robin, Redtail hawk, Gray jay, Blue grouse, Ptarmigan, Broadtailed hummingbird, Violet-green swallow, crow and various sparrows). Species of elk, deer, mountain lion, black bear, coyote, beaver, skunk, chipmunks, squirrels, muskrat and other rodents are all known to occur in the *Project area*. A diversity of bats (Mexican freetail, Hoary bat, Silver-haired bat, Big brown bat, Little brown bat, small footed myotis, long legged myotis, Fringed Myotis, Long eared myotis and Pipestrilla) have been inventoried by the Colorado Division of Wildlife (CDOW).

2.5.2 Aquatic

The aquatic habitat setting within the *Project area* would be best described as a limited cold water habitat. The fisheries condition within the Dolores River watershed as a whole has been described by others. CDOW (Colorado Outdoors, 1989) described the Dolores River as being a minimal fishery until the establishment of the McPhee Dam. The 270-foot dam created a fishery below by providing stable water temperatures for a trout haven. Prior to the Dam, the fishing was 'fair at best'. Fish up to 5 pounds may have been taken, but most were smaller (Colorado Outdoors, 1989).

Specifically within the *Project area* here are some trout populations present. Species that have been collected include rainbow trout (*Onchorhynchus mykiss*), Brown trout (*Salmo trutta*), Brook trout (*Salvalinus fontinallis*), Cutthroat trout (*Salmo clarki*) and Mottled sculpin (*Cottus bairdi*). With the exception of the sculpin, all other species have been introduced. Historically, the only trout that occupied the Dolores drainage were strains of the Colorado cutthroat. Only a few remnant populations of these 'pure' fish can be found in steep, remote drainages throughout the San Juan Mountains.

The aquatic ecology of the *Project area* water systems is a function of its altitude, gradient, water quality, valley confinement and management of the aquatic populations. There is conflicting information available about the aquatic health of the *Project area*. It has often been assumed that degraded water quality as a result of the mining issues has caused an adverse effect to the aquatic populations of insects and fish. However, others have observed fish and invertebrate populations within the most potentially impacted areas (Derfus, C., 2001). Having reviewed the information available from these studies it appears that there are several factors affecting the aquatic community. These factors include the lack of available habitat as caused by the high gradient channel and flows, the lack of meandering of the channel due to confinement (created by the valley form and artificial sources such as roads, railroads and development). A summary of the studies

describing the *Project area* aquatic setting that were reviewed for this report are as follows;

CDOW, 1982 (as documented within USEPA, 1994). The CDOW conducted fish studies on two 500-foot reaches of the Dolores River near Spruce Creek, one and one-half miles below the Town of Rico in 1982. Results indicated that they found three rainbow trout between ten and twelve inches in length, and one small brown trout. The CDOW performed habitat improvement in the form of in-stream boulders and check dams which led to increased populations of brown trout between five and six inches in length in 1983. By 1984, CDOW fish sampling showed greatly increased populations of ten to twelve inch brown trout and slightly increased populations of rainbow and brook trout. At the time of this effort, the Dolores River was recorded to experience heavy fishing pressure, therefore the CDOW stocked fish through the Town. The upper head-waters of the River (above the Town) support a viable native cutthroat trout fishery. At the time of the study, Silver Creek was investigated and found to have little aquatic life because of the heavily mineralized water below the mines; however, CDOW stocked native cutthroat approximately two miles above Rico within the Silver creek drainage and were found to be doing well (USEPA, 1994).

CDOW, 1992. In 1992, fish sampling was completed at the Montelores Bridge by USFS, CDOW and others. Results documented by CDOW indicate that the fishery is entirely reliant on stocking due to poor water quality and lack of habitat (CDOW as cited by C. Derfus, 2001).

C. Derfus, 2001. Corey Sue Derfus completed a '*Report of Biological & Aquatic Surveys Along the Dolores River Corridor at Rico'* in 2001. Her observations indicate the presence of trout in viable habitat areas which are few in the reach of the Dolores River spanning from just above Rico to approximately one mile below Rico. Fish were observed in pool areas below the confluence of Silver Creek, and within Silver Creek itself. Aquatic benthic macroinvertebrate samples were collected above and below the town of Rico (one location above, and one location below). The results were provided with some interpretation. Having reviewed the taxonomic list of species gathered, it appears that there is a decrease in the numbers and types of sensitive invertebrate species. This can be the result of diminished water quality in combination with habitat characteristics (bottom substrate composition). Further evaluation of this data in combination with measures of water quality and habitat characteristics needs to be completed in order to understand the cause of any observed aquatic insect population effects. Results of C. Derfus's work were summarized as a list of recommended habitat improvements that could benefit the main stem of the Dolores adjacent to the Rico area. A multitude of approaches were provided. Improvements were not recommended for silver Creek since they would be limited due to the high bed-load movement and general channel type. Further discussion of the application of these suggested improvements is described within **Section 7**.

CDOW, 2005. A fisheries inventory was completed in 2004 by the CDOW regional aquatic biologist, Mike Japhet (and others). The CDOW researches completed an electro-shocking effort at two locations on the Dolores River that bracketed the Town of Rico. They gathered information from an above location at the US Forest Service (USFS) road crossing adjacent to Cayton campground, and at a location below the Town at the Montelores bridge. The data have yet to be compiled into an overall evaluation for the River, but preliminary findings from field gathered data are summarized in **Table 2.7** and are as follows;

- For the location above the Town of Rico; *"Numerous 10 – 12 inch catchable rainbow trout were caught at this site. Catchables were stocked at this location four days before this survey. Fingerling brown trout are also stocked here earlier in the summer of 2005 and were found in this survey. The presence of fingerling rainbow trout indicates some natural reproduction is occurring. Nearby Barlow Creek has naturally reproducing brook, which is probably the source for brook trout found in this survey. Caddis flies and stoneflies were found on the rocks at this location. A thin layer of dark silt from recent rains covered the rock substrate."(CDOW, 2006)*

- For the location below the Town of Rico; *"there is little evidence of natural reproduction of trout at this station – fingerling brown trout and catchable size rainbow trout are stocked here. Heavy metals pollution from the Rico area is probably the limiting factor."(CDOW, 2006)*

The 2006 fish stocking schedule for the Dolores River between the West Fork confluence and the headwaters calls for stocking of 15,000 3-inch Colorado River strain rainbow trout and 2,500 10-inch rainbow trout (CDOW, 2006).

2.5.3 Wetlands

Wetland areas occur throughout the *Project area*. Two surveys have been completed in order to delineate the type and amount of jurisdictional wetlands that are within the Town of Rico proposed development areas. One was completed by D. Derfus, 2001 and served as baseline information for the completion of a more current and comprehensive inventory completed in 2005 by Patrick Drew (Drew, P., 2005). The 2005 report provides a delineation of wetlands within the Town of Rico's 'urban growth boundary' with a set of detailed maps of the inventory findings. Readers are referred to this document for further information, which was not revisited herein.

2.6 Mining History of the Area

The mining history of the *Project area* is mentioned within this Section since it is a relevant part of the planning process, a value to the area and a factor affecting the

hydrology. The historic mining practices have left residual material within the basin as a result of the mining and extraction of metals. These waste materials have various characteristics that can range from being inert (non-reactive) to reactive. Certain reactive wastes come in contact with water and can leach metals and/or acid mine waste characteristics which can adversely affect the environment.. Additionally, the mines themselves can alter the natural groundwater hydrology and may also cause settling and instability of the surface as demonstrated by a collapse in 1994 at the Atlantic Cable Mine within the Silver Creek basin (CGS, 1994).

In 1892 Rico had a population of 5,000 people, with 23 saloons, 3 blocks of red light district, 2 churches, 2 newspapers, a theater, the Rico State Bank and other stores and hotels. That same year the Dolores County Courthouse was built and Rico became the county seat, remaining so until 1946, at which time it was moved to the Town of Dove Creek. In 1893 Rico suffered a ***Silver Panic*** and many businesses were closed. By the turn of the century the population had declined to 811 people. The mining district had its ups and downs until 1926 when the Rico Company started to rebuild the mining industry. In 1937 the Rico Argentine Mining Company constructed a mill and eventually became the only surviving mining company of size. A sulphuric acid plant was constructed in 1953 and operated until 1965. At this time there were only about 300 people left in the town. From 1965 to 1971 the industry concentrated on lead and zinc mining and the population dropped again, to approximately 45 (Dolores County CEDS, 2006).

The early history of the Rico mining district was documented by Ransome (1901) and Anonymous (date unknown) a summary of which is provided herein. Exploration activities in the Rico area began with claim staking in 1869 and were sporadic until 10 years later when Rico silver ore was discovered and a small but unsuccessful smelter was built north of town. Another smelter was built south of town and operated into the middle 1880s. Rich silver in a blanket-type ore body was encountered by accident in a prospect shaft on the Enterprise Claim on Newman Hill. These large blanket ore bodies encouraged the Rio Grande Southern Railroad Company to build a narrow gauge line into the area. This line was followed shortly by spur lines up Silver Creek and to the portal of the Enterprise Tunnel. In 1893 the Newman Hill mines produced much of the 2.6 million oz of silver mined in Colorado that year, but production then fell dramatically due to the silver crash and to the decline in grade of the local ores. Base metal ore production increased in the early 1900s and reached a peak just prior to World War I but then again declined rapidly until the flotation process of the early 1920s made zinc recovery profitable (CGS, 1994).

In the early production of the district, silver was the major economic product; but upon depletion of the rich silver ores, lead, zinc and to a less extent, copper were the main products, and silver was an important byproduct. Gold was always a significant byproduct, and at least one small mine was worked exclusively for this metal. In 1955 the sulfuric acid production plant was built and used pyrite ores for its process. In the next 9 years a substantial amount of acid was produced for use in the uranium mills of the adjacent Colorado plateau (McKnight, 1974). The production of the Rico district from

1879 to 1968 has been about 83,000 oz. or gold, 14,500 oz. of silver, 5,600 tons of copper, 84,000 tons of lead and 83,000 tons of zinc (McKnight, 1974).

In 1926 International Smelting Company, a subsidiary of Anaconda Mining Company, leased and remodeled the Pro patria mill. This custom mill handled much of the ore from the district but closed after two years of operation. Production was only sporadic during the Depression and for several years thereafter but resumed in 1939 when the Rico Argentine Mining Company built and operated a 135 ton per day flotation mill and became the major producer of lead and zinc during the World War II. The Rico Argentine Mining Company maintained relatively steady production until the middle 1970s and also produced sulfuric acid for the milling of plateau uranium ores during the first uranium boom and until 1964 (CGS, 1994).

Drilling during the 1970s encountered a large deposit of molybdenum situated approximately 5,100 ft under the base metal deposits to the east of town. Development of this deposit which included a proposed 12-mile haulage tunnel was abandoned in the late 1970s (CGS, 1994). There are no current, active mines within the Rico mining district. Activity within the district is confined to recreator activity and some closure/remedy actions for certain features (described more fully in **Section 6**).

2.7 Land Uses and Population Characteristics

The *Project area* is encompassed by Dolores County. Dolores County is comprised of 673,897 acres (1,052 sq. miles). Of these, 58% are state and federal lands, and 42% are private ownership (**Figure 2.18**). The Dolores County economy is dominated by an agriculture sector built upon the production of dry land crops. Historically the mountainous areas (which encompass the *Project area*) supplied timber to a number of small saw mills and were the site of gold, silver, copper, lead, zinc and molybdenum mining (Dolores County CEDs, 2006).

There are mixed land-use settings within the *Project area*. The predominant land-owner is the U.S. Forest Service: San Juan National Forest. There is one wilderness are to the North (Lizard Head wilderness area), that is also managed by the USFS but occurs outside the *Project area*. The remaining lands are privately owned. The USFS represents over 80% of the land-use in the *Project area*. The private holdings are either in the form of mine claims (**Figure 2.19**) within the historic mining districts, or residential, commercial and industrial holdings which primarily occur within the Town of Rico or along the Dolores River corridor. The Bureau of Land Management (BLM) does not manage any land-surface within the area, but they are involved with recreator permitting and access as related to the Dolores River.

The major population center in the *Project area* is the Town of Rico. From data gathered from the Colorado census the data indicate that Colorado's population has increased by slightly over 30 percent from 1990 to 2000. The summarized evidence from the census indicates that Dolores County has between 0-3 people per square mile of county area.

Specifically, as per the area census, the Town of Rico has approximately 205 residents. The population within the Town of Rico is comprised of various types of work forces. The major industry of the Town is tourism in support of the recreator activity which dominates the area. **Section 3** provides further detail in regards to the types of commercial/industry activity present within the Town.

With the predominant land-use being 'public lands' as managed by the USFS, the most significant types of land-use activities are related to recreation, with secondary types of activities including timber harvest, and leasing of grazing allotments. There is some mineral lease activity within the San Juan National Forest, but there is no current activity within the *Project area* (USFS SJNF, 2006). Recreational use includes water sport activities (kayaking and some rafting launch sites), camping, hiking, hunting and fishing. Grazing allotments include leases for cattle and sheep. Timber harvest activities occur for a multitude of purposes including fuels reduction (hazard reduction), thinning for forest health and for recreation activity management. The following describes the level of activity within the *Project area* as identified from the San Juan National Forest project planning and historic efforts.

2.7.1 Recreation Uses

There are numerous trails including the E. Fort Trail (TR 636), the Calico Trail system (Trails 202, 203, 206, 207, 208, 640 and 641), the Horse Creek trail (Trail 624) and the edge of Navajo Lake Trail (Trail 635) (USFS, 2001). There is also a variety of 4-wheel drive or forest roads which traverse the *Project area* (Forest Service Roads 550, 578, 204 and others). There is one campground, and a private campground/RV park along Hwy 145. The USFS campground (Cayton campground) occurs 6.0 miles north of the Town of Rico along Hwy 145 (T41N, R10W, Sec 33). There are planned improvements to this campground in order to accommodate more users (as per SJNF scoped projects – January, 2006; USFS SJNF, 2006).

Hunting and fishing pressure are described as being 'intense' by area resource managers (Colorado Division of Wildlife – Wildlife Manager: David Harper; Scott Wait – Area wildlife Biologist). There are a variety of hunting activities in the area including small game, bear, deer and elk. The *Project area* occurs within game management unit (gmu) #71 which extends from Lizard Head Pass to Dolores and over to Groundhog Lake. This unit is defined as being bounded on the North by Disappointment Creek and Dolores-San Miguel County line; on the East by Dolores-San Juan County line, Montezuma-La Plata County line and Bear Creek; on the South by Colorado Hwy 145; on the West by USFS Road 526 (Dolores-Norwood Road) (CDOW, 2006). **Figure 2.20** depicts the boundaries of gmu #71. The *Project area* is only a small portion of this management unit; therefore the numbers of licenses issued would over-estimate hunting pressure within the *Project area* itself. A summary of the elk, deer and bear harvest, number of recreator days for all manners of take for 2005 is summarized in **Table 2.8.** There is very little information regarding the amount of fishing pressure within the area. Review of CDOW records indicates that the Upper Dolores is a good fisheries for cold-water species, yet there are

no records indicating number of recreators, or release rates for stockable trout (CDOW, 2006).

In addition to individuals who hunt and fish, there are a number of professional guides/outfitters that hold permits for the use of the Dolores River within the *Project area*. The process of review and management of guide/outfitter resource users falls within the USFS purview (Tom Kelly/Dolores County Office) In regards to recreator rafting use, there are 16 listed 'Dolores River Rafting Outfitters (BLM, 2006) for the use of the Dolores River corridor (points of contact provided in **Appendix B – Points of Contact and Additional Sources of Information**). The Upper Dolores which is defined as spanning from the 'headwaters to the Confluence with the San Miguel River' has a range of appropriation water rights dates from May 1, 1975 to July 13,1984 that affects 5 reaches within the watershed (CWCB, 2004). The upper-most reach which is defined as the 'Dolores River from Rico to McPhee Reservoir' is a Class II-III water with no minimum or maximum suggested flow as per the American Whitewater association (CWCB, 2004).

The actual amount of recreator activity observed in the *Project area* has not been evaluated (USFS personnel, personal communication) but likely to continue in pressure over time. The number of user-days and scope of recreator impact to the *Project area* is further described in **Section 6**.

2.7.2 Potential Wild and Scenic Designation

The National Park Service has called the area adjacent to the Dolores River a healthy and relatively undisturbed ecosystem with outstanding wildlife values. Having a 'wild and scenic' designation tends to draw tourism and distinct types of land-use activities. The information available which describes the rationale for the Dolores River corridor designation is provided herein and affects potential future planning activities for the watershed.

As per the NPS, the wild and scenic designation was applied due to the values of the watershed (Deidrich, J. 1999). The Dolores River nourishes a lush riparian floodplain of cottonwood, cedar, squawberry, shadscale, sagebrush, juniper, and willow that stretches nearly an entire mile in width at its confluence with the Colorado River. The Dolores was part of the historical distribution of all four species of Colorado River endangered fish. As a side channel of the Colorado, it is possible that the lower Dolores still provides spawning habitat for these fish. As per the NPS, the following outstanding values were identified for the Dolores River;

- **Fish and Wildlife:** The Dolores River supports an enormous diversity of aquatic, terrestrial, and avian species. Bighorn sheep, mountain lion, mule deer, and elk roam the river corridor. Reptiles and amphibians present include the red-spotted toad, bullfrog, side blotched lizard, striped whipsnake, gopher snake, and collared lizard. In addition to waterfowl, bird species include great blue heron, bald eagle,

golden eagle, songbirds, and peregrine falcon. Four native endangered plant species are found in the area: *Astragalus eastwoodiae, Astragalus abulosus, Psoralea aromatic*, and *Aquilegia micrantha*. Deeper stretches of the river create ideal habitat for the flannel mouth and bluehead suckers, speckled dace, roundtail chub, and mottled sculpin.

- **Scenic & Geologic:** The unearthing of the Morrison Formation along the Dolores has exposed many fossilized dinosaur bones. Eight other strata can be seen along the river including the Summerville, Entrada Sandstone, Navajo, Kayenta, Wingate, Chinle, Moenkopi, and Cutler Formations. The purple ledges, red cliffs, and mauve overhangs of Navajo sandstone that contrast the snowcapped La Sal mountains create an incredible backdrop to the Dolores River. The abundant avian and terrestrial fauna of this pristine river provide a vast array of photographic opportunities.
- **Cultural/Historic:** One of the first documented explorers to the region, Father Escalante traveled along part of the length of the Dolores River. After a long and exhausting journey, Escalante christened the river '*Rio de Nuestra Senora de los Dolores*' -- River of Our Lady of Sorrows. Remnants of temporary Ute Indian shelters called wickiups exist along the Dolores. Uncounted Native American ruins from the Fremont culture are also present along the river corridor. Other than these known sites, no archaeological studies have been completed on the Dolores River.
- **Recreation:** During spring runoff, canoers, kayakers, and rafters challenge themselves on the Class IV rapids of the upper section while relaxing amid the dramatic scenery of the lower portion of the river. Hikers, backpackers, hunters, anglers, and photographers enjoy the solitude afforded adjacent to this large desert river.

2.7.3 Agricultural and Mineral Leases

Review of available information regarding agricultural (grazing allotments), timber harvest, and mineral leasing activity was completed in order to determine the types of historic and future activities that have occurred. Grazing activity and timber harvest information were obtained from the San Juan National Forest office (Points of Contact: Cliff Stewart, Annette Joseph and Phil Camp). Mineral leasing information was also reviewed (from the Colorado Oil and Gas Control Commission and from BLM and USFS records.

Grazing Allotments

The USFS SJNF maintains a GIS database that outlines the various allotments within the SJNF by type, area, number etc. A summary of the allotments within the *Project area* is provided within **Table 2.9**. As per communication with the USFS, several of these allotments are designated as 'non-use or vacant' and include the Sheep Mountain allotments, Rico Watershed, Divide and Expectation. The remaining allotments have various permits and ongoing grazing activities as follows;

- The Coke Oven allotment has an active sheep grazing permit for 250 adult sheep, and 750 ewe lamps. This allotment is paired with the 'Summit' allotment so that the animals are moved between two allotments during the permitted grazing season (July 1 through September, 30). The animals spend approximately one week at the beginning of the season within the Coke Oven allotment, then get moved to the Summit allotment until approximately September and spend the rest of the time within Coke Oven. The Coke Oven allotment is overseen by Annette Joseph/USFS.

- The remaining potential allotments within the Rico Watershed, Expectation areas are inactive. The Rico Watershed is a protected unit due to the Town of Rico potable supply and the Expectation allotment has been vacant since 1993 due to conflicting uses with recreation (C. Steward, pers. Comm.., 2006).

As per communication with the range personnel for the SJNF, the non-use or vacant allotments will remain as such for at least the next 5 years. Similarly, the current uses and permits for the grazed allotments will stay the same. There are no changes anticipated to the current grazing activities within the *Project area*.

Timber Harvest

The available USFS SJNF GIS information indicates that the timber stands within the *Project area* are of suitable 'harvest' type. However, it appears that a summary of types of harvest activities is not available as yet. Direct communication with the area Timber supervisor (Phil Camp/USFS) revealed the following information pertinent to the *Project area*;

- Historically, in the past 15+ years, there has been one timber harvest in the *Project area* associated with the Barlow Creek area (**Figure 2.21**).

- The Barlow Creek cut was completed by 12/31/1995and was designed as a partial cut with some small clear cuts (2 acres and less).

- The cut was an 'individual' tree mark approach in which each tree was marked that would be cut, and all trees less than 8" in diameter were retained.

- The purpose of the effort was for watershed yield. The theory being that if a certain portion of trees were removed, the interception of water (snow and rain) by the tree crowns would be eliminated, allowing for better infiltration of water into the ground surface. The success of the effort was not measured, but was a part of the 1984 Forest Plan objective to enhance watershed yield.

Discussion with the SJNF hydrologist and others indicates that the current (and soon to be amended) Forest Plan will not prescribe timber harvest activities for the purposes of

watershed yield. There are no future timber projects for the *Project area* within the next five years. The only future project within close proximity (but outside) the *Project area* includes the following;

- Fuels management– Upper Dolores: mechanical thinning (1,000 acres) and prescribed fire (4,500 acres) within the Mancos/Dolores Ranger District: T40N, R12W; sec 5,6 (Upper Dolores). This project was 'on hold' as per 01/06.

Mineral and Oil & Gas Leases

The permits associated with 'mineral' leases are managed by the Colorado Division of Minerals and Geology (CDMG), while oil and gas permitting is regulated by the Colorado Oil and Gas Commission. A review of available information was queried in order to identify the permitted mineral/oil & gas leases within the *Project area*. **Table 2.10** provides a summary of mineral mine site permits. As summarized within this Table, only one permit is active, while the remaining indicate that no activity associated with the various mines. The one active mine is associated with a small-scale hard rock gold mine located within the vicinity of the Town of Rico.

The surface and minerals management status of the *Project area* were mapped by the BLM (BLM, 2001). The map information indicates that the entire *Project area* outside of the private land-holdings has been delineated as having 'all minerals' owned by the federal government. There is a patented claim due south of Rico along Hwy 145 along the west side of the highway. It is unknown as to the commodities associated with this patent.

Review of the COGCC well permit information indicates that there are no current or proposed oil and gas permits within the *Project area*. There are several down-gradient along the Dolores River and the West Dolores River sub-basins. A summary of these well permits is provided in **Table 2.11** and depicted within **Figure 2.22**.

2.8 Water Uses, Water Rights and Water Budget Estimates

The following provides a summary of the various types of water uses within the *Project area*, the appropriated water rights and estimates of water need over time (water budget). Information for these topics are typically summarized by water Division by the CDWR. The State of Colorado has completed a 'Statewide Water Supply Initiative' from which a lot of information for this subsection was taken (CWCB, 2004).

2.8.1 Water Uses

Water in Colorado is used primarily for agricultural purposes. Of the approximately 12.4 million acre-feet (af) diverted for use state-wide each year, irrigation for agriculture accounts for about 11.1 million af, or about 90%. About half of the diversions for

irrigation return to the river and go towards meeting Colorado compact obligations to downstream states. Municipal use is about 800,000 af (7%), industrial use is about 250,000 af (2%), stock water use is about 132,000 af (1%), and commercial use is about 16,000 af (<1%).

Colorado's population is growing with an average rate of 2.9% per year. At this rate, the population will double every 24 years. Assuming one af per four persons per year, the need for municipal and industrial water is projected to increase from 1.0 million af in the year 2000 to 2.2 million af in 2100 (CWCB, 2004). In order to meet these increased demands, reservoir storage is a critical element to Colorado's strategy for water management. It has been estimated that approximately 80% of the surface water supply in Colorado is naturally available during the four-month snowmelt runoff period in April, May, June and July (CWCB, 2004). During this time, it is important to store appropriated water resources in order to be able to rely upon them later in the year when resource may be scarce.

In 2002, the CWCB described the San Juan/Dolores Division 7 area as having an approximate consumptive use of 330,000 af, of which approximately 4,300 af is in the form of exports to other river basins. A more recent state-wide water supply evaluation was completed in 2004 as mandated by Governor Owens in order to assess water supply needs currently and for the future (CWCB, 2004). The CWCB has estimated that Division 7 as a whole, may need about 80% more water than it currently uses by 2030 based on demand estimates developed during the State Wide Supply Initiative inventory (CWCB, 2004). The estimated water demand for Division 7 in 2000 was 23,600 af, with a projected increased water demand need of 18,800 by 2030, for a calculated change of 80%. As an example, the City of Durango had a water demand of 4,400 af in 1990 with a population of approximately 12,200. Given the average rate of growth, the City of Durango will require an additional 1,200 af of water by 2030 (for a total water demand of 8,665 af) (CWCB, 2002). As per the 'Statewide Water Supply Initiative', the CWCB states "given the juxtaposition of water need and water availability, Division 7 may be the most precariously positioned of the state's river basins when it comes to having adequate supply for future water demand and drought mitigation" (CWCB, 2004).

Total water use in Colorado for 2000 was determined from estimates of water withdrawals for the eight categories of water use (USGS, 2000). The USGS maintains data files that present water use estimates by county for the United States and others, which support the State-level water use estimates published in the USGS Circular 1268 (USGS, 2000). The data categories collected include; public supply, domestic, irrigation, industrial and thermoelectric power water use. These categories represent 97 percent of water use during 1995. Additional use categories of livestock aquaculture and mining were collected from certain states with these particular use types. In the USGS data sets, water use was defined as water withdrawals and are expressed in terms of million gallons per day (Mgal/d) and thousand acre-feet per year.

Tables 2.12 through 2.14 summarize the measured rates for various uses for the Counties within the State of Colorado (USGS, 2000). Dolores County measures are highlighted within each table. In addition, the particular use rates are shown comparatively against 'total' use rates in order to provide a context of the percentage of water a given use will take. Domestic, public supply, irrigation and industrial rates are provided in **Tables 2.12, 2.13, 2.14 and 2.15**. An example of the amount of use for a 'domestic' setting and an industrial work-place setting using standard rates of consumption is as follows;

- person household – year-round: using 110 gallons of water per day per person equaling 440 gallons of water per day x 365 days per year = 160,600 gallons total.

- permanent employees – year-round: + 1 half-time person equates to 3.5 people using 50 gallons of water per day, per man equaling 175 gallons per day x 365 days per year = 63,875 gallons total.

Summary of use rates from 2002 based upon 215 residential taps (160 active) and 21 commercial (16 active) taps revealed a metered use rate of 5,897,000 gallons. Residential use accounted for 4,672,000 gallons of the total. The estimated total withdrawals of groundwater for Dolores County was between 1000 – 5000 acre-feet in 1995 (Solley et al., 1998). Approximately 5% of the water used is groundwater, while the remaining 95% is surface water. The predominant use of groundwater is for agricultural uses (CGS, 2003). The rate of groundwater use within Dolores county is relatively higher than surrounding mountainous counties of San Juan Ouray, San Miguel, Mineral, LaPlata and Hinsdale.

The type of use sustained by a water body is dependent upon it's water quality. The state of Colorado, through the WQCD is working towards achieving the goal of comprehensive assessment and reporting of its waters. The WQCD is responsible for monitoring and assessing the water quality in Colorado and managing the discharge of pollutants into waters of the state from various facilities. If a water body is found to have a pollutant discharge that exceeds criteria protective of its use, the water body is referred to as being impaired (further discussion is provided in **Section 4**). In 2002 and 2004, the WQCD inventoried the amount of surface water bodies that have 'impaired status' and thereby affected uses (CDPHE, 2002 and 2004). A summary of the water use types, the number of river miles that support the use and the number of river miles affected by contaminants and therefore do not support the use is provided in **Table 2.16**. The loss of river miles for use is attributed largely to mine-related issues. The CWCD recognizes the loss within headwaters regions near Silverton and Rico as source areas of concern (CDPHE, 2002).

Groundwater quality from the Dolores River alluvium is characterized as calcium-sulfate or calcium-bicarbonate type water. Total dissolved solids (TDS) averaged 770 milligrams per liter (mg/L) for sample results compiled by CGS, which is above the USEPA secondary drinking water standard of 500 mg/L for TDS. The average sulfate

concentration of 315 mg/L also exceeds the USEPA secondary drinking water standard of 250 mg/L (Weir et al., 1983, Ackerman and Brooks, 1985 as cited in CGS, 2003). Discharge from the underlying Paradox Basin salt formations is thought to be the source of the lower quality waters, as the Dolores River is a gaining river within the Paradox Basin (USGS, 2000). Although data were unavailable, it was hypothesized that alluvial water quality for the Upper Dolores area is likely much better since it has not gained much alluvial character (CGS, 2003).

2.8.2 Water Rights

In order to understand the amount of 'available water' to potential users within the *Project area*, one must have at least a cursory understanding of Colorado Water Law. Numerous documents describe water law, water rights and concepts of water appropriation. The following was adapted from Vranesh (1989) and provides an overview of water rights as they apply to in-stream flows within the *Project area*.

Overview of Colorado Water Law

Colorado is an appropriation doctrine state, meaning that an appropriator acquires rights to water by taking the water and applying it to a beneficial use. The Colorado constitution declares that the un-appropriated water of every natural stream is the property of the public, subject to appropriation, and that the right to divert un-appropriated waters of any natural stream to beneficial uses shall never be denied. The constitution also provides that, between those using water for the same purpose, priority of appropriation shall give the better right ('first in time; first in right'). Colorado administers surface streams and tributary groundwater aquifers as a unified system, with both being subject to the appropriation doctrine and subject to administration based upon the priorities of the stream system. An adjudicated water right is one that is confirmed through a judicial process with a court decree.

Appropriators are entitled to be supplied in order of their priorities. The most senior appropriator is entitled to be supplied to the full extent of the original appropriation, even when there is insufficient water in the river to meet the demands of junior appropriators. The uses by junior appropriators are curtailed if a senior appropriator puts a 'call' on the river to the water commissioners, to satisfy the senior's lawful demand for water. In Colorado, water rights are treated as real property and may be sold or transferred freely, so long as such change does not injure the vested rights of others. In addition, water rights may be lost through long periods of non-use (and is referred to as an abandonment of a water right).

There is also an innovative program referred to as the 'augmentation' plan that enables an increase of the supply of water for beneficial use by allowing a junior appropriator to replace the depletions to the stream at a time and place that will overcome an injury to vested senior rights. The junior appropriator may then divert water out of priority without curtailment. The Dolores River basin has seen several cases of 'appropriative

rights of exchange' and plans for augmentation (i.e. CWCB, 2005). When these opportunities arise, the CWCB makes available the information for public review and comment (refer to the CWCB web page regarding Board Meetings; CWCB, 2005).

Responsibility for water administration and control in Colorado is divided between the state engineer, the executive director of the Division of Water Resources of the Colorado Department of Natural Resources and the judiciary. Specifically, a district court judge is designated a water judge in each of the seven water divisions of the state. The state engineer has exclusive jurisdiction to administer, distribute and regulate the waters of he state. The state engineer appoints a division engineer for each division. Each division engineer has assistants and each division is further divided into district field offices. The district field office associated with the *Project area* is located in Mancos, CO. The points of contact are listed in the "**Points of Contact, and Additional Sources of Information**" Appendix (**Appendix B**).

The state engineer is charged with the initial authority to grant or deny well permits. Such a permit is essential to construct a well for the appropriation of groundwater. Water withdrawn from gravel pits is also treated as a well. Although water quality is a related concern, the state of Colorado, operating through the Colorado Water Quality Control Commission as assumed primary enforcement authority for water quality related issues, including the National Pollution Discharge Elimination System. Water quality regulations exercised by the WQCC were previously described in subsections 4.1 through 4.4. The CWCB has multiple powers related to protection of in-stream flows. The board continuously studies the water resources of the state, including present and potential uses and has the authority to conduct state water planning under the Federal Water Resources Planning Act. The board also has the power to file claims for minimum stream flows to protect the environment to a reasonable degree.

In-stream Water Rights within the Project area

The *Project area* is within the Southwestern Water Conservation District (CWCB, 2006), and CDWR's Division 7 and is defined as a critical water district which means there is not enough surface water instream flow for the cumulative water rights decreed for the River (CDWR, 2005). This defined status for the Dolores River is based upon a comparison of cumulative water rights as being 'absolute' from the 1893 plus 1933 decreed amounts, as compared to annual flow rates measured at the 'Dolores at Dolores' gauging station (just up-gradient of the 7th St bridge in Dolores Colorado). Therefore, this definition applies to the entire length of the Dolores River from the *Project area* down-gradient to McPhee reservoir (B. Becker and D. Miller, CDWR – Water Commissioner's office, Mancos, CO). Numerous CWCB instream flow rights have been decreed on major rivers and tributaries in Water Division 7. A summary of these decreed rights are provided in **Appendix C** to this report and depicted within **Figure 2.23** for the *Project area*.. These rights are year-round rights with seasonal variability as reflected in the range of values shown. Flow rights on small tributaries in the basins are also referenced within this summary (CWCB, 2003).

Rico has a 3.0 cfs (2.78 cfs conditional, with 0.28 cfs absolute) water right on Silver Creek that is senior to CWCB's in-stream flow right. CWCB has a 20 cfs in-stream flow right on the Dolores River that is more than natural winter baseline flows (16 – 17 cfs on average in winter months). The Town is in the process of securing the right to draw their potable supply from the Dolores River alluvial aquifer above town. The diminished flow that occurs as a result of the draw, is referred to as an injury to the water resource that must be mitigated. In response to this potential injury, the Town of Rico is pursuing a watershed planning and river restoration program in cooperation with the USEPA and CWCB. The CWCB could be satisfied by either pumping lower alluvium for augmentation, or injuring with mitigation (Heil, E., No date). Within the CWCB, 2004 report, the 'water needs assessment' for the *Project area* is described as being similar to headwaters areas in other basins and will need augmentation credits above CWCB instream flow rights, (or where warranted) in order for a finding of de minimus impacts.

Both the CDWR and the USFS have not noticed a significant number of 'encroachments' whereby the water was used without permit or right. There are few water rights within the *Project area* that pose difficult management issues. In one instance, there was a siphon located on Horse Creek, northwest of Rico, but was dealt with by the USFS and should no longer exist.

As described within CWCB (2004) the overall water supply within Division 7 is good. Using the 'Dolores and Dolores' gauging station, the CWCB characterizes the upper basin as having 'minimal priority calls downstream'. Given the rates of water calls as compared to available supply, The upper Dolores basin has a substantial amount of 'legally available water' that is met (in abundance) by the natural and physically available water. The only 'project' need as identified within the Statewide Water Supply Initiative' is the possible need for augmentation to CWCB instream flows in order to achieve a finding of de minimus impacts to instream flow rights as a result of the potable supply re-routing for the Town of Rico

2.8.3 Water Budget Estimates

The Water Balance throughout the State of Colorado **was shown in Figure 1.8** within **Section 1** (CGS, 2004). As shown within this Figure, the water balance within the region is '0'. This means that the amount of available precipitation in the form of rain and snow is absorbed into the aquifers and used by existing features (vegetation). There is no 'excess' resource available in this system. Whatever amount is taken for various human uses is represented as a net loss to the system.

2.9 General Water Quality Issues

Most of the streams in the *Project area* are very high quality and support their desired uses. The emphasis of water quality planning in the *Project area* therefore, is largely directed toward preserving this existing high quality. There are some areas however,

where improvement to water quality is desired as a result of impacts from the following sources;

Drainage from historic mining areas: Drainage from mined areas can impede attainment of water quality standards. Several portions of the watershed have been impacted from historic mining activities (CGS, 2000 and others). Of particular concern is the drainage associated with the St. Louis tunnel, and the cumulative mine area impacts associated with Silver Creek. There are also other less obvious mining-related nonpoint sources directly associated with the main stem of the Dolores River itself (within the Town of Rico area). These sources can potentially provide metals to receiving drainages and can in turn, affect aquatic life or other beneficial uses to a surface water body.

Nonpoint source pollutants from development areas: Nonpoint source pollution from development areas is a significant issue in most watersheds and of potential concern to the *Project area* since the *Project area* is a sensitive setting. Water pollutants in nonpoint source runoff from urbanized areas can include nutrients (nitrogen and phosphorus), sediment, heavy metals, salt constituents (sodium, magnesium, and chloride) petroleum products, and organic pesticides.
The Town may also have heavy metals associated with the soils above and beyond what is normal of typical development areas as a result of natural mineralization and mining activity. As the Town of Rico continues to grow, the areas contributing to construction-related erosion and urban runoff will increase.

Potential impacts associated with point source discharges: The Town of Rico is going to install a wastewater treatment plant which will provide a point source discharge to the river. This discharge will no doubt be well managed. Advanced wastewater treatment is often required for ammonia removal to protect fisheries and advanced phosphorus removal is required in some mountain watersheds. Continued attention to this point source is needed to ensure that the area's high water quality is maintained.

Roadways, pavement and impervious surfaces: Water quality problems associated with roadways and pavement include sediment and associated nutrients resulting from road cuts and fills, continuing erosion of unstable slopes adjacent to roads, erosion of unpaved road and parking surfaces, and road sanding operations. To a lesser degree, heavy metals, petroleum products, and hazardous materials spills along roadways near water bodies also have been documented to impact Colorado water quality. The Colorado Department of Transportation (CDOT) has a program underway to address these concerns while also considering public driving safety and existing funds and needs. All watersheds, however, are potentially vulnerable to water quality impacts from this type of activity, although the major areas of concern are in those areas where development is occurring. Impervious surfaces is a term that captures all types of surface that are impervious to the absorption of water. These types of surfaces lead to 'shedding' of natural water fall and can in turn create stormwater and erosion issues. The amount of impervious surface within a given watershed is a good indicator of future water quality issues over time.

Naturally Degraded Surface Waters. In 1999, CGS conducted a reconnaissance-level investigation of naturally degraded surface waters associated with hydrothermal alteration in Colorado. The Horse Creek tributary within the *Project area* was identified as a setting with naturally degraded water quality conditions which emanate from the Calico Peak-Eagle Peak area, and from Darling Ridge, lying between Rico and Dunton. Results of sample analysis indicate acidic pH conditions and the presence of metals (manganese, aluminum, cadmium, copper, iron and zinc) above stream standards. The presence of these 'natural' conditions are an important consideration for the watershed as a whole, and put into perspective the range of naturally occurring metals concentrations that can occur within the *Project area*. (Neubert, 2000). It is important to consider the influences from these natural sources when comparing water quality results to water quality standards, and for planning purposes. It is apparent that the natural setting has conditions which already limit its potential use by aquatic life, wildlife and humans.

The majority of the potential water quality issues are nonpoint source related. Point source controls for the wastewater treatment plant discharge can prevent damage to the *Project area*. The real challenge for water quality management however lies in the area of nonpoint source management and control. In addition, the *Project area* is confounded by the fact that the setting has 'natural metals enriched' water quality characteristics. Further discussion of point source issues are provided in **Section 5**.and nonpoint source issues in **Section 6** of this plan.

TABLES

Table 2.1 Project Area Soils Types and Characteristics (source: NRCS, No date). Pg 1 of 3										
Map Unit	Map Unit Name	Acres in Project Area	Parent Material	Vegetation	Soil Management Practices	Permeability	Available Water Capacity	Potential rooting depth	Runoff	Hazard of Water Erosion
53	Cryaquolls-Typic Cryaquents comples, 1 to 5 % slopes	207	Alluvium – mixed	Tuft hairgrass, sedge, slender wheatgrass, willow	Livestock grazing, recreation and wildlife	Moderate	Moderate	60 “	Low	Slight
54	Quazar very cobbly loam, 5 to 25 % slopes	170.3	Alluvium – rhyolite, tuff	Thurber fescue, brome sp., needlegrass	Livestock grazing, recreation and wildlife	Moderate	Low	60 “	Medium	Slight
152	Frisco Loam, 25 to 45 % slopes	48.1	Outwash alluvium – granite and others	Engleman spruce, Rocky mountain Douglas fir, Subalpine fir, Quaking aspen	Timber, wildlife and livestock grazing	Moderate	Low	60 “	High	Slight
154	Fisco Horsethief complex, 30 to 75 % slopes	3,551	Outwash alluvium – granite and others	Engleman spruce, Rocky mountain Douglas fir, Subalpine fir, Quaking aspen, White fir	Timber, wildlife and livestock grazing	Moderate	Low	60 “	High	Moderate
155	Tuckerville Rock outcrop complex, 30 to 60 % slopes	85.9	Slope alluvium, colluvium, granite and sandstone	Engleman spruce, Rocky mountain Douglas fir, Subalpine fir, Quaking aspen, White fir	Timber, wildlife and limited livestock grazing	Moderate	Low	60 “	High	Moderate

Table 2.1. Project Area Soils Types and Characteristics (source: NRCS, No date). Pg 2 of 3										
163	Clayburn Hourglass complex, 15 to 30 % slopes	3.1	Slope alluvium, colluvium sandstone and shale	Quaking aspen, snowberry, bluegrass, Mountain brome	Timber, wildlife, recreation and livestock grazing	Moderately slow	High	60 “	High	Moderate
164	Hourglass Bucklon Wander Complex 30 to 75 % slopes	179	Slope alluvium, colluvium sandstone and shale	Quaking aspen, snowberry, bluegrass, Mountain brome, Thurber fescue, White fir	Timber, wildlife, recreation and livestock grazing	Moderately slow	High	60 “	High	Severe
254	Cryothents Rubble land complex, 30 to 75 % slopes	57.6	Slope alluvium, rhyolite	None typical	Wildlife, water catchment, construction material	Moderate – Moderately rapid	Low	60 “	Medium	Slight
378	Needleton Haviland complex, 30 to 60 % slopes	472.9	Slope colluvium, sandstone, shale, rhyolite	Engleman spruce, Rocky mountain Douglas fir, Subalpine fir, Quaking aspen, Whortleberry	Timber, wildlife, and livestock grazing	Moderately slow	Low	60 “	High	Severe
381	Needleton Snowdon Rock outcrop complex, 30 to 80 % slopes	979.4	Slope colluvium, rhyolite	Engleman spruce, Subalpine fir, Quaking aspen,	Wildlife, limited recreation and livestock grazing	Moderately slow	Low	60 “	High	Severe
387	Frisco Quazar complex, 30 to 60 % slopes	84.9	Slope colluvium, rhyolite, tuff	Engleman spruce, Rocky mountain Douglas fir, Subalpine fir, Quaking aspen	Timber, wildlife, and livestock grazing	Moderate	Low	60 “ or >	High	Moderate
606	Snowdon Needleton complex, 45 to 90 % slopes	190.6	Slope alluvium, red bed sandstone	Engleman spruce, Subalpine fir, Quaking aspen, Snowberry	Woodland, wildlife, and limited recreation	Moderate	Low	10 - 20 “	High	Severe

Table 2.1 Project Area Soils Types and Characteristics (source: NRCS, No date). Pg 3 of 3										
607	Gray6sill Scotch complex, south aspect, 30 to 60 % slopes	813.3	Residuum slope alluvium red bed sandstone	Quaking aspen, Thurber fescue, Mountain brome	Timber, wildlife, recreation and livestock grazing	Moderately slow	Low	20 - 40 “	High	Severe
610	Wader Hotter Hourglass complex, 30 to 60 % slopes	182.8	Colluvium slope sandstone, shale	Thurber fescue, Arizona fescue, Mountain brome	Wildlife and livestock grazing	Moderately slow	Moderate	60 “ or >	High	Severe
830	Dressel Jersey complex, 30 to 80 % slopes	996.7	Colluvium sandstone, shale	Quaking aspen, snowberry, needlegrass	Timber, wildlife, and livestock grazing	Moderate	Low	60 “ or >	High	Severe

Soils Identified by the NRCS as being present within the Project Area, but have not been characterized. Information provided presents the Map unit number, name and number of acres within the project area:

56 Typic Cryaquents Cryaquolls Cryofibrists complex, 0 to 5 percent slopes 10.7
153 Fisco Horsethief complex, 10 to 30 percent slopes 88.9
158 Sponsor Tuckerville complex, 30 to 60 percent slopes 153
251 Rock outcrop Snowdon complex, 45 to 75 percent slopes 31.6
336 Whitecross Rock outcrop comples, south aspect, 30 to 75 percent slopes 7.2
337 Whitecross rock outcrop complex, 45 to 75 percent slopes 5.4
339 Henson very gravelly loam, 30 to 60 percent slopes 40.5
383 Haviland Needleton comples, 10 to 30 percent slopes 48.3
394 Clayburn Heisspitz comples, 15 to 30 percent slopes 4.6
495 Riverwash 0.6
496 Rock outcrop155.8
497 Rubble land73.1
499 Water32.6
608 Scotch Graysill complex 30 to 60 percent slopes5.0
816 Storm extremely flaggy loam, 15 to 30 percent slopes 16.5
832 Storm extremely flaggy loam, 0 to 15 percent slopes 20.6

Table 2.2. Flow Historic Annual Peak Flows (source: Dames & Moore, 1981)		
Year	Flow	Date
1952	2120	6/10
1953	1460	5/28
1954	786	5/21
1955	1360	6/8
1956	1020	5/31
1957	2080	6/5
1958	1900	5/27
1959	585	5/15
1960	1170	6/3
1961	1020	5/19
1962	1190	5/9
1963	867	5/8
1964	1220	5/26
1965	1330	5/21
1966	951	5/9
1967	769	5/21
1968	1360	6/4
1969	1210	5/3
1970	1930	9/6
1971	1100	6/17
1972	776	6/8
1973	1810	6/11
1974	786	5/10
1975	1620	6/5
1976	958	6/4
1977	270	5/9
1978	1330	6/10
1979	1600	6/13
1980	1770	6/10

Table 2.3. 2002-2005, Monthly Stream Flow Values (cfs) of the Dolores River at the Montelores Bridge USGS Gauging Station.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2000	14.8	16.4	27.3	191	492	165	45.1	41.4	37.4	33.3	27.8	21
2001	21	22	36.6	156	611	315	80.5	92.7	29	25	20.2	27.9
2002	21.8	18.1	20	110	108	36.3	16.7	14.2	34.8	30.3	18	10.8
2003	10.3	9.78	33.8	115	477	264	38.7	51.2	99.8	32.3	20.9	7.96
2004	8.65	16.6	159	418	600	331	64.3	29.5	57.2	52.3	37.9	20.4
2005	28.3	29.9	43.5	199	713	596	153	54.9	28.4	ice	ice	ice

Table 2.4 Lizard Head Pass Annual and Monthly Precipication (NRCS, Snotel data)

Year	October		November		December		January		February		March		April		May		June		July		August		September	
	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA
99/00	0.2	0.2	0.5	0.3	1.5	1.0	5.0	3.5	8.6	3.6	13.1	4.5	15.3	2.2	17.1	1.8	17.2	0.1	19.0	1.8	23.1	4.1	25.5	2.4
00/01	3.9	3.9	5.6	1.7	7.8	2.2	9.7	1.9	12.0	2.3	14.9	2.9	18.9	4.0	20.7	1.8	20.8	0.1	23.4	2.6	25.9	2.5	26.5	0.6
01/02	1.4	1.4	4.6	3.2	6.7	2.1	6.8	0.1	7.3	0.5	8.3	1.0	9.6	1.3	10.7	1.1	10.8	0.1	11.9	1.1	14.6	2.7	18.2	3.6
02/03	3.0	3.0	6.2	3.2	8.3	2.1	9.2	0.9	11.7	2.5	14.7	3.0	17.0	2.3	18.7	1.7	19.4	0.7	21.5	2.1	24.4	2.9	27.2	2.8
03/04	0.8	0.8	3.1	2.3	4.7	1.6	7.2	2.5	9.8	2.6	11.2	1.4	15.6	4.4	16.3	0.7	16.8	0.5	19.2	2.4	20.5	1.3	25.4	4.9
04/05	3.8	3.8	7.2	3.4	9.0	1.8	13.8	4.8	16.7	2.9	18.6	1.9	21.4	2.8	22.6	1.2	23.8	1.2	25.4	1.6	27.8	2.4	32.5	4.7

TA = Total Accumulation, the total precipitation accumulated during the water year (October through September).

MA = Monthly Accumulation, the total precipitation accumulated during the entire month.

Table 2.5 Scotch Creek Annual and Monthly Precipication (NRCS, Snotel data)

Year	October		November		December		January		February		March		April		May		June		July		August		September	
	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA	TA	MA
99/00	0.1	0.1	0.3	0.2	1.0	0.7	3.8	2.8	8.4	4.6	13.8	5.4	16.8	3.0	17.5	0.7	17.6	0.1	18.2	0.6	19.4	1.2	20.8	1.4
00/01	3.8	3.8	6.1	2.3	8.0	1.9	11.0	3.0	13.9	2.9	16.6	2.7	18.5	1.9	19.9	1.4	19.9	0.0	20.5	0.6	20.9	0.4	21.0	0.1
01/02	0.3	0.3	3.2	2.9	5.1	1.9	7.5	2.4	8.8	1.3	10.7	1.9	12.2	1.5	12.6	0.4	12.6	0.0	13.9	1.3	15.7	1.8	18.9	3.2
02/03	2.5	2.5	4.9	2.4	6.9	2.0	8.1	1.2	11.3	3.2	14.0	2.7	16.0	2.0	17.1	1.1	17.4	0.3	19.2	1.8	24.2	5.0	26.9	2.7
03/04	0.9	0.9	4.6	3.7	7.5	2.9	10.9	3.4	14.8	3.9	15.6	0.8	21.3	5.7	21.9	0.6	22.0	0.1	23.8	1.8	24.4	0.6	28.2	3.8
04/05	3.9	3.9	6.8	2.9	9.0	2.2	15.9	6.9	19.4	3.5	22.2	2.8	24.9	2.7	26.1	1.2	27.2	1.1	27.9	0.7	30.4	2.5	32.4	2.0

TA = Total Accumulation, the total precipitation accumulated during the water year (October through September).

MA = Monthly Accumulation, the total precipitation accumulated during the entire month.

Table 2.6. Threatened and Endangered Species that could Occur within the Project Area. (sources; C. Derfus, 2001, and C. Wilbur, 1995).		
Species	Status	Habitat Requirements
Northern Leopard Frog	S	Favors wet meadows, stream margins and seasonally flooded areas up to an elevation of 11000 ft.
Striped Chorus Frog	MBP	Inhabits wet meadows
Western Toad	MBP	Inhabits wet meadows
Smooth Green Snake	MBP	Unknown
Northern Goshawk	S	Spruce fir – mixed conifer forest. Nest on northern aspect of drainage's and canyons. Feeds on birds, chipmunks, squirrels and rabbits.
Boreal Owl	S	Favors high elevation spruce fir stands of transitional forests. Is a secondary cavity nester and favor larger older tress. Feed on mice, squirrels, chipmunks, small birds and insects.
SW Willow Flycatcher	E	Tends to occur in thick willow stands with standing water.
Townsend Big Eared Bat	R	Inhabits higher elevations of caves and mine sites.
Canadian Lynx	E	Tracks are thought to have been sighted in the area. They favor high elevations, thick vegetation and are closely associated with the snowshoe hare.
Western Boreal Toad	E	Inhabits wet meadows, margins nf streams and beaver ponds with shallow water at elevations of 8500 to 11000 ft.
Wood Frog	T	Inhabits similar areas to the Boreal Toad. Its elevation ranges from 8300 to 9800 and tends to be associated with willow thickets.
Tiger Salamander	S	Inhabits larger ponds or wetland fringe areas.
Colorado River Cutthroat	S	This trout occupies less than 1% of its historical range. Introduction of non-native trout has seriously affected this species.

S: State Sensitive List
R: Rare
E: Federal Endangered
T: Federal Threatened
MBP: May be present

Table 2.7 CDOW Stream Fisheries Survey Results for Locations Above and Below Rico. (source; CDOW, 2006).																	
Length Frequency Record cm (No.# of individuals caught by length range)																	
Species	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38
Above Rico – USFS Rd. crossing adjacent to Cayton Campground																	
BRK					1				1								
LOC					7	3	2	2	2								
MTS			1	6	1		1										
NAT		1										1					
RBT				2	2			1		3	11	30	25	14	4	1	1
Below Rico – Montelores bridge																	
BRK			1						1								
LOC					2	1	1					1		1			
MTS	1	8	15	3	2	1											
RBT							1	1	8	16	45	28	1	1		1	

BRK – Brook trout
LOC – Brown trout
MTS – Mottled sculpin
NAT – Cutthroat trout
RBT – Rainbow trout

Table 2.8 2005 Big Game Summary Information. (source; CDOW, 2006)								
Species	Type			Total Harvest	Total Hunters	Percent Harvest	Total Recreator Days	Total Season Pressure
Elk	Bulls	Cows	Calves					
	357	541	18	916	3714	25	20812	3977
Deer	Bucks	Does	Fawns					
	232	0	0	232	563	41	2584	646
Bear	Boars	Sows						
	1	0		1			9	

Table 2.9 Summary of Range Allotments Leased within the Project Area (source; USFS SJNF, 2006)			
Allotment Name	Allotment No.	Area (acres)	Pasture and No.
Expectation	13222	28,146.20	-
Sheep Mountain	13231	7,920.51	Barlow 002
Sheep Mountain	13231	6,769.00	Flat top 003
Sheep Mountain	13231	9,946.51	Sheep Mountain 001
Coke Oven	13228	16,749.29	-
Rico Watershed	13998	6,774.77	Rico Watershed 001
Divide	13234	7,338.20	Scotch Creek 001
Divide	13234	7,127.30	Ryman 001
Divide	13234	7,995.15	Roaring Fork 005

Table 2.10 Summary of Mine Permits and their Status within the Project Area. (source; CDMG, 2006).

Mine Name	Permit No.#	Permit Type	Permit Status	Township	Range	Commodities Mined
Montelores Placer	M1990011	Hard rock limited impact	Terminated	39N	11W	Gold
Lizard head Pit	M1982153	Construction by Government Agency	Terminated	41N	10W	Borrow material for construction
Argentine Borrow Pit	M1999151	Not mining	Not mining	40N	10W	Borrow material for construction
Little Silver Mine	M1981242	Hard rock limited impact	Revoked	40N	12W	Gold, silver and copper
Horse Creek Pit 2	M1995077	Illegal	Application withdrawn	40N	11W	Crushed stone material, sand and gravel
Horse Creek Pit 1	M1995071	Illegal	Application withdrawn	40N	11W	Crushed stone material, sand and gravel, limestone
Emma Mine	M1982226	Hard rock limited impact	Active	41N	11W	Gold and silver

Table 2.11 Summary of Oil & Gas Permitted Wells Adjacent to the Project Area. (source; COGCC, 2006).			
Sub-basin	Operator	Permit No.#	Name of Well
West Dolores River	Smith* Ray Drilling	05-033-05005	Brown Chester l1
	Gulf Oil Corp.	05-033-06028	Stoner Creek Unit 1
	Chevron USA Inc.	05-033-06068	Gillespie Federal “S” 2
Dolores River	Davis Oil Co.	05-083-05268	Short 1
	Gulf Oil Corp.	05-083-06194	Dolores River Unit 1

Table 2.12 Colorado County Domestic Water Use Rates (source; USGS, 2006).

COUNTY	TP-TotPop	DO-SSPop	DO-WGWFr	DO-WFrTo	TO-WGWFr	TO-WSWFr	TO-WFrTo
001	363.86	35.08	4.21	4.21	27.04	106.55	133.59
003	14.97	3.21	0.39	0.39	125.27	99.56	224.83
005	487.97	68.48	8.21	8.21	15.81	96.18	111.99
007	9.90	5.06	0.61	0.61	0.83	65.78	66.61
009	4.52	1.28	0.15	0.15	111.58	0.00	111.58
011	6.00	2.27	0.27	0.27	7.55	316.95	324.50
013	291.29	4.44	0.53	0.53	5.85	176.17	182.02
015	16.24	5.20	0.63	0.63	0.92	71.24	72.16
017	2.23	0.74	0.09	0.09	29.40	3.18	32.58
019	9.32	2.13	0.25	0.25	0.59	1.22	1.81
021	8.40	3.44	0.41	0.41	34.70	219.32	254.02
023	3.66	0.67	0.08	0.08	50.67	49.65	100.32
025	5.52	0.74	0.09	0.09	0.97	96.98	97.95
027	3.50	2.70	0.33	0.33	0.45	48.85	49.30
029	27.83	9.71	1.16	1.16	4.68	673.86	678.54
031	554.64	0.00	0.00	0.00	6.91	152.26	159.17
033	1.84	0.79	0.09	0.09	1.82	52.82	54.64
035	175.77	41.42	4.97	4.97	15.72	27.62	43.34
037	41.66	8.46	1.02	1.02	2.41	138.18	140.59
039	19.87	16.47	1.97	1.97	11.26	7.13	18.39
041	516.93	47.65	5.95	5.95	16.88	121.61	138.49
043	46.15	2.54	0.30	0.30	0.88	159.54	160.42
045	43.79	14.88	1.79	1.79	4.73	416.07	420.80
047	4.76	4.32	0.52	0.52	0.52	0.11	0.63
049	12.44	4.79	0.58	0.58	1.06	109.33	110.39
051	13.96	4.04	0.49	0.49	3.34	238.60	241.94
053	0.79	0.39	0.05	0.05	0.12	9.59	9.71
055	7.86	2.83	0.34	0.34	1.88	66.28	68.16
057	1.58	0.61	0.07	0.07	0.08	322.74	322.82
059	527.06	77.71	9.32	9.32	16.77	127.37	144.14
061	1.62	0.60	0.07	0.07	26.61	2.14	28.75
063	8.01	3.18	0.38	0.38	186.44	0.00	186.44
065	7.81	3.46	0.42	0.42	0.64	40.38	41.02
067	43.94	18.70	2.24	2.24	3.97	216.64	220.61
069	251.49	13.33	1.60	1.60	27.03	245.01	272.04
071	15.21	3.77	0.45	0.45	2.89	118.84	121.73
073	6.09	1.41	0.18	0.18	20.04	0.18	20.22
075	20.50	6.52	0.78	0.78	55.94	253.37	309.31
077	116.26	24.17	2.90	2.90	7.60	1194.37	1201.97
079	0.83	0.27	0.03	0.03	0.11	0.00	0.11
081	13.18	3.43	0.42	0.42	1.32	207.42	208.74
083	23.83	0.81	0.10	0.10	1.15	427.60	428.75
085	33.43	13.34	1.60	1.60	5.83	591.91	597.74
087	27.17	3.72	0.44	0.44	111.80	176.41	288.21
089	20.31	0.69	0.09	0.09	10.17	271.74	281.91
091	3.74	1.49	0.18	0.18	0.36	81.74	82.10
093	14.52	12.91	1.55	1.55	1.72	26.41	28.13
095	4.48	1.15	0.13	0.13	128.11	1.72	129.83
097	14.87	1.52	0.18	0.18	0.48	42.71	43.19
099	14.48	1.49	0.18	0.18	96.58	332.48	429.06
101	141.47	3.57	0.43	0.43	10.61	235.71	246.32
103	5.99	1.51	0.18	0.18	1.78	214.80	216.58
105	12.41	5.88	0.71	0.71	171.59	113.74	285.33
107	19.69	6.68	0.80	0.80	2.94	268.28	271.22
109	5.92	2.12	0.25	0.25	357.81	289.22	647.03
111	0.56	0.05	0.01	0.01	0.02	0.15	0.17
113	6.59	1.20	0.15	0.15	0.33	9.55	9.88
115	2.75	0.91	0.11	0.11	62.39	49.67	112.06
117	23.55	9.01	1.08	1.08	2.33	2.17	4.50
119	20.56	6.89	0.82	0.82	1.40	5.44	6.84
121	4.93	2.71	0.32	0.32	58.59	5.65	64.24
123	180.94	22.20	2.66	2.66	142.19	921.98	1064.17
125	9.84	4.22	0.51	0.51	315.18	5.95	321.13

TP-TotPop	Total Population of County, in thousands
DO-SSPop	Domestic, self-supplied population in thousands
DO-WGWFr	Domestic, groundwater self supplied withdrawals in freshwate
DO-WFrTo	Domestic Total self supplied withdrawals Mgal/day
TO-WGWFr	Total surface water withdrawals in freshwater Mgal/day
TO-WSWFr	Total withdrawals of freshwater Mgal/day

Table 2.13 Colorado County Public Supply Water Use Rates. (source; USGS, 2006).

COUNTY	TP-TotPop	PS-TOPop	PS-WGWFr	PS-WSWFr	PS-WFrTo	TO-WGWFr	TO-WSWFr	TO-WFrTo
001	363.86	328.78	4.30	70.75	75.05	27.04	106.55	133.59
003	14.97	11.76	1.76	0.00	1.76	125.27	99.56	224.83
005	487.97	419.49	3.40	92.02	95.42	15.81	96.18	111.99
007	9.90	4.84	0.09	1.45	1.54	0.83	65.78	66.61
009	4.52	3.24	0.49	0.00	0.49	111.58	0.00	111.58
011	6.00	3.73	0.56	0.00	0.56	7.55	316.95	324.50
013	291.29	286.85	0.31	70.99	71.30	5.85	176.17	182.02
015	16.24	11.04	0.29	2.29	2.58	0.92	71.24	72.16
017	2.23	1.49	0.23	0.00	0.23	29.40	3.18	32.58
019	9.32	7.19	0.34	1.22	1.56	0.59	1.22	1.81
021	8.40	4.96	0.76	0.00	0.76	34.70	219.32	254.02
023	3.66	2.99	0.46	0.00	0.46	50.67	49.65	100.32
025	5.52	4.78	0.37	0.46	0.83	0.97	96.98	97.95
027	3.50	0.80	0.12	0.00	0.12	0.45	48.85	49.30
029	27.83	18.12	1.03	4.18	5.21	4.68	673.86	678.54
031	554.64	554.64	0.00	140.86	140.86	6.91	152.26	159.17
033	1.84	1.05	0.00	0.29	0.29	1.82	52.82	54.64
035	175.77	134.35	9.19	18.28	27.47	15.72	27.62	43.34
037	41.66	33.20	0.97	9.14	10.11	2.41	138.18	140.59
039	19.87	3.40	0.52	0.00	0.52	11.26	7.13	18.39
041	516.93	469.28	4.66	109.56	114.22	16.88	121.61	138.49
043	46.15	43.61	0.00	10.89	10.89	0.88	159.54	160.42
045	43.79	28.91	0.71	8.37	9.08	4.73	416.07	420.80
047	4.76	0.44	0.00	0.11	0.11	0.52	0.11	0.63
049	12.44	7.65	0.48	1.52	2.00	1.06	109.33	110.39
051	13.96	9.92	1.07	1.18	2.25	3.34	238.60	241.94
053	0.79	0.40	0.06	0.00	0.06	0.12	9.59	9.71
055	7.86	5.03	0.06	1.18	1.24	1.88	66.28	68.16
057	1.58	0.97	0.01	0.18	0.19	0.08	322.74	322.82
059	527.06	449.35	0.76	97.74	98.50	16.77	127.37	144.14
061	1.62	1.02	0.15	0.00	0.15	26.61	2.14	28.75
063	8.01	4.83	0.73	0.00	0.73	186.44	0.00	186.44
065	7.81	4.35	0.22	0.74	0.96	0.64	40.38	41.02
067	43.94	25.24	1.24	5.77	7.01	3.97	216.64	220.61
069	251.49	238.16	1.23	55.83	57.06	27.03	245.01	272.04
071	15.21	11.44	0.16	2.68	2.84	2.89	118.84	121.73
073	6.09	4.68	0.57	0.18	0.75	20.04	0.18	20.22
075	20.50	13.98	2.10	0.00	2.10	55.94	253.37	309.31
077	116.26	92.09	0.26	31.75	32.01	7.60	1194.37	1201.97
079	0.83	0.56	0.08	0.00	0.08	0.11	0.00	0.11
081	13.18	9.75	0.05	3.65	3.70	1.32	207.42	208.74
083	23.83	23.02	0.00	7.27	7.27	1.15	427.60	428.75
085	33.43	20.09	0.10	5.93	6.03	5.83	591.91	597.74
087	27.17	23.45	1.72	3.05	4.77	111.80	176.41	288.21
089	20.31	19.62	2.29	1.10	3.39	10.17	271.74	281.91
091	3.74	2.25	0.18	0.41	0.59	0.36	81.74	82.10
093	14.52	1.61	0.17	0.11	0.28	1.72	26.41	28.13
095	4.48	3.33	0.50	0.00	0.50	128.11	1.72	129.83
097	14.87	13.35	0.30	3.92	4.22	0.48	42.71	43.19
099	14.48	12.99	1.96	0.01	1.97	96.58	332.48	429.06
101	141.47	137.90	0.81	34.00	34.81	10.61	235.71	246.32
103	5.99	4.48	0.32	0.93	1.25	1.78	214.80	216.58
105	12.41	6.53	0.71	0.36	1.07	171.59	113.74	285.33
107	19.69	13.01	0.35	3.62	3.97	2.94	268.28	271.22
109	5.92	3.80	0.45	0.17	0.62	357.81	289.22	647.03
111	0.56	0.51	0.01	0.15	0.16	0.02	0.15	0.17
113	6.59	5.39	0.18	0.46	0.64	0.33	9.55	9.88
115	2.75	1.84	0.29	0.00	0.29	62.39	49.67	112.06
117	23.55	14.54	1.25	2.17	3.42	2.33	2.17	4.50
119	20.56	13.67	0.58	2.49	3.07	1.40	5.44	6.84
121	4.93	2.22	0.34	0.00	0.34	58.59	5.65	64.24
123	180.94	158.74	0.56	36.31	36.87	142.19	921.98	1064.17
125	9.84	5.62	0.83	0.00	0.83	315.18	5.95	321.13

TP-TotPop	Total Population of County, in thousands
PS-TOPop	Public supply, total population served in thousands
PS-WGWFr	Public supply, groundwater withdrawals in freshwater Mgal/day
PS-WSWFr	Public supply, surface water withdrawals in freshwater Mgal/day
PS-WFrTo	Public supply, total withdrawals of freshwater Mgal/day
TO-WGWFr	Total groundwater withdrawals in freshwater Mgal/day
TO-WSWFr	Total surface water withdrawals in freshwater Mgal/day
TO-WFrTo	Total withdrawals of freshwater Mgal/day

Table 2.14 Colorado County Irrigation Water Use Rates. (source; USGS, 2006).

COUNTY	TP-TotPop	IT-IrSpr	IT-IrSur	IT-IrTot	IT-WGWFr	IT-WSWFr	IT-WFrTo	TO-WGWFr	TO-WSWFr	TO-WFrTo
001	363.86	13.05	14.52	27.57	15.03	29.67	44.70	27.04	106.55	133.59
003	14.97	108.17	1.10	109.27	123.12	99.56	222.68	125.27	99.56	224.83
005	487.97	3.36	0.00	3.36	2.53	0.68	3.21	15.81	96.18	111.99
007	9.90	0.19	16.76	16.95	0.13	64.33	64.46	0.83	65.78	66.61
009	4.52	57.94	20.13	78.13	110.94	0.00	110.94	111.58	0.00	111.58
011	6.00	0.00	58.52	58.52	6.72	316.95	323.67	7.55	316.95	324.50
013	291.29	0.00	33.94	33.94	3.87	101.35	105.22	5.85	176.17	182.02
015	16.24	4.64	17.43	22.07	0.00	68.95	68.95	0.92	71.24	72.16
017	2.23	23.37	2.32	25.69	29.08	3.18	32.26	29.40	3.18	32.58
019	9.32	0.00	0.00	0.00	0.00	0.00	0.00	0.59	1.22	1.81
021	8.40	39.48	71.06	110.54	33.53	219.32	252.85	34.70	219.32	254.02
023	3.66	29.73	24.87	54.60	50.13	49.65	99.78	50.67	49.65	100.32
025	5.52	0.00	20.81	20.81	0.51	96.52	97.03	0.97	96.98	97.95
027	3.50	0.00	18.30	18.30	0.00	48.85	48.85	0.45	48.85	49.30
029	27.83	0.00	72.20	72.20	2.49	669.68	672.17	4.68	673.86	678.54
031	554.64	0.00	0.00	0.00	0.00	0.00	0.00	6.91	152.26	159.17
033	1.84	13.06	0.00	13.06	1.71	52.52	54.23	1.82	52.82	54.64
035	175.77	1.93	3.69	5.62	1.56	9.34	10.90	15.72	27.62	43.34
037	41.66	0.00	18.01	18.01	0.42	129.04	129.46	2.41	138.18	140.59
039	19.87	12.92	0.47	13.39	8.77	7.13	15.90	11.26	7.13	18.39
041	516.93	5.58	2.72	8.30	3.61	11.35	14.96	16.88	121.61	138.49
043	46.15	0.00	22.49	22.49	0.20	107.08	107.28	0.88	159.54	160.42
045	43.79	0.00	43.54	43.54	2.23	407.70	409.93	4.73	416.07	420.80
047	4.76	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.11	0.63
049	12.44	0.00	27.41	27.41	0.00	107.81	107.81	1.06	109.33	110.39
051	13.96	0.00	46.76	46.76	1.78	237.42	239.20	3.34	238.60	241.94
053	0.79	0.00	2.44	2.44	0.01	9.59	9.60	0.12	9.59	9.71
055	7.86	0.00	15.77	15.77	1.48	65.10	66.58	1.88	66.28	68.16
057	1.58	0.00	104.37	104.37	0.00	322.56	322.56	0.08	322.74	322.82
059	527.06	0.00	7.14	7.14	0.56	21.61	22.17	16.77	127.37	144.14
061	1.62	5.36	3.39	8.75	26.39	2.14	28.53	26.61	2.14	28.75
063	8.01	123.58	24.03	147.61	185.32	0.00	185.32	186.44	0.00	186.44
065	7.81	0.00	34.06	34.06	0.00	39.64	39.64	0.64	40.38	41.02
067	43.94	6.99	33.07	40.06	0.46	210.86	211.32	3.97	216.64	220.61
069	251.49	4.29	77.18	81.47	23.70	188.36	212.06	27.03	245.01	272.04
071	15.21	0.00	23.37	23.37	2.28	116.16	118.44	2.89	118.84	121.73
073	6.09	5.01	2.21	7.22	19.29	0.00	19.29	20.04	0.18	20.22
075	20.50	31.20	87.69	118.89	52.37	253.35	305.72	55.94	253.37	309.31
077	116.26	0.00	89.72	89.72	4.14	1117.36	1121.50	7.60	1194.37	1201.97
079	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.11
081	13.18	0.97	35.40	36.37	0.85	192.52	193.37	1.32	207.42	208.74
083	23.83	20.47	35.86	56.33	1.05	420.33	421.38	1.15	427.60	428.75
085	33.43	0.00	81.65	81.65	4.13	584.62	588.75	5.83	591.91	597.74
087	27.17	87.98	78.64	166.62	104.28	173.34	277.62	111.80	176.41	288.21
089	20.31	0.00	63.96	64.31	7.69	270.60	278.29	10.17	271.74	281.91
091	3.74	0.00	16.81	16.81	0.00	81.33	81.33	0.36	81.74	82.10
093	14.52	0.00	16.25	16.25	0.00	26.30	26.30	1.72	26.41	28.13
095	4.48	72.03	9.13	81.16	127.48	1.72	129.20	128.11	1.72	129.83
097	14.87	0.00	12.03	12.03	0.00	38.79	38.79	0.48	42.71	43.19
099	14.48	12.21	97.43	109.74	87.45	332.47	419.92	96.58	332.48	429.06
101	141.47	1.78	31.40	33.23	7.03	122.78	129.81	10.61	235.71	246.32
103	5.99	0.00	32.64	32.64	1.28	213.87	215.15	1.78	214.80	216.58
105	12.41	113.99	29.26	143.25	170.15	113.37	283.52	171.59	113.74	285.33
107	19.69	0.00	48.55	48.55	1.79	262.27	264.06	2.94	268.28	271.22
109	5.92	0.00	209.89	209.89	357.11	289.05	646.16	357.81	289.22	647.03
111	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.15	0.17
113	6.59	0.00	1.86	1.86	0.00	9.09	9.09	0.33	9.55	9.88
115	2.75	33.27	27.34	60.61	61.99	49.67	111.66	62.39	49.67	112.06
117	23.55	0.00	0.00	0.00	0.00	0.00	0.00	2.33	2.17	4.50
119	20.56	0.00	1.81	1.81	0.00	2.95	2.95	1.40	5.44	6.84
121	4.93	46.31	7.79	54.10	57.92	5.65	63.57	58.59	5.65	64.24
123	180.94	64.82	336.70	402.12	137.96	882.46	1020.42	142.19	921.98	1064.17
125	9.84	242.77	0.32	243.09	313.84	5.95	319.79	315.18	5.95	321.13

TP-TotPop	Total population of County in thousands
IT-IrSpr	Irrigation acres Irrigated sprinkler in thousands
IT-IrSur	Irrigation acres Irrigated surface (flooding) in thousands
IT-IrTot	Irrigation acres irrigated in Total in thousands
IT-WGWFr	Irrigation groundwater withdrawals in freshwater Mgal/day
IT-WSWFr	Irrigation surface water withdrawals in freshwater Mgal/day
IT-WFrTo	Irrigation surface water withdrawals in freshwater Mgal/day
TO-WGWFr	Total groundwater withdrawals fresh in Mgal/day
TO-WSWFr	Total surface water withdrawals fresh in Mgal/day
TO-WFrTo	Total withdrawals fresh in Mgal/day

Table 2.15 Colorado County Industrial Water Use Rates. (source; USGS, 2006).

COUNTY	TP-TotPop	IN-WGWTo	IN-WSWTo	IN-WtotI	TO-WGWFr	TO-WSWFr	TO-WFrTo
001	363.86	3.50	2.97	6.47	27.04	106.55	133.59
003	14.97	0.00	0.00	0.00	125.27	99.56	224.83
005	487.97	1.67	3.48	5.15	15.81	96.18	111.99
007	9.90	0.00	0.00	0.00	0.83	65.78	66.61
009	4.52	0.00	0.00	0.00	111.58	0.00	111.58
011	6.00	0.00	0.00	0.00	7.55	316.95	324.50
013	291.29	1.14	1.24	2.38	5.85	176.17	182.02
015	16.24	0.00	0.00	0.00	0.92	71.24	72.16
017	2.23	0.00	0.00	0.00	29.40	3.18	32.58
019	9.32	0.00	0.00	0.00	0.59	1.22	1.81
021	8.40	0.00	0.00	0.00	34.70	219.32	254.02
023	3.66	0.00	0.00	0.00	50.67	49.65	100.32
025	5.52	0.00	0.00	0.00	0.97	96.98	97.95
027	3.50	0.00	0.00	0.00	0.45	48.85	49.30
029	27.83	0.00	0.00	0.00	4.68	673.86	678.54
031	554.64	4.99	6.73	11.72	6.91	152.26	159.17
033	1.84	0.02	0.01	0.03	1.82	52.82	54.64
035	175.77	0.00	0.00	0.00	15.72	27.62	43.34
037	41.66	0.00	0.00	0.00	2.41	138.18	140.59
039	19.87	0.00	0.00	0.00	11.26	7.13	18.39
041	516.93	0.72	0.70	1.42	16.88	121.61	138.49
043	46.15	0.38	0.87	1.25	0.88	159.54	160.42
045	43.79	0.00	0.00	0.00	4.73	416.07	420.80
047	4.76	0.00	0.00	0.00	0.52	0.11	0.63
049	12.44	0.00	0.00	0.00	1.06	109.33	110.39
051	13.96	0.00	0.00	0.00	3.34	238.60	241.94
053	0.79	0.00	0.00	0.00	0.12	9.59	9.71
055	7.86	0.00	0.00	0.00	1.88	66.28	68.16
057	1.58	0.00	0.00	0.00	0.08	322.74	322.82
059	527.06	6.13	8.02	14.15	16.77	127.37	144.14
061	1.62	0.00	0.00	0.00	26.61	2.14	28.75
063	8.01	0.01	0.00	0.01	186.44	0.00	186.44
065	7.81	0.00	0.00	0.00	0.64	40.38	41.02
067	43.94	0.03	0.01	0.04	3.97	216.64	220.61
069	251.49	0.50	0.82	1.32	27.03	245.01	272.04
071	15.21	0.00	0.00	0.00	2.89	118.84	121.73
073	6.09	0.00	0.00	0.00	20.04	0.18	20.22
075	20.50	0.69	0.02	0.71	55.94	253.37	309.31
077	116.26	0.30	0.18	0.48	7.60	1194.37	1201.97
079	0.83	0.00	0.00	0.00	0.11	0.00	0.11
081	13.18	0.00	0.00	0.00	1.32	207.42	208.74
083	23.83	0.00	0.00	0.00	1.15	427.60	428.75
085	33.43	0.00	0.00	0.00	5.83	591.91	597.74
087	27.17	0.06	0.02	0.08	111.80	176.41	288.21
089	20.31	0.10	0.04	0.14	10.17	271.74	281.91
091	3.74	0.00	0.00	0.00	0.36	81.74	82.10
093	14.52	0.00	0.00	0.00	1.72	26.41	28.13
095	4.48	0.00	0.00	0.00	128.11	1.72	129.83
097	14.87	0.00	0.00	0.00	0.48	42.71	43.19
099	14.48	0.01	0.00	0.01	96.58	332.48	429.06
101	141.47	2.34	70.85	73.19	10.61	235.71	246.32
103	5.99	0.00	0.00	0.00	1.78	214.80	216.58
105	12.41	0.02	0.01	0.03	171.59	113.74	285.33
107	19.69	0.00	0.00	0.00	2.94	268.28	271.22
109	5.92	0.00	0.00	0.00	357.81	289.22	647.03
111	0.56	0.00	0.00	0.00	0.02	0.15	0.17
113	6.59	0.00	0.00	0.00	0.33	9.55	9.88
115	2.75	0.00	0.00	0.00	62.39	49.67	112.06
117	23.55	0.00	0.00	0.00	2.33	2.17	4.50
119	20.56	0.00	0.00	0.00	1.40	5.44	6.84
121	4.93	0.01	0.00	0.01	58.59	5.65	64.24
123	180.94	1.01	0.43	1.44	142.19	921.98	1064.17
125	9.84	0.00	0.00	0.00	315.18	5.95	321.13

TP-TotPop	Total population of County in thousands
IN-WGWTo	Industrial groundwater self supplied withdrawals in total Mgal/day
IN-WSWTo	Industrial surface water self supplied withdrawals in total Mgal/day
IN-WtotI	Industrial total self supplied withdrawals Mgal/day
TO-WGWFr	Total groundwater withdrawals in freshwater Mgal/day
TO-WSWFr	Total surface water withdrawals in freshwater Mgal/day
TO-WFrTo	Total withdrawals freshwater in Mgal/day

Footnotes: Codes for Colorado Counties.

001 Adams	051 Gunnison	101 Pueblo
003 Alamosa	053 Hinsdale	103 Rio Blanco
005 Arapahoe	055 Huerfano	105 Rio Grande
007 Archuleta	057 Jackson	107 Routt
009 Baca	059 Jefferson	109 Saguache
011 Bent	061 Kiowa	111 San Juan
013 Boulder	063 Kit Carson	113 San Miguel
015 Chaffee	065 Lake	115 Sedgwick
017 Cheyenne	067 La Plata	117 Summit
019 Clear Creek	069 Larimer	119 Teller
021 Conejos	071 Las Animas	121 Washington
023 Costilla	073 Lincoln	123 Weld
025 Crowley	075 Logan	125 Yuma
027 Custer	077 Mesa	
029 Delta	079 Mineral	
031 Denver	081 Moffat	
033 Dolores	083 Montezuma	
035 Douglas	085 Montrose	
037 Eagle	087 Morgan	
039 Elbert	089 Otero	
041 El Paso	091 Ouray	
043 Fremont	093 Park	
045 Garfield	095 Phillips	
047 Gilpin	097 Pitkin	
049 Grand	099 Prowers	

Table 2.16 River Miles Supporting and Not Supporting of its Designated Use (source; CDPHE, 2002 and 2004).			
Designated Use[1]	No.# River Miles Assessed	No.# River Miles Supporting its Use	No.# of River Miles Not Supporting its Use
2002 Data			
Aquatic Life Cold 1	3,101	2,916	184
Aquatic Life Cold 2	1,535	1,494	41
Aquatic Life Warm 1	317	317	0
Aquatic Life Warm 2	3,000	1,410	1,589
Primary Contact (Recreation, Class 1)	7,780	7,780	0
Secondary Contact (Recreation, Class 2)	99	99	0
Drinking Water Supply	4,415	4,412	2
Agriculture	7,495	7,470	25
2042 Data			
Aquatic Life Cold 1	2,050	1,982	68
Aquatic Life Cold 2	660	624	36
Aquatic Life Warm 1	197	197	0
Aquatic Life Warm 2	1,362	1,362	0
Primary Contact (Recreation, Class 1)	4,148	4,148	0
Secondary Contact (Recreation, Class 2)	99	99	0
Drinking Water Supply	2,556	2,556	0
Agriculture	3,858	3,808	50

1 As defined by the CWCD and CWCC

FIGURES

Figure 2.1. Hydrologic Unit Delineations (source; NRCS, 2006).

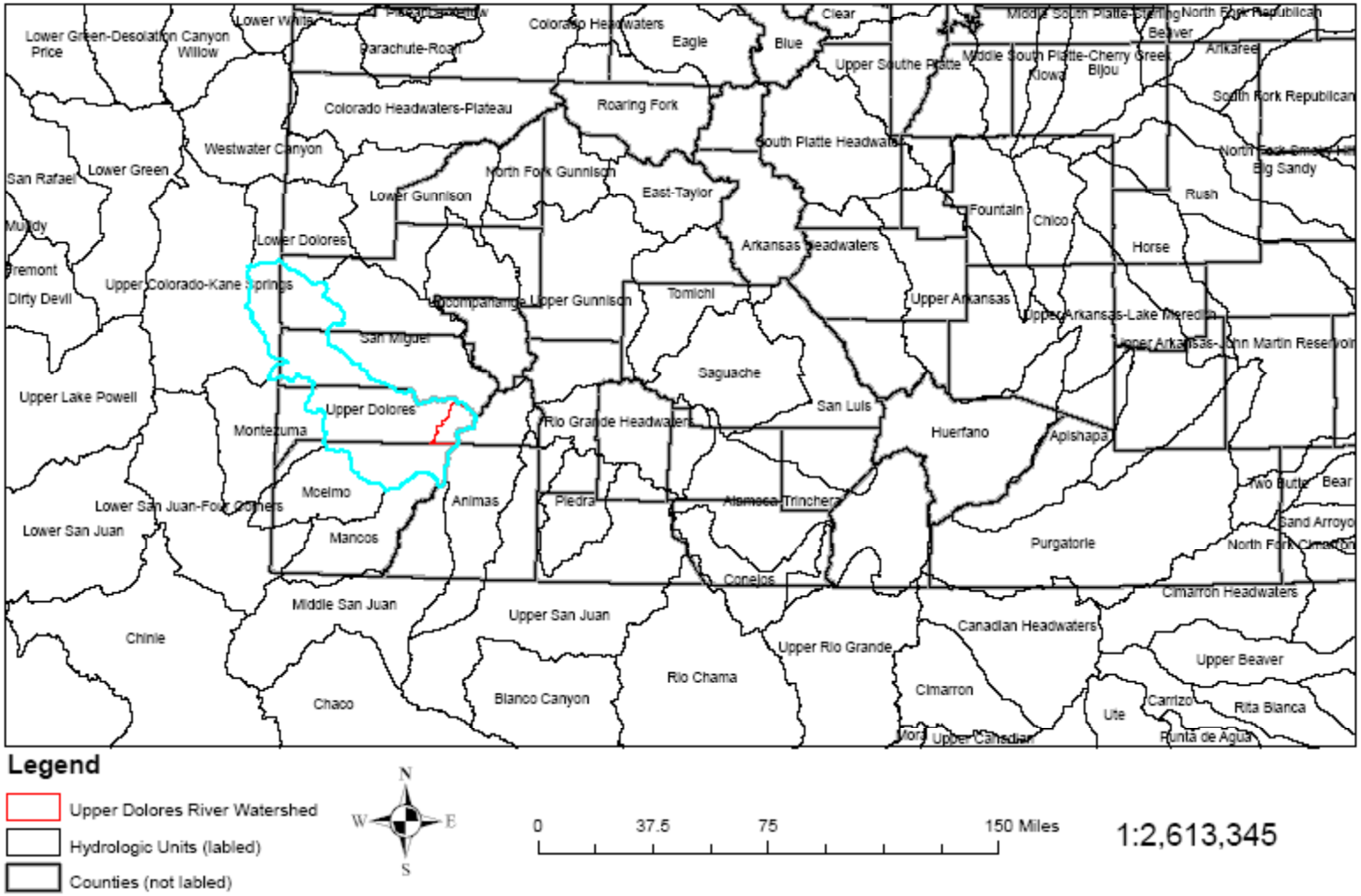


Figure 2.2. Colorado Division of Water Resources' Water Divisions and Districts (source; CDWR).

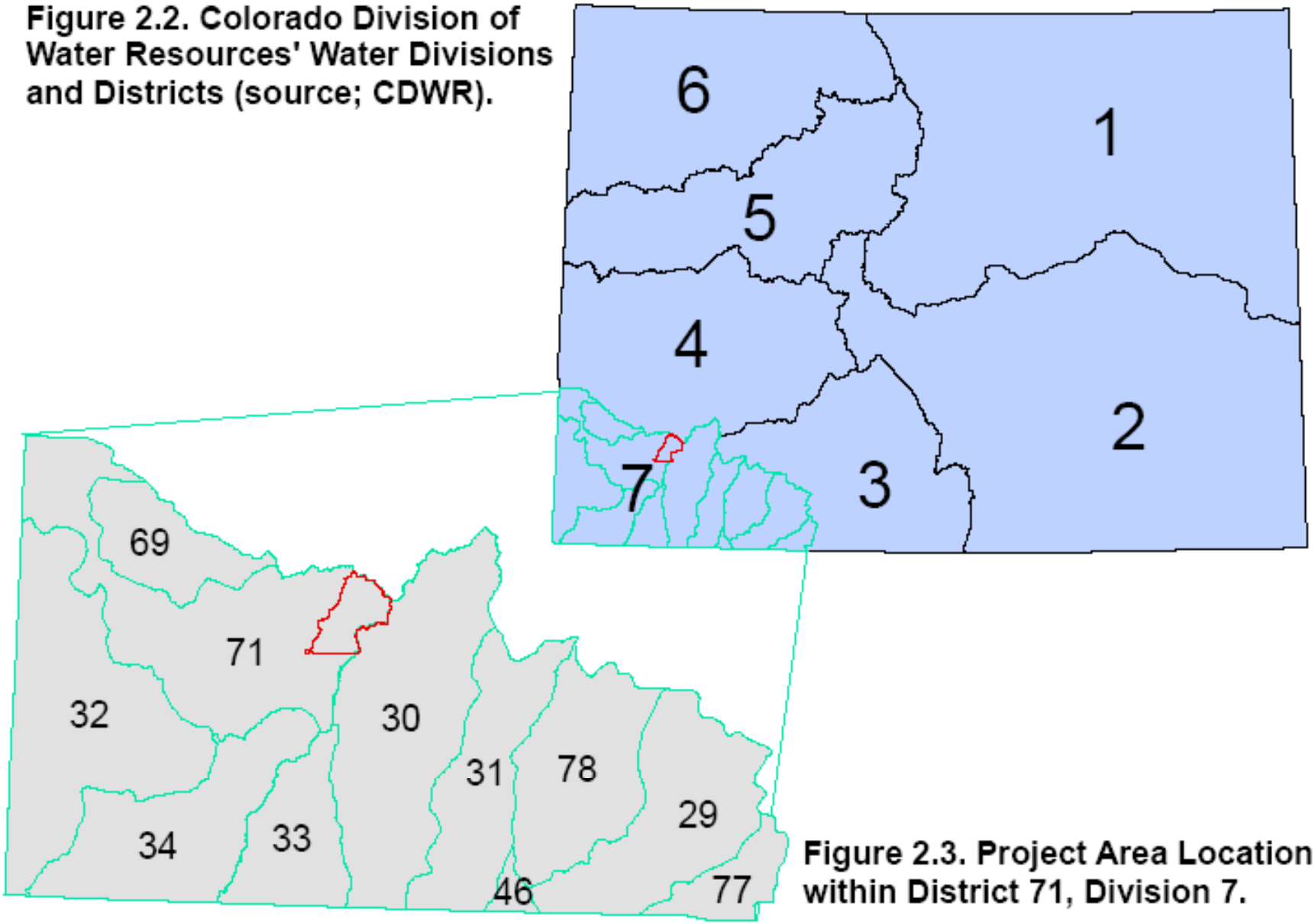
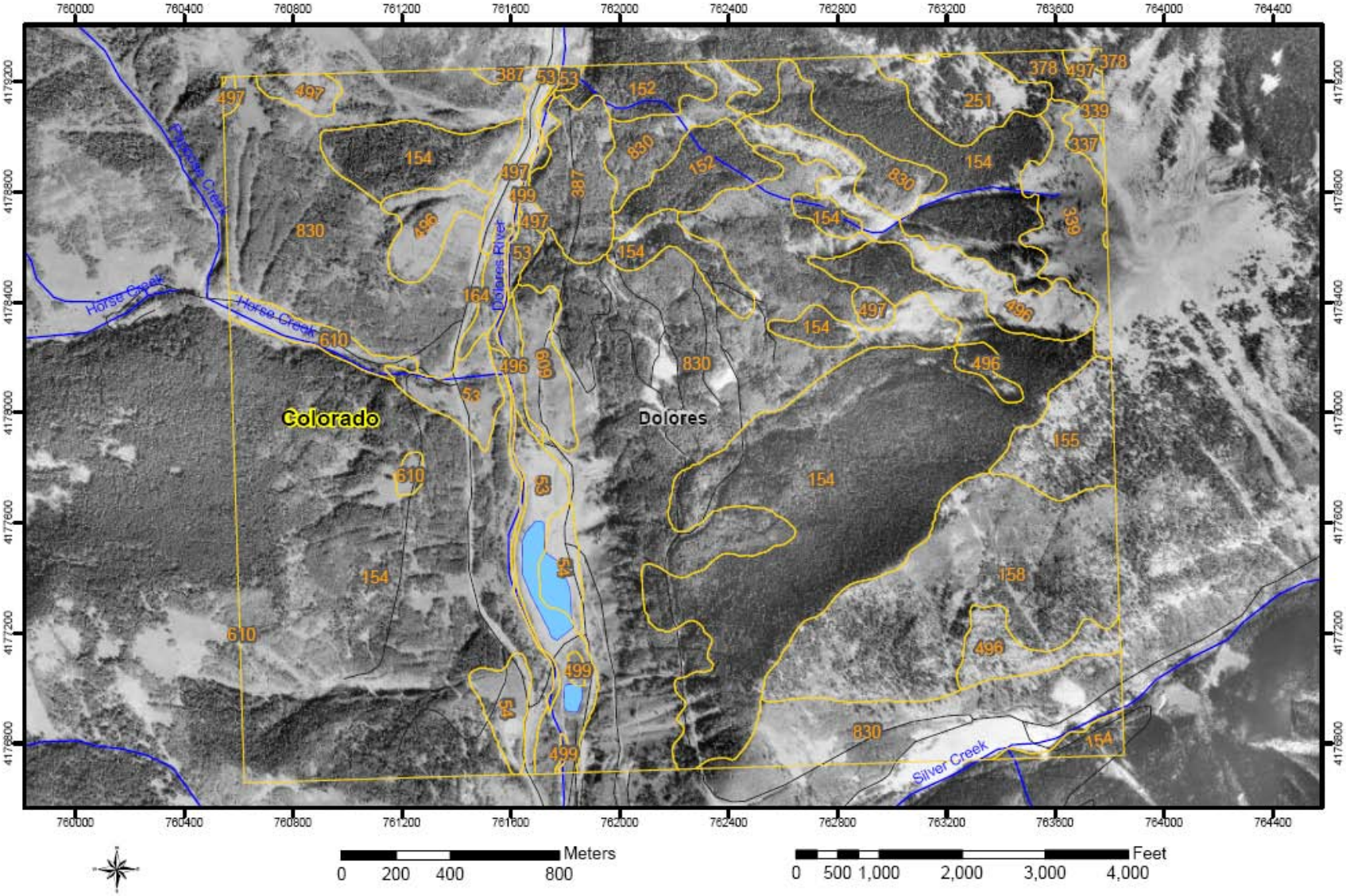


Figure 2.3. Project Area Location within District 71, Division 7.

Figure 2.4. Soils within the Northern portion of the Project Area.

SOIL SURVEY OF ANIMAS-DOLORES AREA, COLORADO, PARTS OF ARCHULETA, DOLORES, HINSDALE, LA PLATA, MONTEZUMA, SAN JUAN, AND SAN MIGUEL COUNTIES

Upper Project Area Soil Survey



USDA Natural Resources Conservation Service

Web Soil Survey 1.1
National Cooperative Soil Survey

Figure 2.5. Soils within the Southern portion of the Project Area.

SOIL SURVEY OF ANIMAS-DOLORES AREA, COLORADO, PARTS OF ARCHULETA, DOLORES, HINSDALE, LA PLATA, MONTEZUMA, SAN JUAN, AND SAN MIGUEL COUNTIES

Lower Project Area Soil Survey

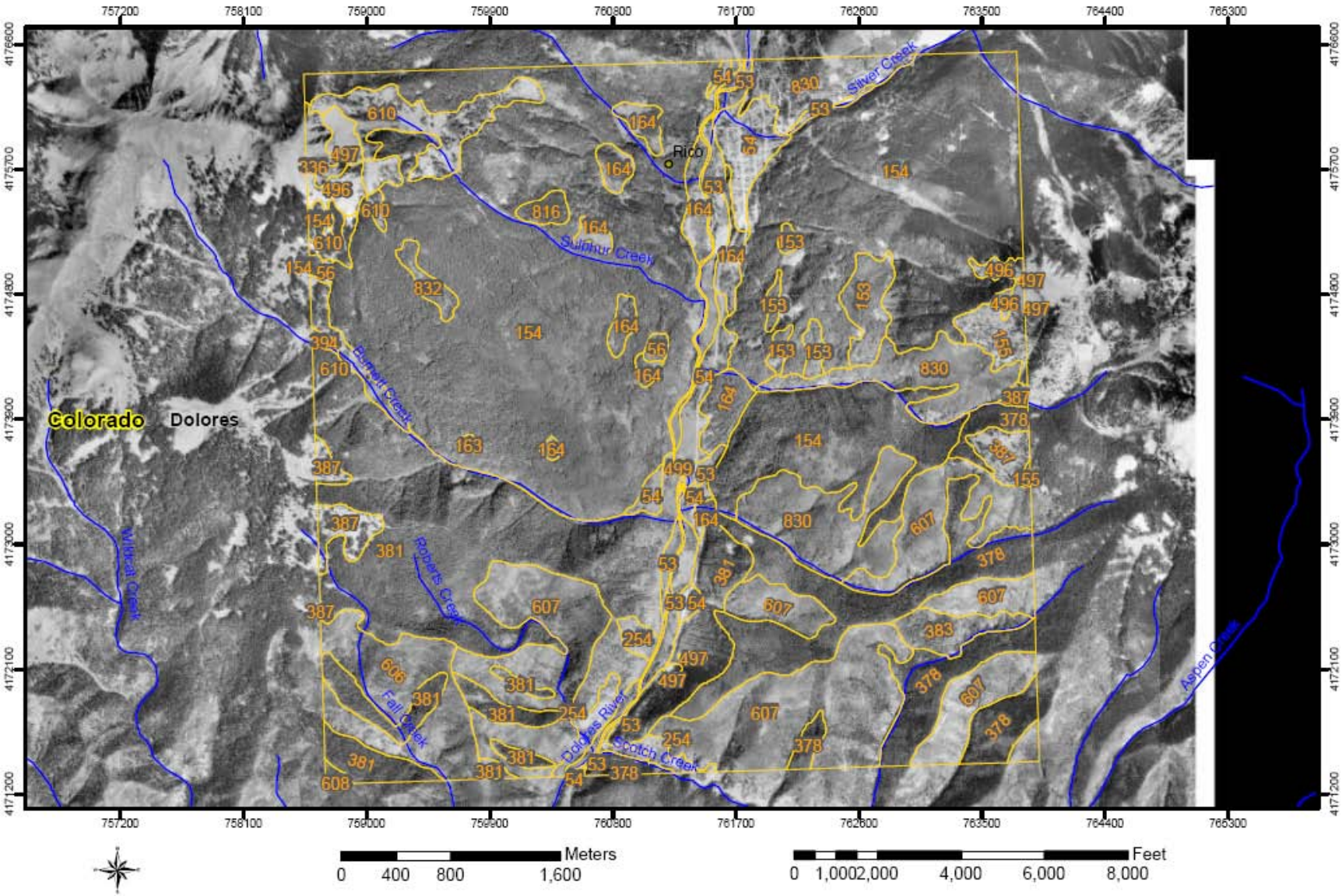


Figure 2.6. Generalized Geology of Colorado (source; CGS, 2004).

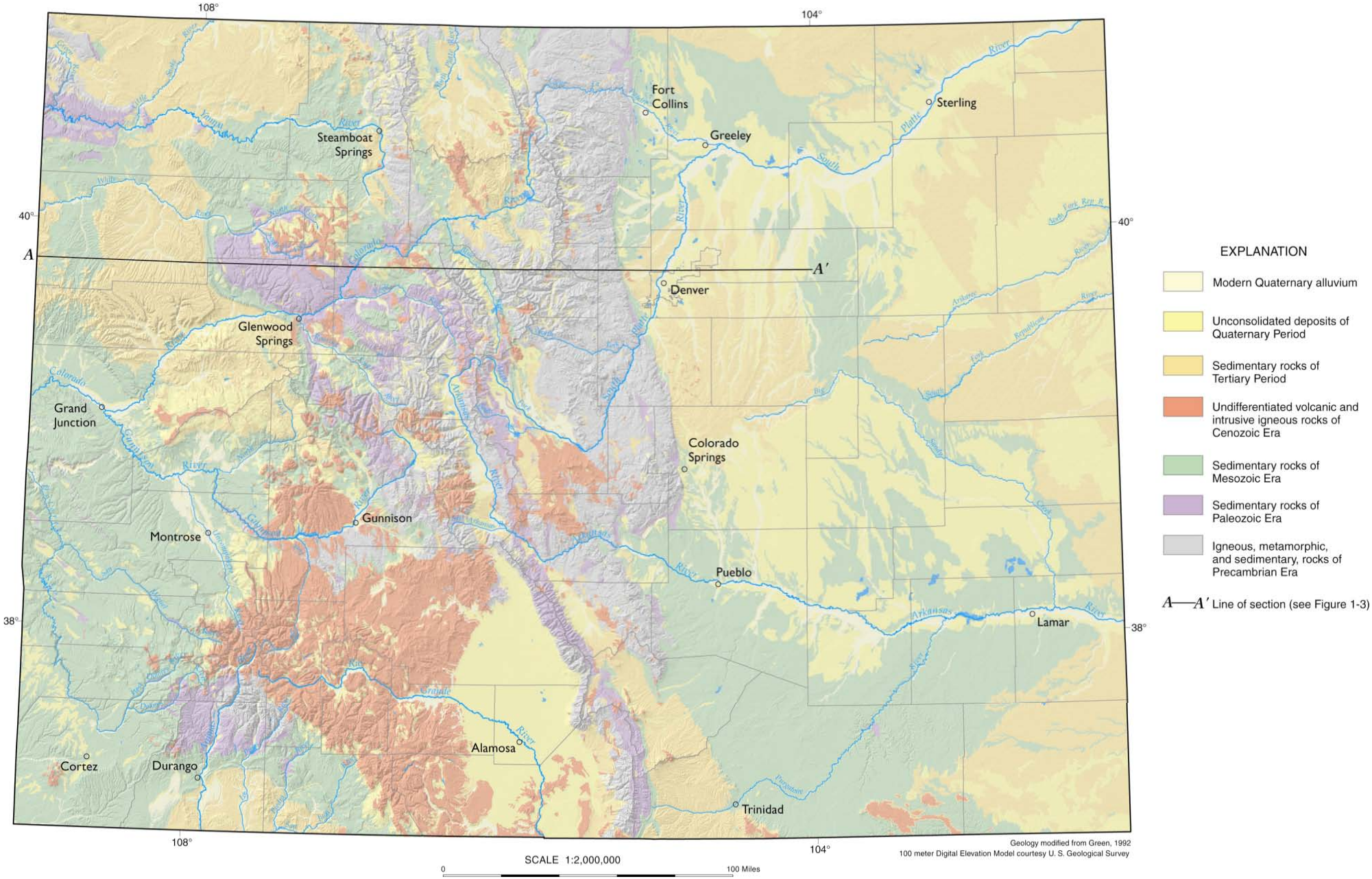


Figure 2.7. Dolores River Basin (source; CGS, 2004).

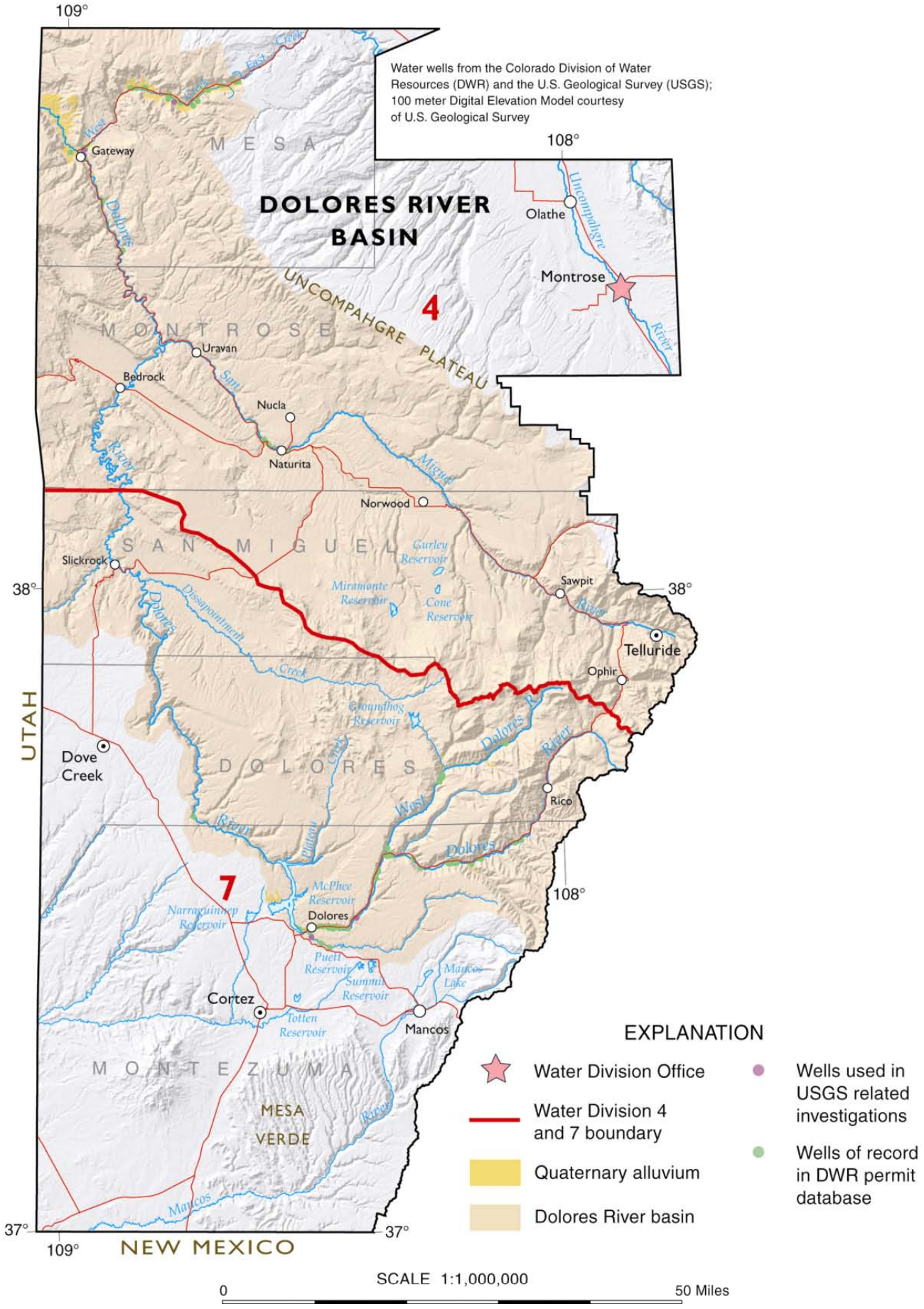


Figure 2.8. Geologic Map of the Rico Area (source; CGS, 2004).

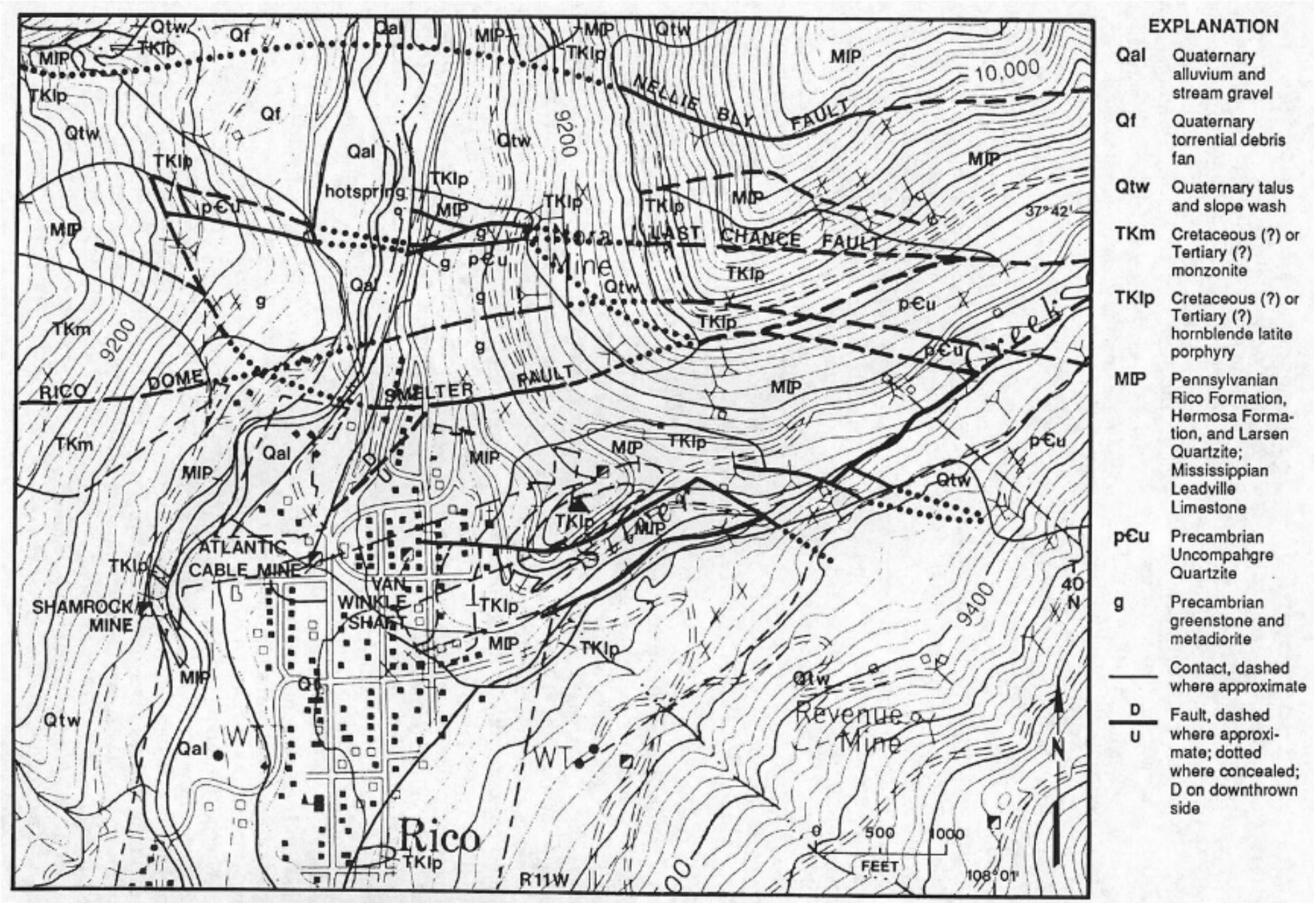


Figure 2.9 Principle Aquifers and Structural Basins within the State of Colorado (source; CGS, 2004).

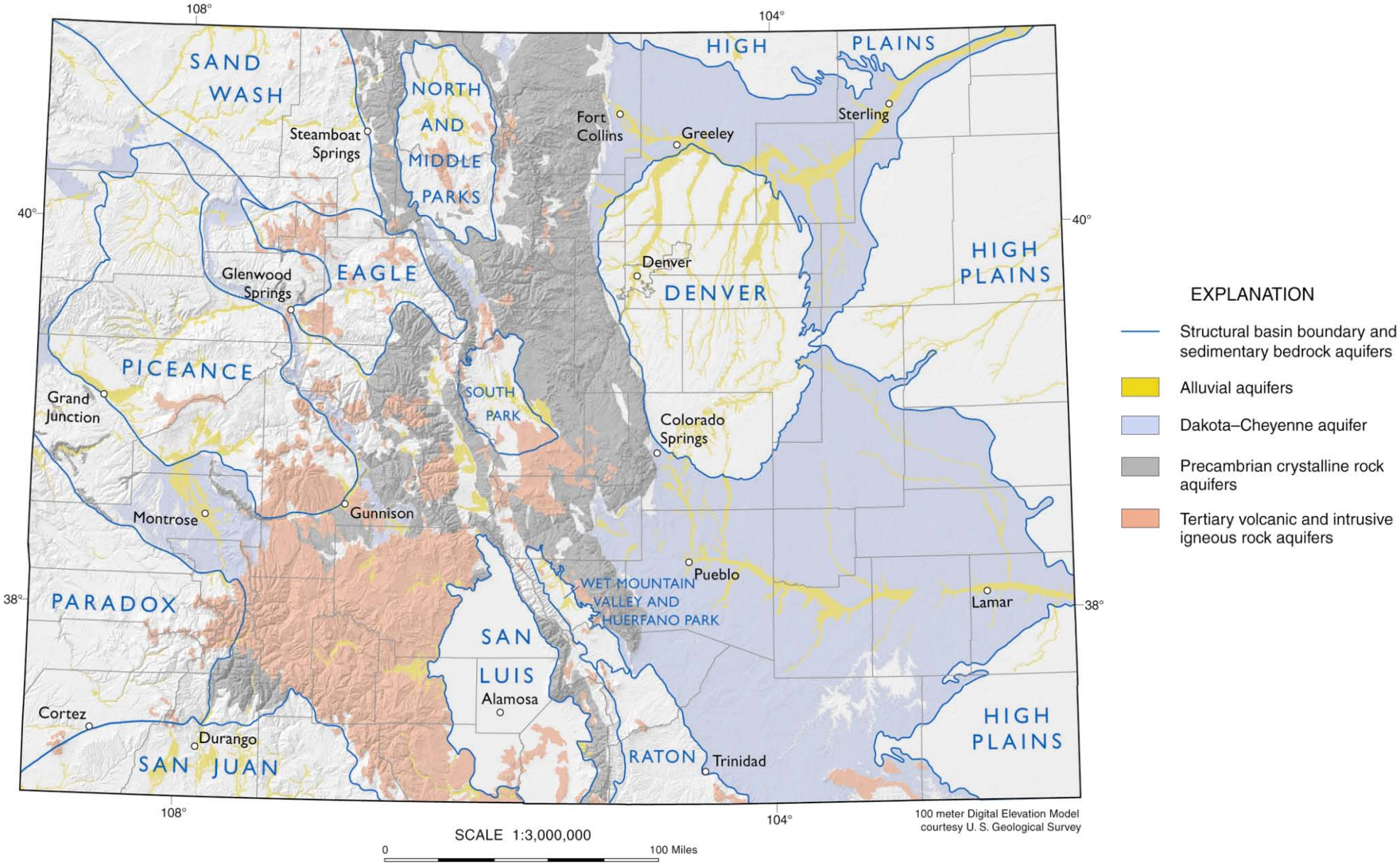


Figure 2.10. Paradox Sedimentary Groundwater Basin (source; CGS, 2004).

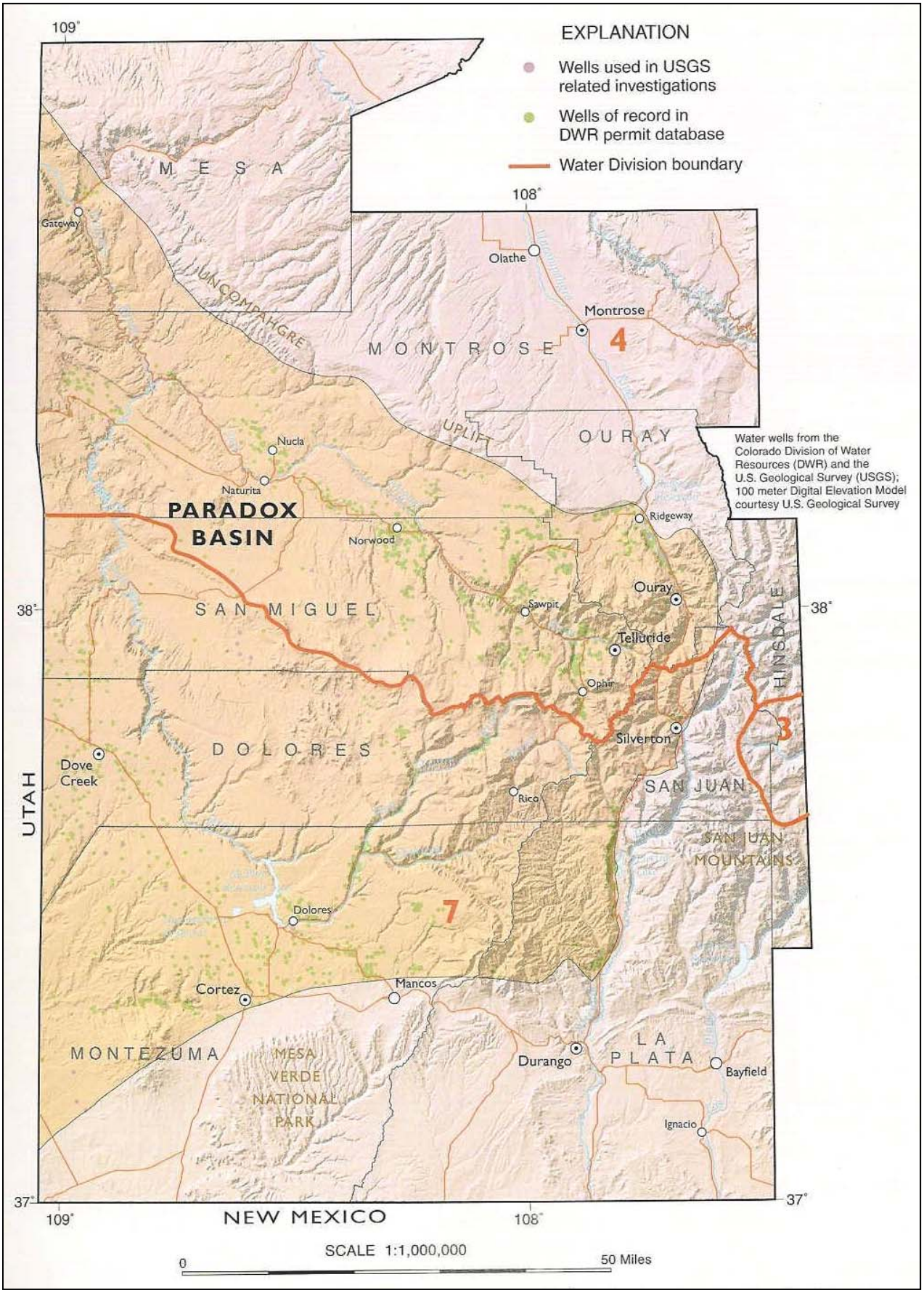


Figure 2.11. Groundwater Wells within the Project Area (source; CDWR, 2006).

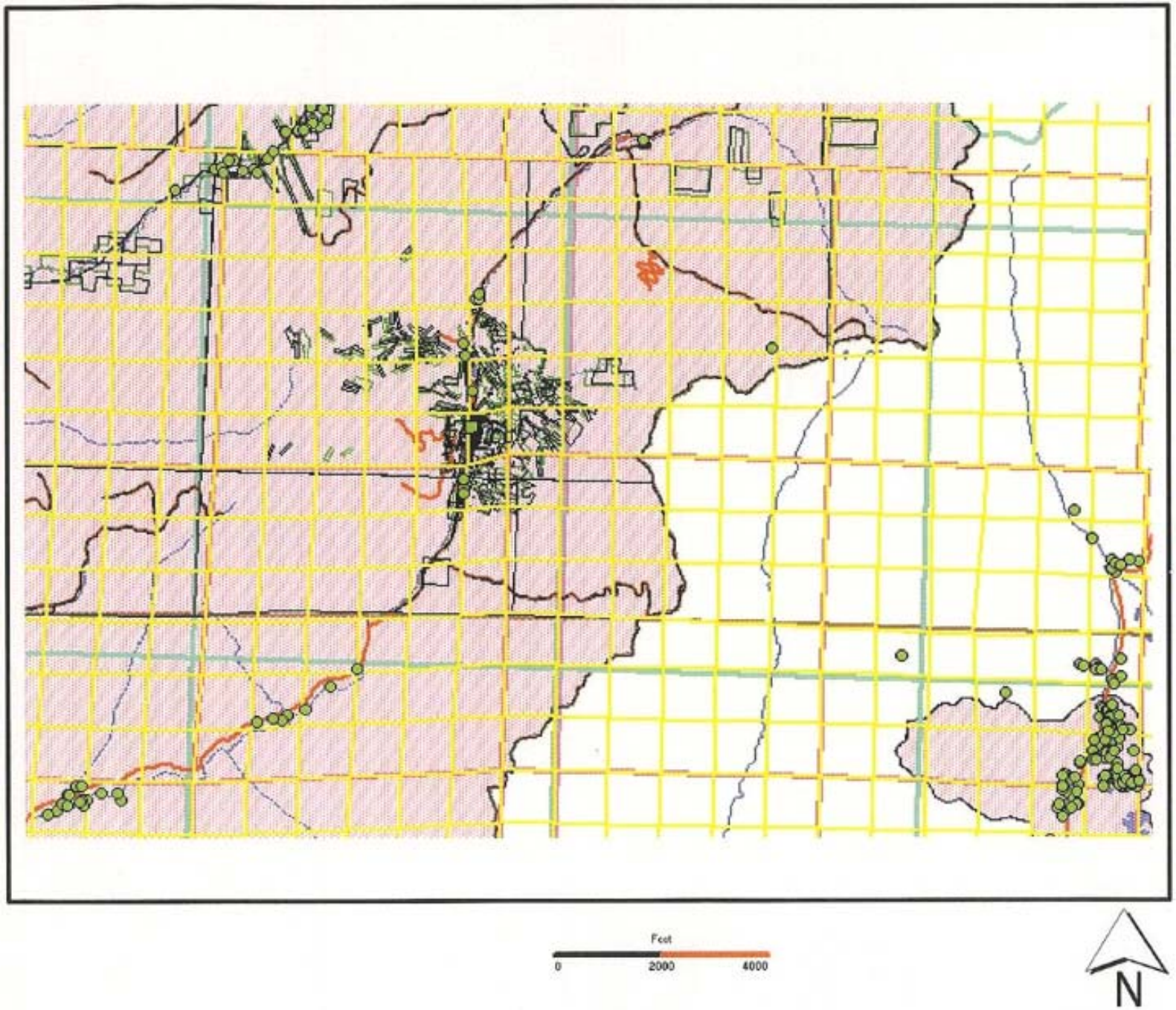


Figure 2.12. 2000-2005, Monthly Stream Flow Hydrograph of the Dolores River at the Montelores Bridge USGS Gauging Station (USGS Gauging Station 09195000).

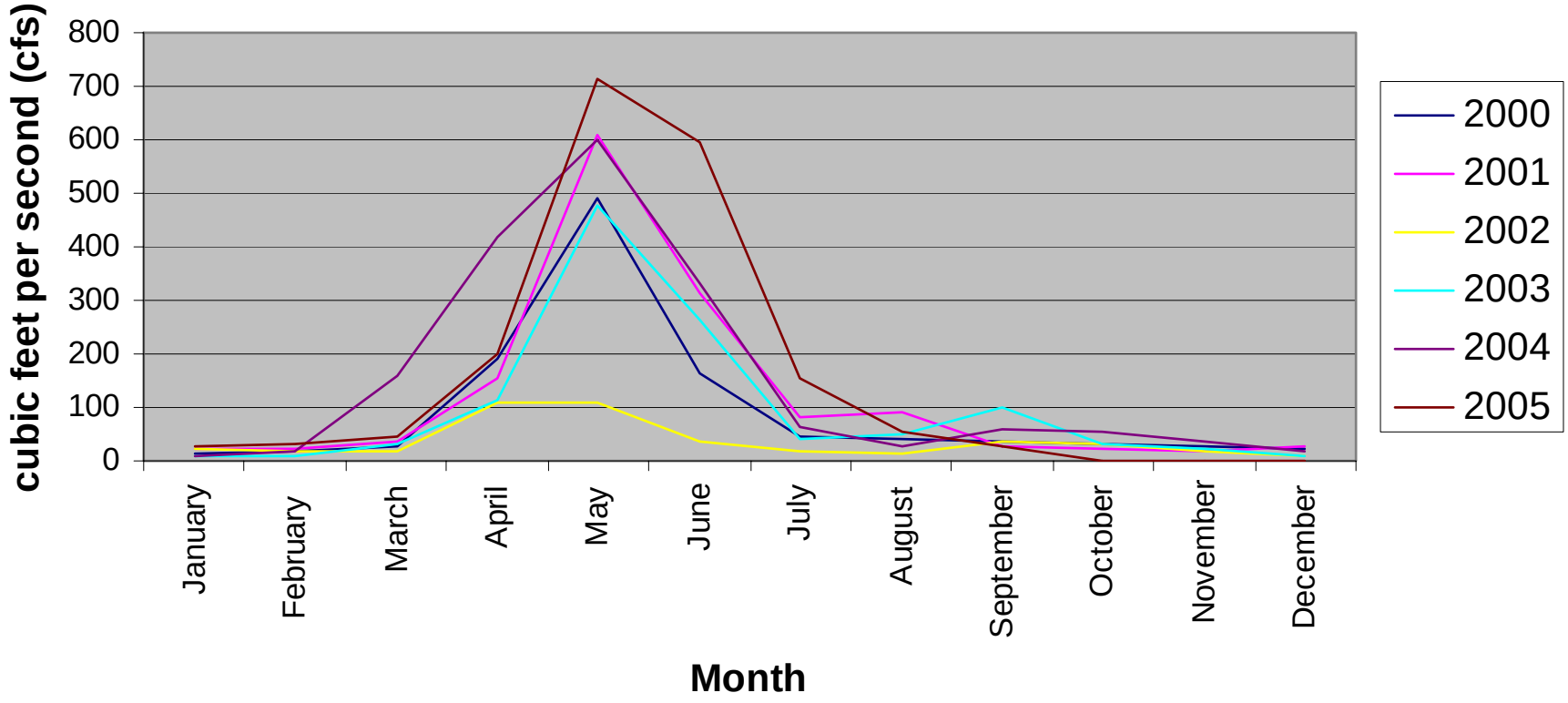


Figure 2.13. Annual Precipication Accumulated at Lizard Head Pass (source; NRCS, 2006).

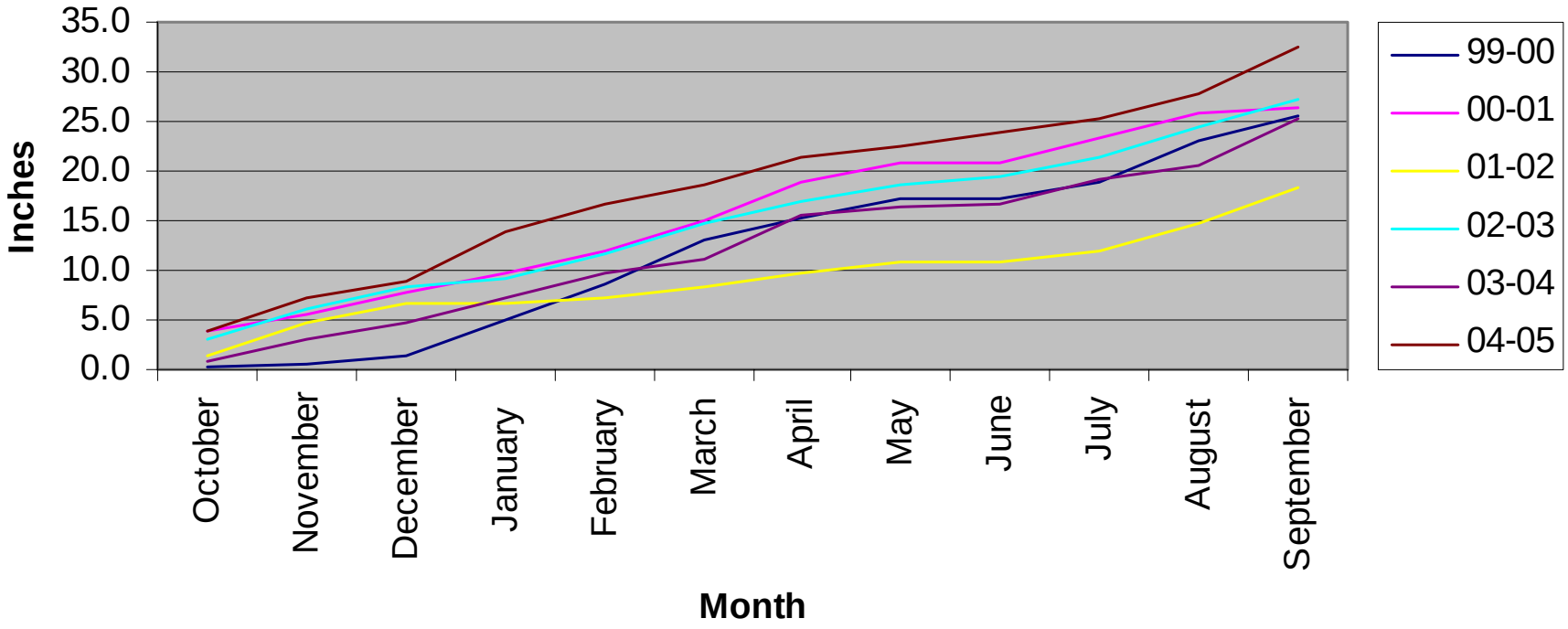


Figure 2.14. Monthly Precipitation Accumulated at Lizard Head Pass (source; NRCS, 2006).

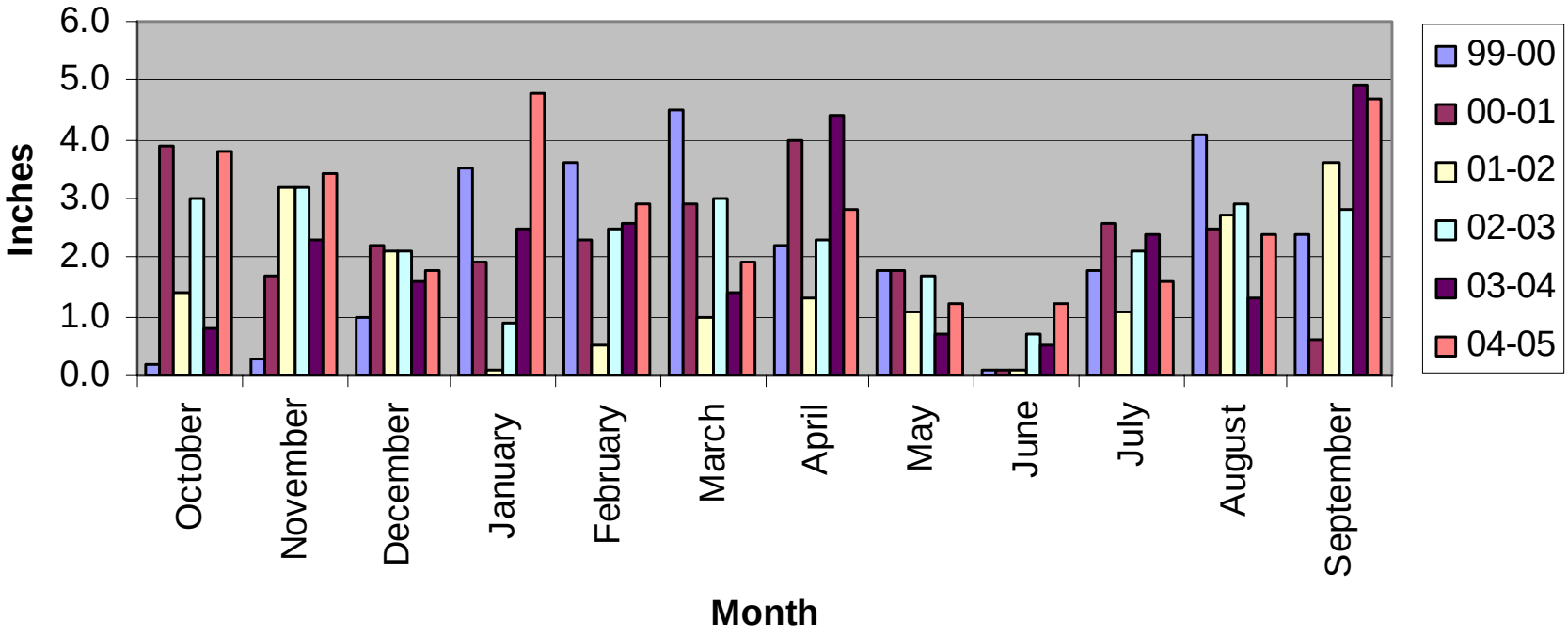


Figure 2.15. Annual Precipitation Accumulated at Scotch Creek (source; NRCS, 2006).

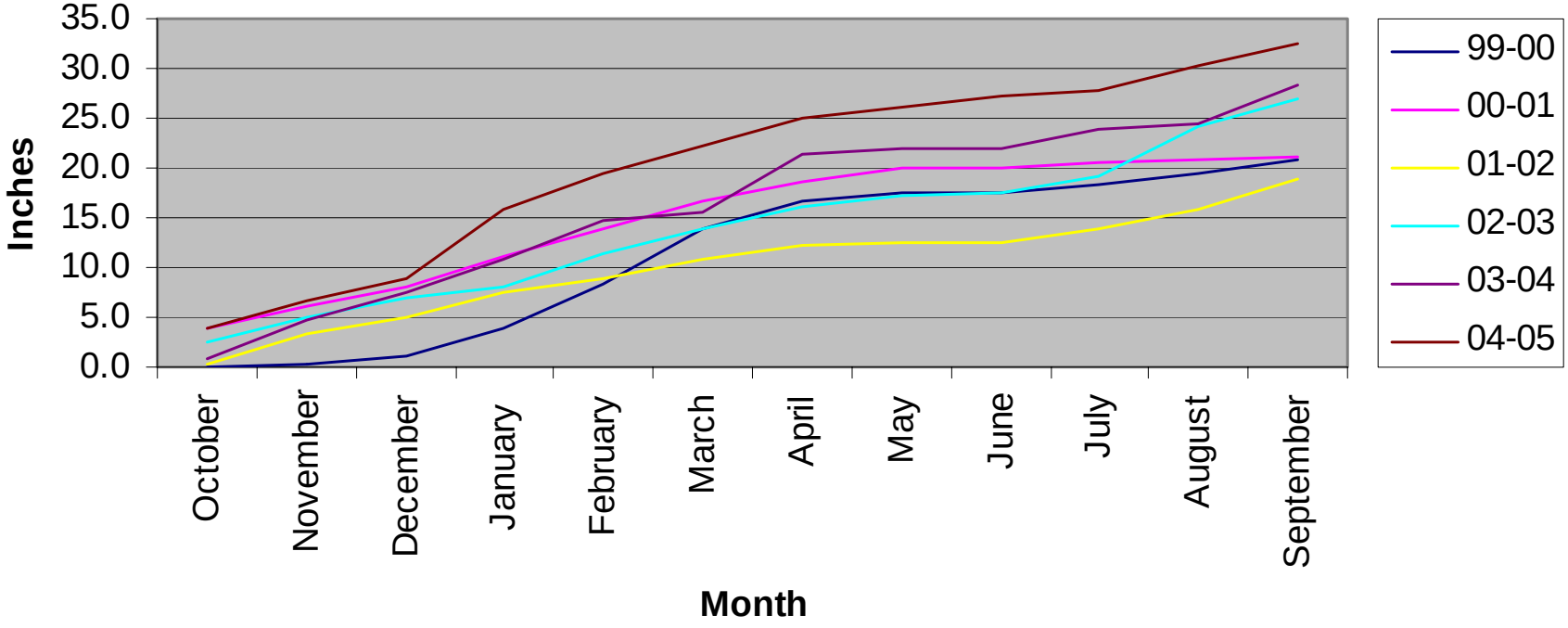


Figure 2.16. Monthly Precipitation Accumulated at Scotch Creek (source; NRCS, 2006).

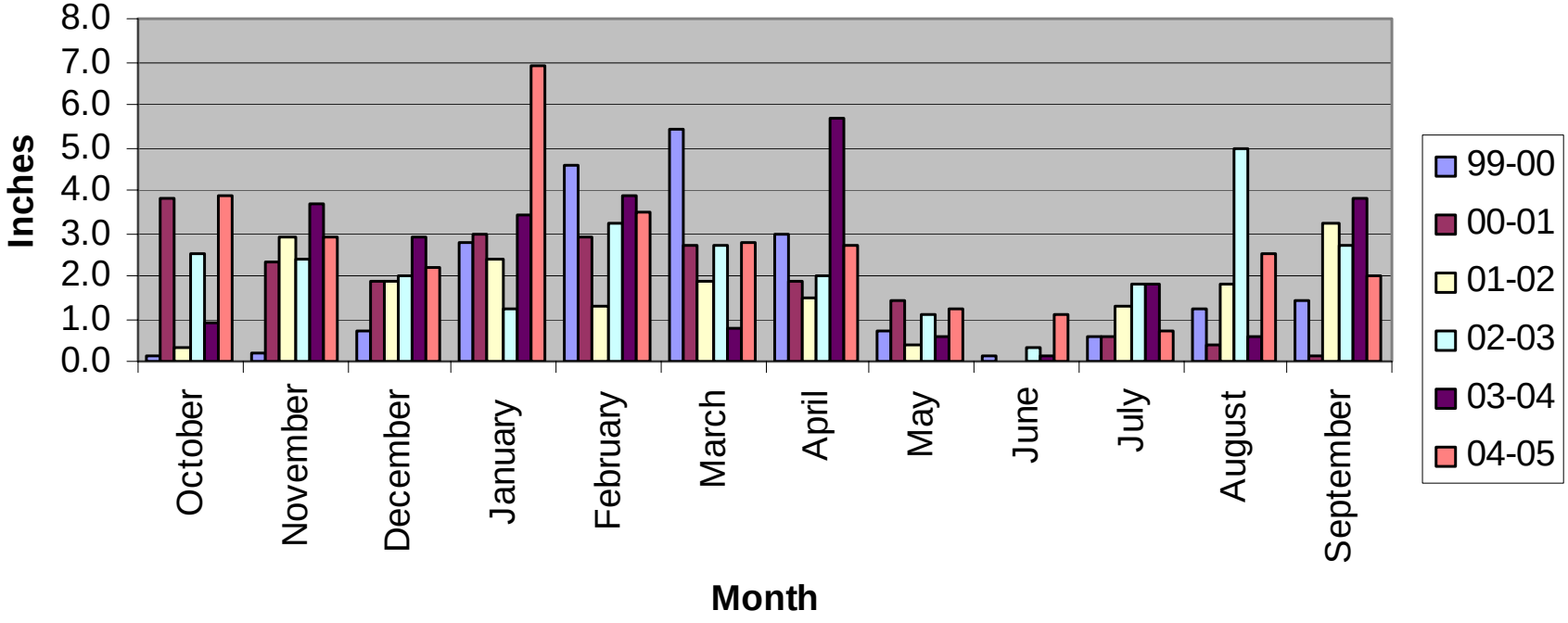


Figure 2.17. Annual Precipitation Contours within the Project Area (source; CDWR).

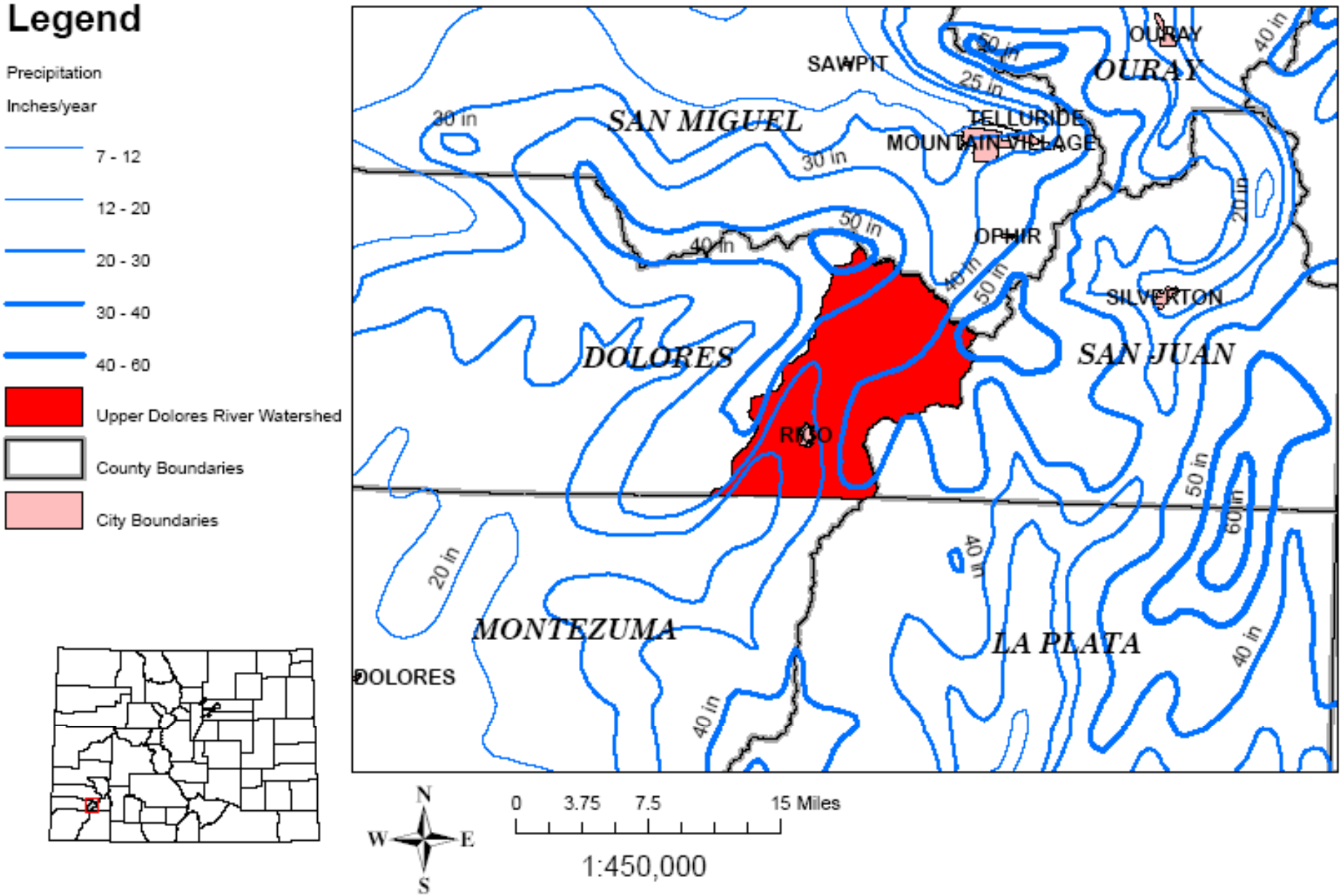


Figure 2.18. Land Ownership within the Project Area (source; CDOT).

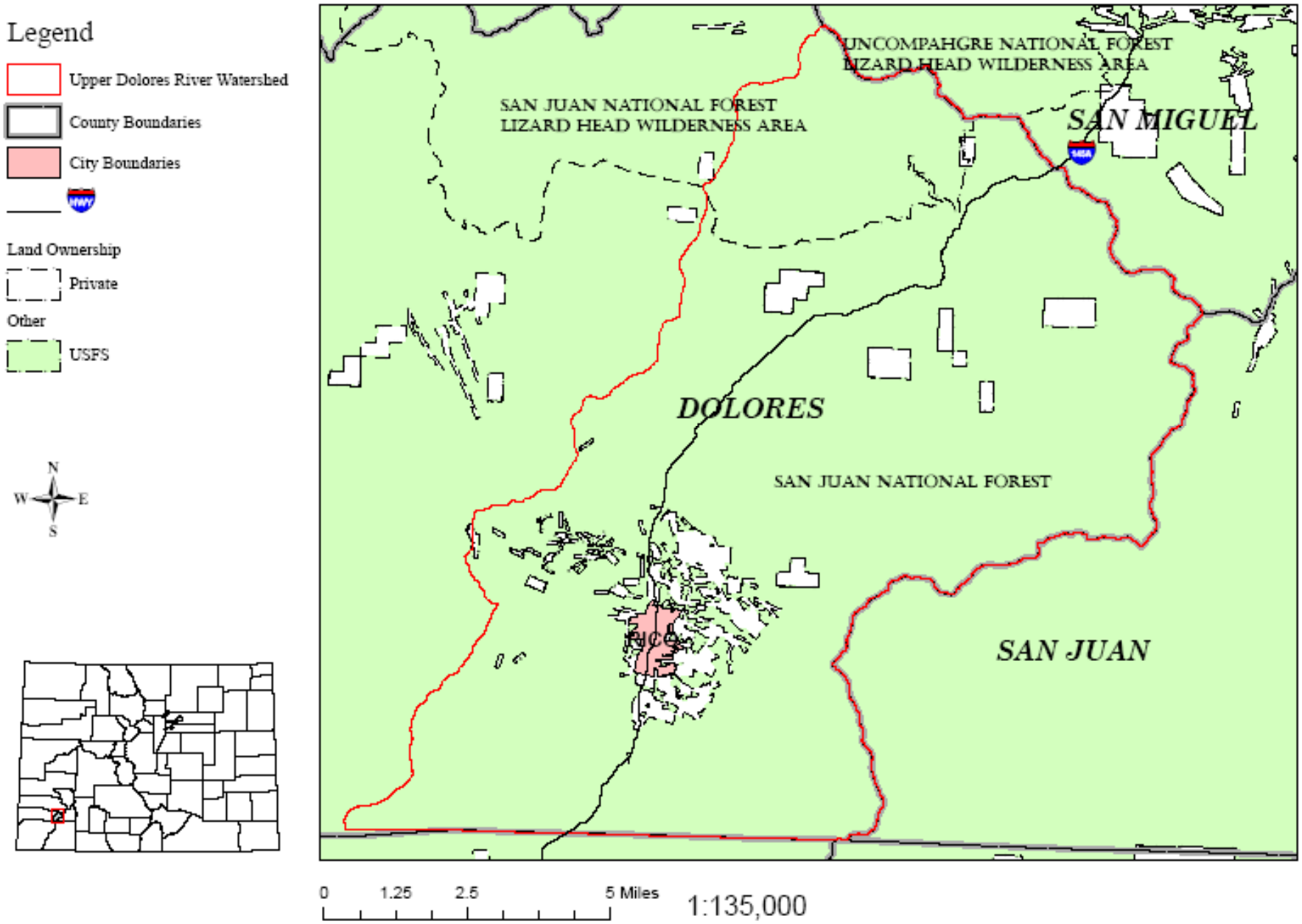


Figure 2.19. Mining Claims within the Project Area (Town of Rico Master Plan, Computer Terrane Mapping, Inc., 2005).

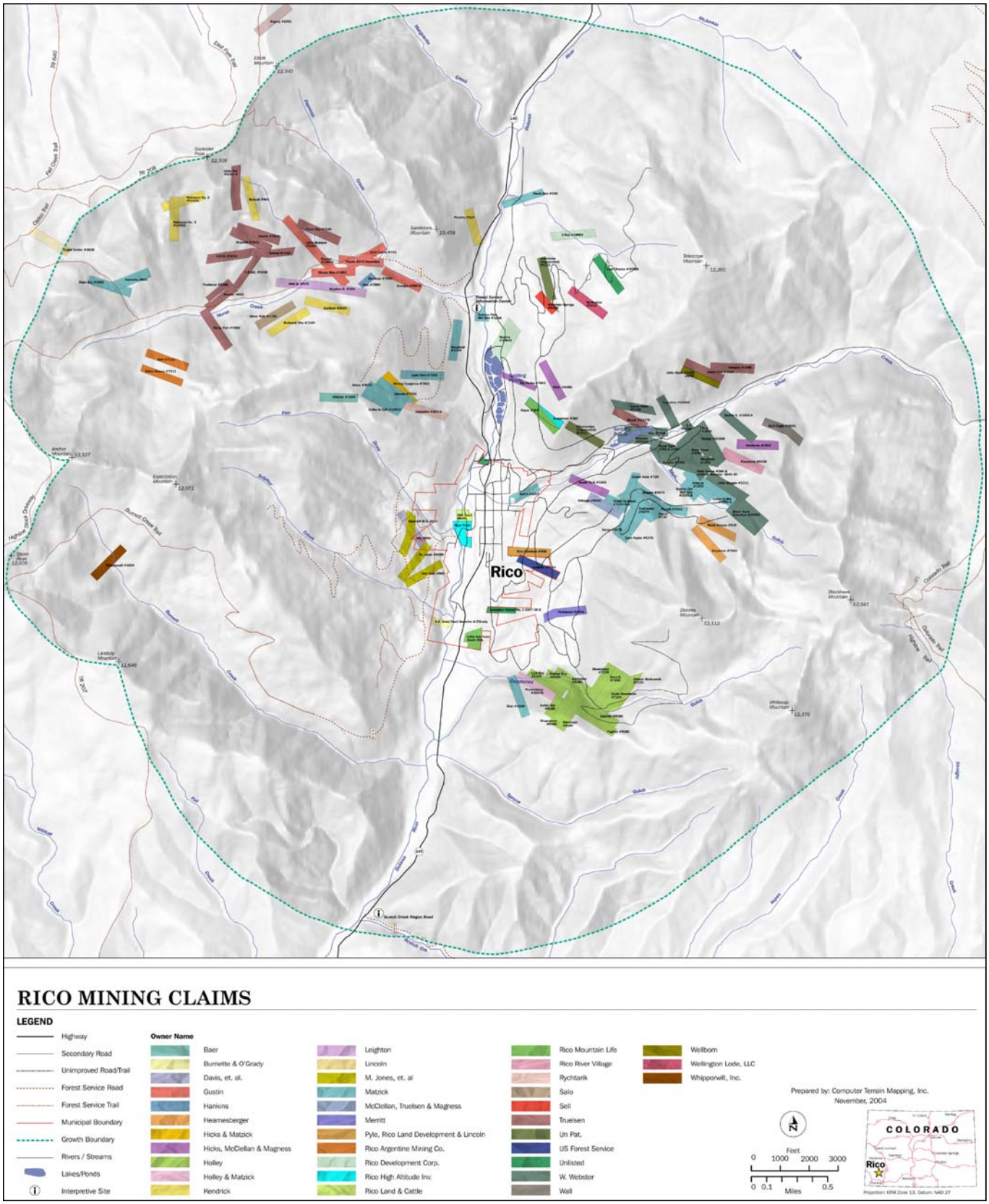
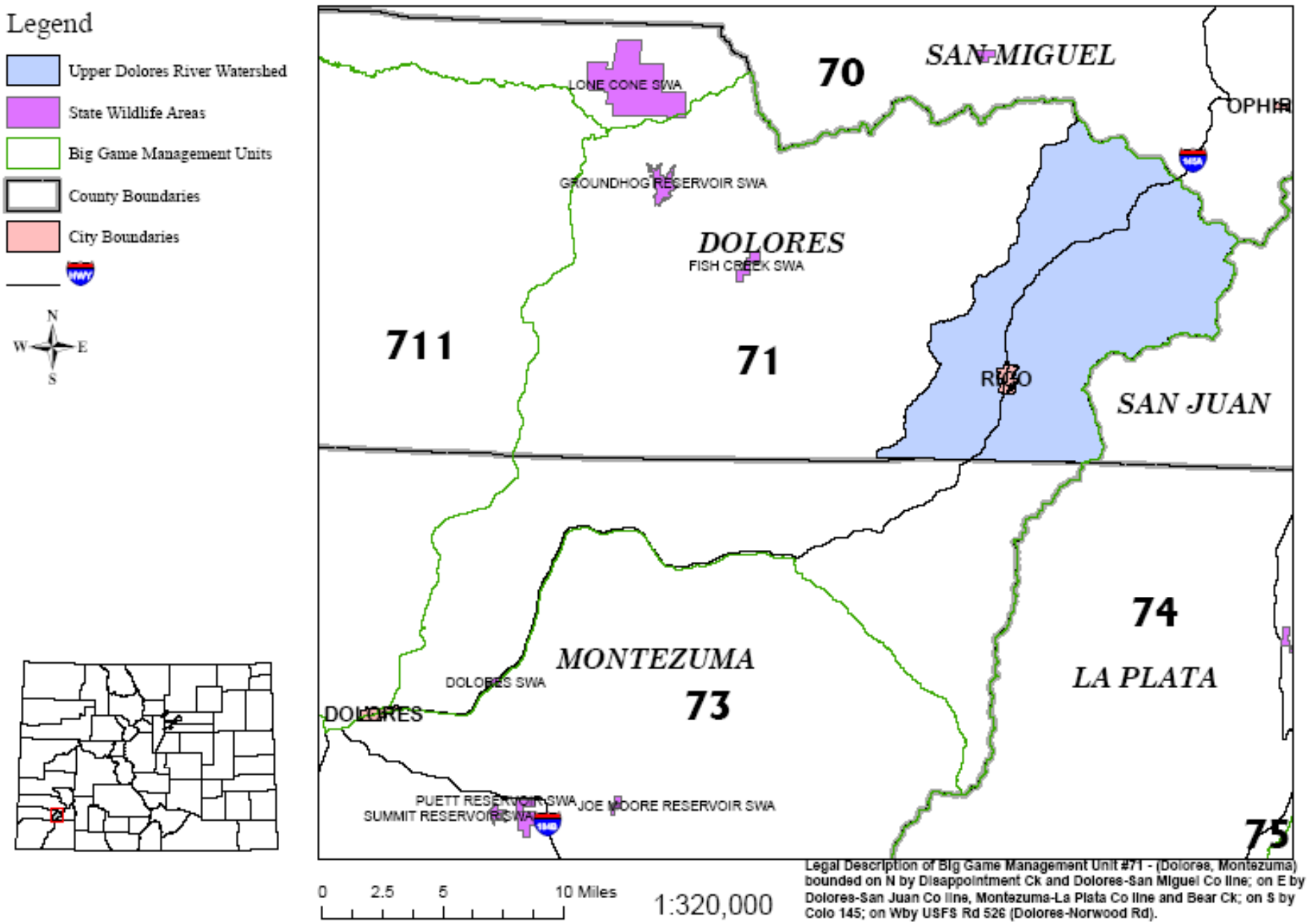


Figure 2.20. CDOW Big Game Managment Unit #71 and State Wildlife Areas within and near the Project Area (source; CDOW).



Legal Description of Big Game Management Unit #71 - (Dolores, Montezuma) bounded on N by Disappointment Ck and Dolores-San Miguel Co line; on E by Dolores-San Juan Co line, Montezuma-La Plata Co line and Bear Ck; on S by Colo 145; on Wby USFS Rd 526 (Dolores-Norwood Rd).

Figure 2.21. USFS Timber Harvest Area within Barlow Creek (source; USFS, 2006).

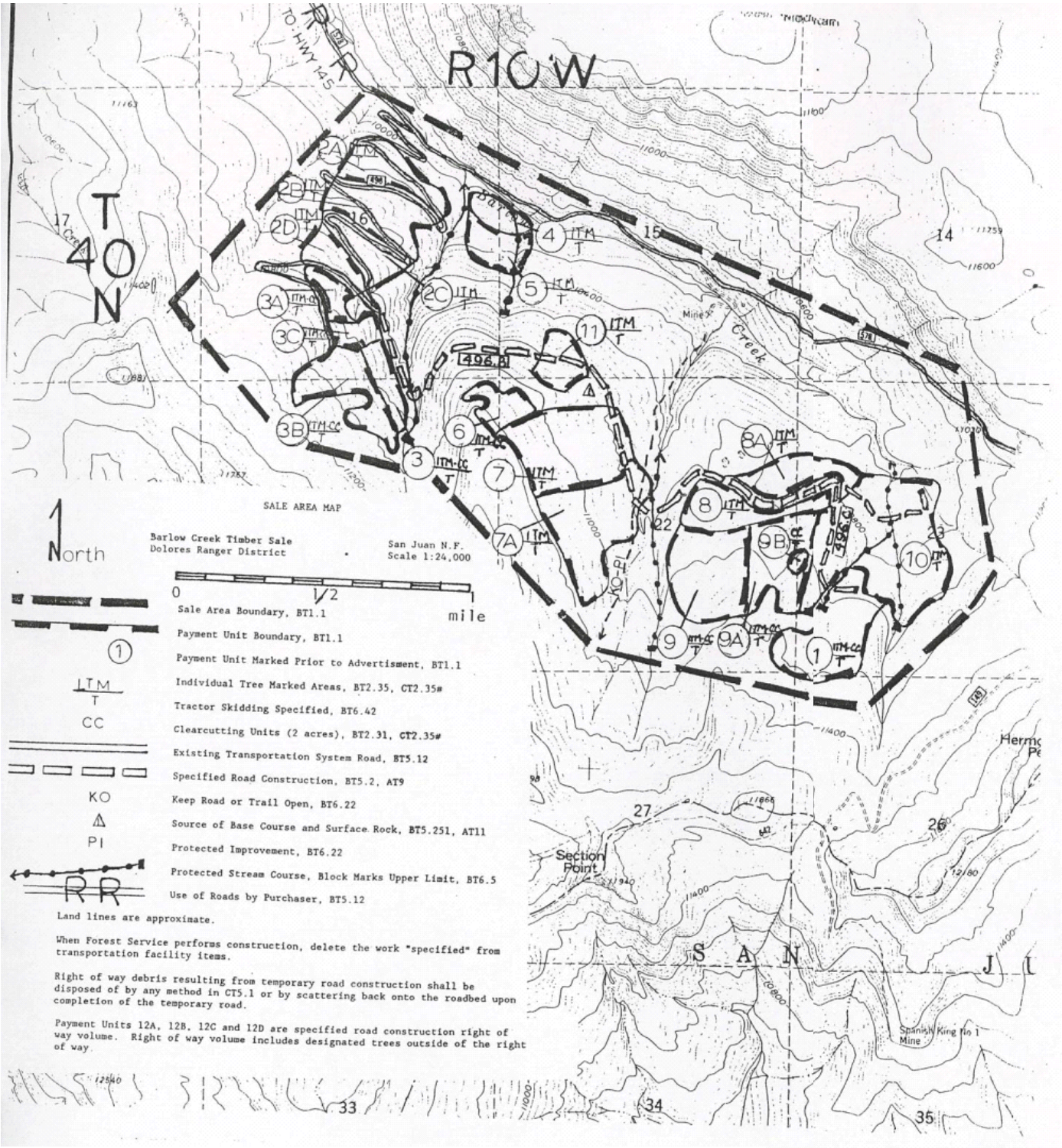


Figure 2.22. COGCC Permitted Wells near the Project Area (source; COGCC).

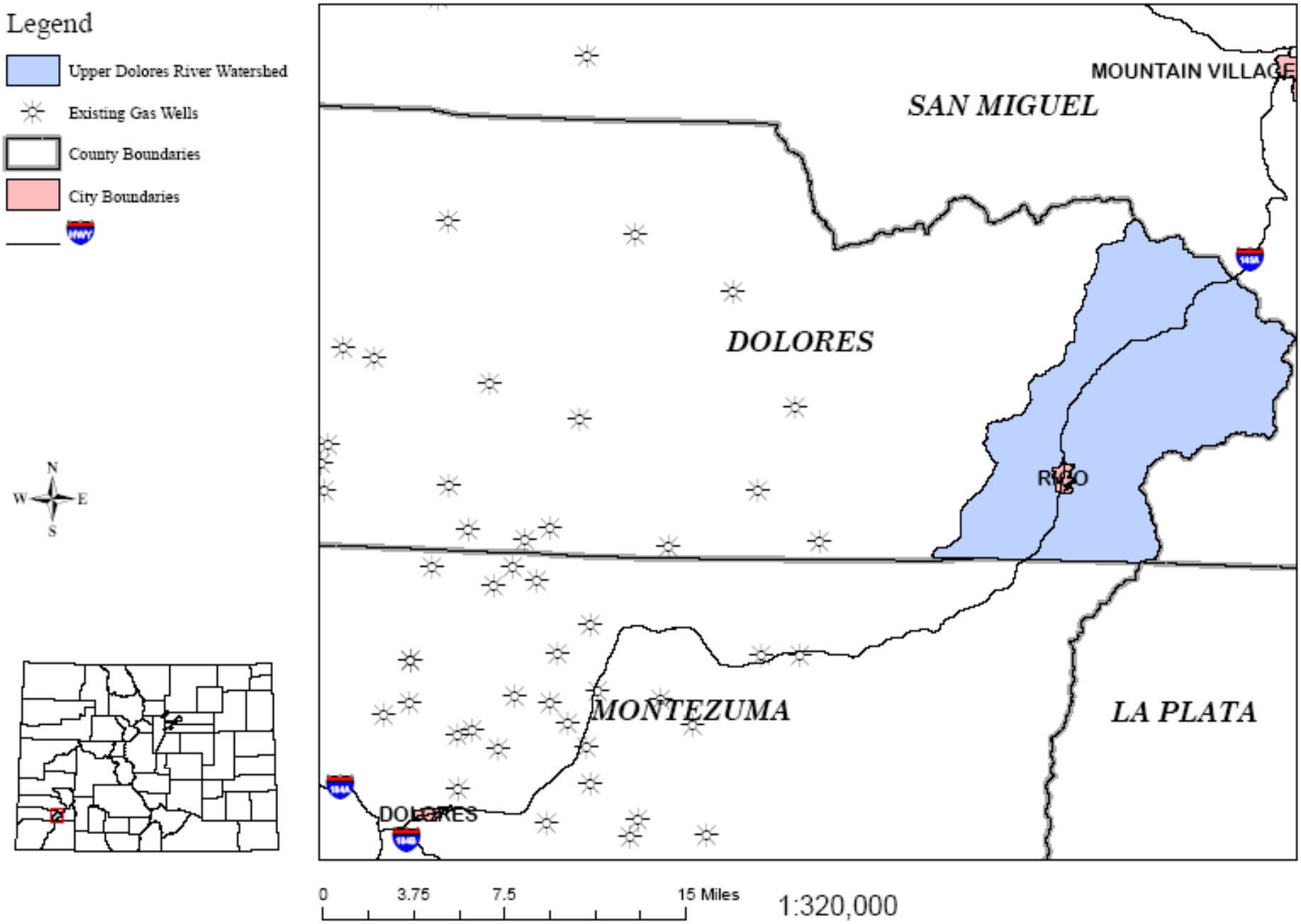


Figure 2.23. Summary of Decreed Water Rights within the Project Area (source; CDWR, 2006).

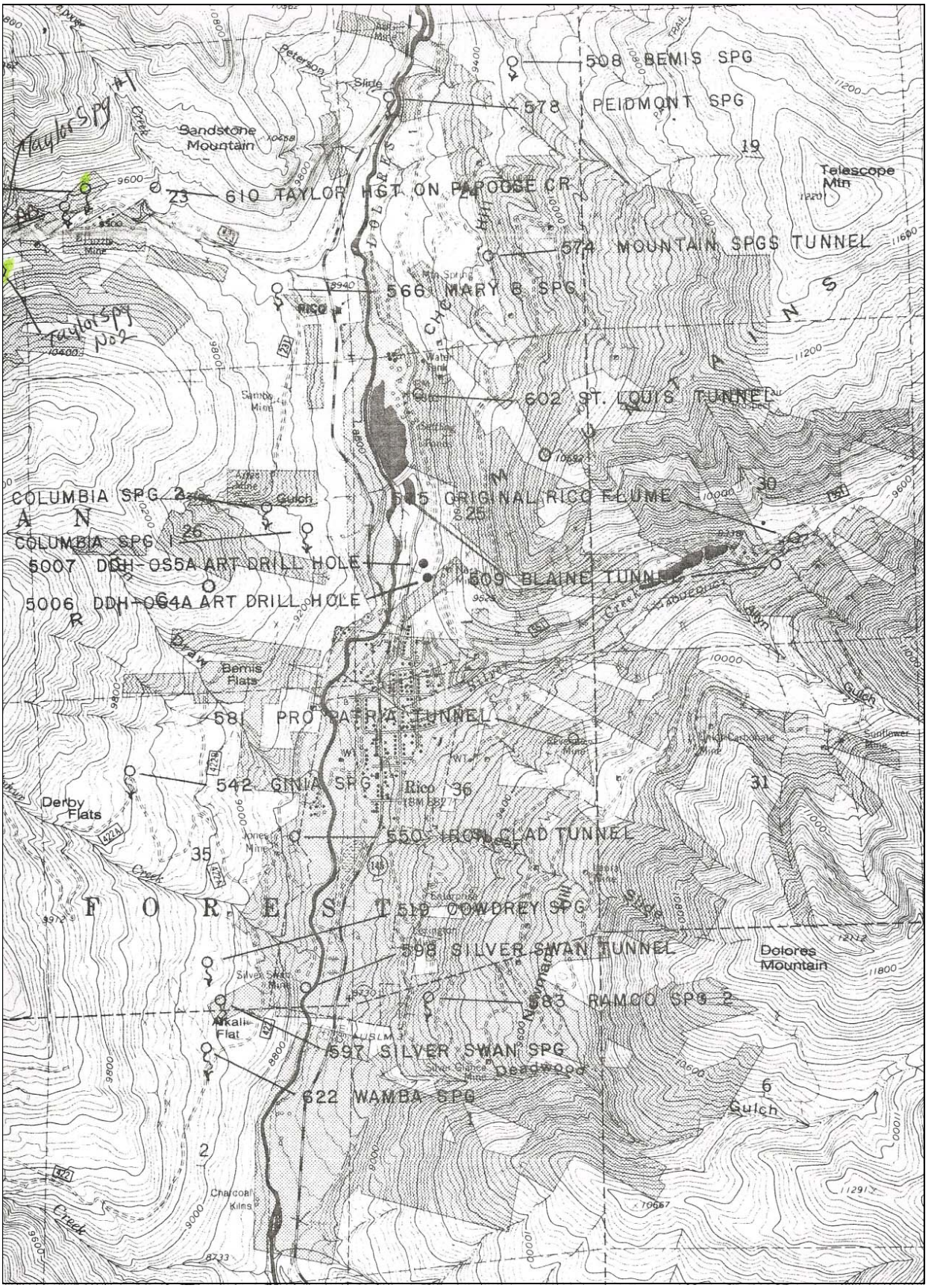


Photo 2.1. “View from Horse Gulch”, DPL (Denver Public Library), Western History Collection, Thomas M. McKee, Z-1246.

SECTION 3

3 POPULATION PROJECTIONS

3.1 Introduction

This Section describes the projected population within the *Project area*. This information is folded into the water quality and water quantity issues and recommendations which can be affected by population change. **Photo 3.1**. depicts the Rico area during the mining area. Change can be observed from the time of this Photo due to tourism, growth and the change in mining-related activities (DPL, No Date :William Henry Jackson, Rico, CO).

This Section documents population figures for Dolores County. The population tables include actual data for the years 1870, 1880, 1890, 1900, 1910, 1920, 1930, 1940, 1950, 1960, 1970, 1980, 1990, and 2000 and projections for the years 2005, 2010, 2015, 2020 and 2025. The purpose of the population projects is to provide a perspective on trends to gauge population impact on water quality and quantity.

3.2 Summary of Previous Data

Previous population evaluations have been compiled by several entities for Colorado Counties. For this report, the historic census and the 'Colorado Preliminary Population Forecasts' (CDOLA, 2006) were relied upon. **Table 3.1** provides a summary of the historic census population for Dolores County and the Town of Rico. The natural population increase rates are shown in **Table 3.2**. Other watershed-related census variables (numbers of housing units by type, and the household size) for the purposes of water planning are provided in **Table 3.3.**

The population of Colorado is expected to increase at annual rates of 1.0% and 1.5% by 2005. For the ten year period thereafter, it is expected to grow at an average annual rate of 1.8%, and then gradually slow to1.5% by 2030 (CDOLA, 2003 and 2004). The Dolores/San Juan River Basin had an increase of 38 percent from 1990 to 2000 and represents about 2.3 percent of the state's total population (CWCB, 2006). Based upon an assumed rate of increase of 1.8%, the projected census for the Town of Rico and Dolores County are provided in **Table 3.4**.

The United States Census Bureau (USCB) compiles statistics of types of industry that occur by area over time. **Table 3.5** provides a summary of the number and types of business establishments recorded within the Town of Rico since 1998 through to 2003. As shown within this Table, the number of businesses grew steadily and then reached a plateau. The most common type of industry is construction, with other categories of manufacturing, trade, information, professional and accommodation.

3.3 Land Use and Development Plans

The Town of Rico currently has a population of 250, which swells to 350 in the summer (2003 population estimate). According to the Vision Statement in the plan, the anticipated build out will accommodate a total of 2200 people, including part-time residents and visitors. The town expects to manage population growth, new development and the overall rate of growth, all of which are essential to preserving its unique character.

While some of the anticipated growth will come from infill development within the current boundaries of the town, the majority is anticipated to come from annexation and development of the Rico Renaissance/Realm Realty land described in Section IX of the Town Master Plan. Proposed development of this land, which surrounds the town, anticipates up to 304 additional single-family homes as well as commercial and light industrial development. The plan anticipates land exchanges with the US Forest Service to consolidate outlying in-holdings within the National Forest to avoid remote development in sensitive and inaccessible areas.

The proposed development activities for the Town of Rico have been documented within the comprehensive Master Plan (Town of Rico, 2004) and were not revisited here. There are certain proposed development activities, such as those associated with the riverwalk/river corridor that were folded into the project recommendations provided herein. These unique development plans present unique opportunities to achieve the Town's development goals and potentially address certain nonpoint and point pollution sources. These are further described in **Sections 6 through 8.**

TABLES

Table 3.1 Historic Census Information for the Town of Rico and Dolores County by Year. (source; CDOLA, 2006).														
Area	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
Town of Rico	N/A	894	1134	811	368	326	447	388	212	353	275	76	92	205
Dolores County	N/A	N/A	1498	1134	642	1243	1412	1958	1966	2196	1641	1658	1504	1844

Table 3.2 Natural Population Increase for the Town of Rico by Year. (source; CDOLA, 2006).															
Area	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Town of Rico	7	0	5	6	-2	4	11	3	3	-4	3	1	-3	8	4

Table 3.3 Dolores County Population Variables useful for Water Planning. (source; CDOLA, 2006).					
Variable	2000	2001	2002	2003	2004
Total Housing Units	1193	1200	1208	1217	1224
Vacant Housing Units	408	414	409	429	441
Net Building Permits	7	8	9	7	6
Household Population (July)	1844	1844	1876	1848	1836
Average Household Size	2.35	2.35	2.35	2.35	2.34
Housing Vacancy Rate	34.20	34.50	33.86	35.25	36.03

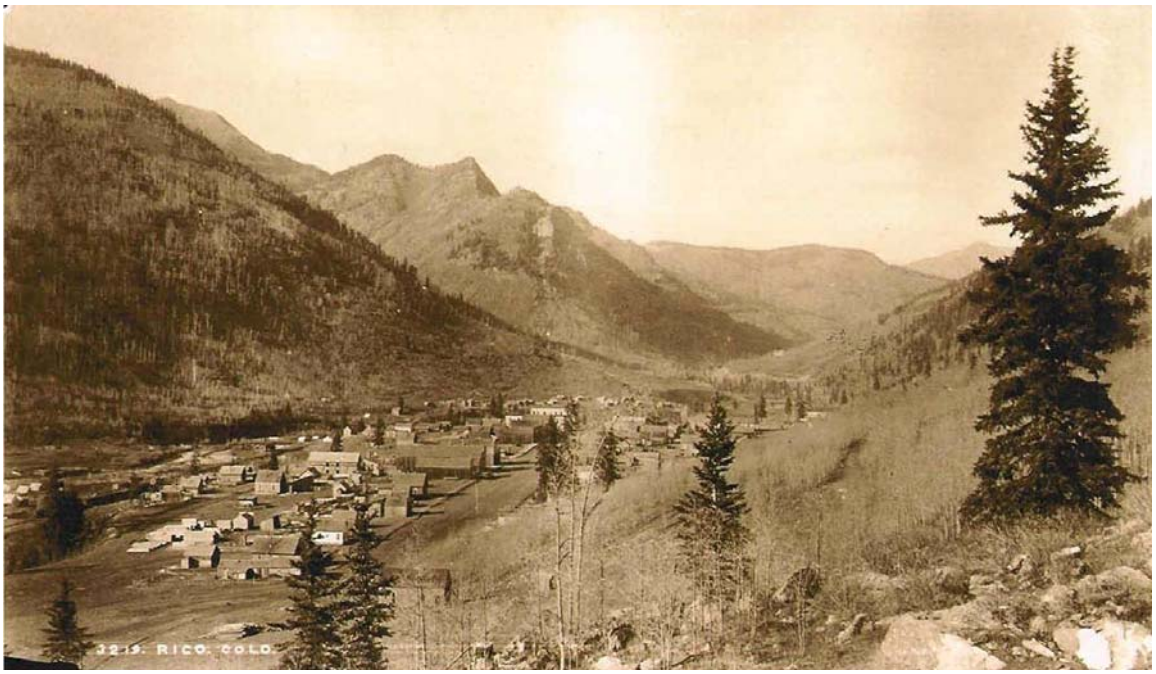
Table 3.4 Town of Rico and Dolores County Projected[1] Population Census. (source; CDOLA, 2006).					
Area	2005	2010	2015	2020	2025
Town of Rico	224	245	268	293	320
Dolores County	2016	2204	2410	2634	2880
1 – Values were projected based upon a conservative annual increase 1.8%.					

Table 3.5 Number of Business Establishments in the Town of Rico, by Year. (source; USCB, 2006).

Industry Code Description	1998	1999	2000	2001	2002	2003
Construction	2	2	4	7	6	8
Manufacturing	2	2	2	3	2	2
Wholesale trade	1	1	1	0	0	0
Retail trade	0	1	1	1	2	1
Information	1	1	1	1	0	0
Professional, scientific and technical services	1	1	2	2	2	2
Accommodation and food services	1	1	1	1	2	2
Unclassified	0	1	1	0	0	0
Total	8	11	13	15	14	15

FIGURES

Photo 3.1. Town of Rico, Colorado, DPL, Western History Collection, Thomas M. McKee, Z-1201.



SECTION 4

4 WATER QUALITY ASSESSMENT

4.1 Introduction

This Section includes an overview of stream classifications and standards and an assessment of available water quality data to determine if there are water quality and related watershed concerns. Water quality data are evaluated to determine if provisions of the Colorado Water Quality Control Act (CWQCA) are being met by the comparison of measured concentrations of chemicals to criteria set forth to protect the designated uses of a given water body.

There is an abundance of entities within the State of Colorado that gather water quality and quantity data as part of their resource management and/or investigative studies. As a first step to identifying those sources with relevant information, the CGS 'Directory of Colorado Water Quality Data' (CGS, 2003) was relied upon. As a result of researching a list of possible sources, it was determined that the information available for the *Project area* fell into the following categories;

- USGS – flow data.
- CGS – water quality, acid mine drainage (AMD) studies.
- Private or special interest group studies – biological and water quality studies.
- Industry/Consulting Groups – water quality and metal loading studies.
- Trustee/Agency studies to evaluate mine adit and mine waste loading within Silver Creek, St. Louis tunnel and others (USEPA, CDPHE).

Any available documentation or data summaries were summarized and discussed within this document. For certain sources, summaries that were directly described within their document were used for this plan (the data was not revisited and reevaluated herein; only the summary was relied upon). For others where data was not interpreted, the data was evaluated in detail within this document.

This Section first presents the applicable stream classifications and associated standards which are assigned to the *Project area*. These standards serve as the basis for understanding the implications of the water quality data. If the water quality data yields levels of contaminants at concentrations, greater than an applicable standard; then the water-body is said to have an 'impaired use'. If the water quality data are comparable, or less than the applicable standards, then the use is defined as being met. Therefore, in order to be able to draw conclusions about the water quality of the *Project area*, the first step is to research and identify the applicable standards. The second step is to obtain all available water quality information and then compare it to the standards. The second step is a formidable task in that it involves the research and identification of *Project area* studies that have acquired water quality information. These studies are often unavailable to the public, or perhaps a 'work in progress.' As such they have limited value and may

be difficult to reproduce. Other studies may be old, or focused upon parameters or areas of little concern. These studies too, will have limited usefulness. It is important during this step to critique the available information and put it into perspective so as to not over or underestimate possible water quality conditions.

The results of this Section were used to identify data gaps that require further study, to determine sources of water quality concern and their trends over time and distance, and to formulate initial recommendations towards addressing the data gaps and water quality concerns. This Section begins with a review of the water quality standards pertinent to the *Project area* (subsection 4.2), a summary of the available water quality data sources (subsection 4.3), an evaluation/interpretation of the water quality findings (subsection 4.4), a review of watershed flow information (subsection 4.5) and a summary of recommendations (subsection 4.6).

4.2 Stream Classifications and Standards

In Colorado, the CWQCC and WQCD are responsible for regulating water quality through the establishment of water quality classifications, designations, standards, and control regulations to protect the beneficial uses of State waters including rivers, streams and lakes. In addition, the CWQCC and WQCD are responsible for the issuance of discharge permits, water quality certifications and enforcement actions. This subsection describes the classification and standards that pertain to the *Project area* as well as the regulatory background for their implementation. A copy of the most recent (DRAFT) CWQCC regulations that pertain to the *Project area* are provided in **Appendix D.**

4.2.1 Overview of Colorado's Classifications and Standards System

Federal Regulatory Overview

Increased awareness of and advocacy for environmental protection legislation took hold in the 1960s and 1970s. Federal law pertinent to surface- and groundwater quality protection has historically been piecemeal and focused at particular problems rather than the comprehensive protection of the resource. A more comprehensive approach to protecting surface and groundwater quality was enacted in the 1970s with passage of the CWA and Safe Drinking Water Act (SDWA). The state of Colorado manages and enforces these laws at the state level. In Colorado, the Colorado Department of Public Health and Environment (CDPHE) is the lead agency responsible for the administration, management, and enforcement of water quality regulations. A brief description of the CWA and SDWA as they pertain to the Upper Dolores watershed are described as follows;

- **CWA** – through the Environmental Protection Agency (USEPA) and state agencies, requires permitting of all point-source discharges through the National Pollutant Discharge Elimination System (NPDES) program authorized in Section 402 of the Act. Each NPDES permit incorporates numerical effluent limitations

issued by the USEPA. Established limitations are applicable to different categories of industry (e.g. manufacturing, mining, etc.). In addition to these limitations, the USEPA has issued water quality criteria for over 115 pollutants including 65 named classes of toxic chemicals or 'priority pollutants'. Violations of the NPDES effluent limitations are punishable by up to a $25,000 per day fine. Other provisions of the DWA include the Section 404 program administered by the U.S. Army Corps of Engineers that requires a permit for the disposal of dredge and fill materials into waters of the U.S. and includes a provision for the protection of our nation's wetlands, and Section 319 of the Act with regulates nonpoint sources of pollution by management of surface runoff (Copeland, 1999).

- **SDWA** – provides national standards to protect the public from harmful effects of some contaminants in our drinking water. Colorado has accepted 'primacy' for this act and therefore accepts responsibility for enforcing these regulations (which are also under the jurisdiction of the CDPHE). The USEPA's National Primary Drinking Water Regulations set enforceable, health-based maximum contaminant levels (MCLs) for particular contaminants in drinking water. These MCLs are established by the USEPA after evaluating numerous toxicological tests and public comment. Secondary MCLs (SMCLs) are available for constituents where health risks are minimal, but certain levels can produce objectionable taste, odor, or appearance (e.g. iron staining, odor etc.). Chemicals or quality characteristics for which SMCLs exist include aluminum, chloride, color, copper, corrosivity, fluoride, foaming agents, iron, manganese, odor, pH, silver, sulfate, total dissolved solids and zinc (USEPA, 1999).

There are other pertinent federal regulations that influence the use and quality of waters that do not currently have a considerable impact to the Upper Dolores. For instance, the 'Wild and Scenic Rivers Act' is a federal program that attempts to preserve the aesthetics and existing uses of significant stream resources by prohibiting water development near the designated segment. Currently, only the Cache Le Poudre River has such a designation, however, other segments such as the Dolores may be proposed (NPS, 2006; Vranesh, 1989)

State Regulatory Overview – Surface Water and Groundwater

In Colorado, the Colorado Water Quality Control Commission and WQCD are responsible for regulating water quality through the establishment of water quality classifications, designations, standards, and control regulations to protect the beneficial uses of State waters including rivers, streams and lakes. In addition, the Commission and WQCD are responsible for the issuance of discharge permits, water quality certifications, and enforcement actions.

The system of assigning surface water and groundwater classifications and standards is administered by the CWQCC and WQCD. Water quality standards set the goals, pollution limits and protection requirements for each water-body and each chemical of

concern. Identification of suitable standards for a water-body is based on adopting use classifications that identify those uses to be protected on a stream segment and then adopting numerical standards for specific pollutants to protect those uses.

Use classifications and numeric water quality standards have been adopted for streams, lakes, and reservoirs throughout each of the State's river basins. Within each basin, waters are divided into individual stream segments for classification and standard setting purposes. Water quality standards are applied in a regulatory context principally through the Colorado Discharge Permit System (CDPS) where point source dischargers are regulated to ensure that water quality standards are met.

Site-specific water quality classifications are intended to protect existing uses of State waters, and any additional uses for which waters are suitable or are intended to become suitable. The current use classification categories are:

- Recreation (Class 1a, 1b, or 2);
- Agriculture;
- Aquatic life (Cold or warm water, Class 1 or 2);
- Water supply (potable supply); and,
- Wetlands.

The CWA requires that water-bodies attain or maintain the water quality needed to support designated and existing uses. For each classified stream segment, numeric water quality standards are adopted that are intended to maintain water quality at a level sufficient to protect the classified uses. There are three potential approaches to the adoption of site-specific numeric standards. First, table value standards (TVS) are based on criteria set forth in three tables contained in the Commission's Basic Standards and Methodologies for Surface Waters (3.1.0 5 CCR1002-8). These are levels of pollutants determined to be generally protective of the corresponding use classifications, and are applied in most circumstances, unless site-specific information indicates that one of the following approaches is more appropriate. Second, ambient quality-based standards (i.e. standards based on the existing instream quality) may be adopted where natural or irreversible pollutant levels are higher than would be allowed by table value standards, but are determined adequate to protect classified uses. The third option is to adopt site specific standards where a bioassay or other site-specific analysis indicates that alternative numeric standards are appropriate for protection of classified uses.

Most domestic-water-supply standards are based on 'total recoverable' metals (unfiltered), and most aquatic-life standards are based on hardness of the water and dissolved ion concentrations (filtered). Important exceptions to this generalization include iron and manganese. Both of these metals have aquatic-life standards of 1,000 ug/L (total recoverable). The much lower dissolved concentrations (300 ug/L for iron; 50 ug/L for manganese) are standards for aesthetic purposes in drinking water.

The quality of Colorado surface waters is reviewed every 2 years by the CWQCD, in compliance with the CWA. Placement on the list of stream segments that are not in compliance with standards (called "303(d) lists") has significant implications for management of those waters (CDOHE, 2002 and 2006). The Nonpoint Assessment Report (CDPHE, 1989) contains more than 180 pages of technical information and lists stream segments that were considered impacted by mining, agricultural or industrial activities; and is referenced in **Section 7** of this report.

Outstanding and Use-Protected Waters

In addition to water quality classifications and standards, either of two water quality based designations may be adopted in appropriate circumstances. An "Outstanding Waters" designation may be applied to certain high quality waters that constitute an outstanding natural resource. No degradation of outstanding waters by regulated activities is allows. A "Use-Protected" designation may be applied to waters with existing quality that is not better than necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water. The quality of these waters may be altered so long as applicable water quality classifications and standards are met. Waters that are not given one of these designations are subject to the State's Antidegradation Review requirements before any new or increased permitted water quality impacts are allows.

Antidegradation Review

The activities that are subject to antidegradation review requirements are those that:

- Require a discharge permit
- Require water quality certification under Section 401 of the CWA
- Are subject to control regulations (WQCC, 1998)

The first step in the antidegradation review process is a determination, in accordance with criteria specified in the regulation, or whether 'significant degradation' would result, a determination is made of whether the degradation is necessary to accommodate important economic or social development in the area in which the waters are located. The determination is based on an assessment of whether there are water quality control alternatives available that would result in less degradation of State waters and which are economically, environmentally, and technologically reasonable. The proposed degradation is allowed only if no such alternatives are available (WQCC, 1998).

303(d) List

Section 303(d) of the Clean Water Act requires each state to identify waters for which technology-based effluent limitations and other required controls are not adequate to attain water quality standards. Those stream segments of water bodies require Total Maximum Daily Load (TMDL) allocations in order for the segment to attain or maintain water quality standards. A TMDL is the estimated assimilative capacity of a water-body,

which indicates how much of a pollutant may enter a water-body without impairing its designated uses. The TMDL represents the sum of the point sources, the nonpoint sources, and a margin of safety (which can include anticipated future pollutant loading). The current 303(d) List is presented in the Status of Water Quality in Colorado 2000 (the State's 2000 305(b) Report (CDPHE WQCD, 2000) and the 'Water Quality Limited Segments Still Requiring TMDLs document (CDPHE, 2002). Subsection 4.2.2 describes the 303(d) listed areas that pertain to the *Project area*.

Groundwater

Groundwater quality in the State of Colorado is addressed in the Colorado Water Quality Control Act (CWQCA). The Colorado Water Quality Control Commission and Water Quality Control Division, both a part of the CDPHE, administer this act. The basic standards for groundwater are found in the Colorado Code of Regulations, 5 CCR 1002-41. The key narrative standard is that "groundwater shall be free of pollutants" that may be toxic to human beings or a danger to the public health and safety (CGS, 2003). To administer the policies and rules pertaining to water quality management, the CWQCC has established the following groundwater classification system:

Domestic Use Quality
- Meet human health Standards (as shown in **Table 4.1**).
- Total Dissolved Solids (TDS) < 10,000 mg/L

Agricultural Use Quality
- Meet Agricultural Standards (as shown in **Table 4.1**).
- TDS < 10,000 mg/L

Surface Water Quality Protection
- If proposed or existing activity will impact groundwaters such that water quality standards of classified surface water bodies will be exceeded.

Potentially Usable Quality
- TDS < 10,000 mg/L
- Not currently used for domestic or agricultural, but the potential exists in the future

Limited Use and Quality
- TDS > 10,000 mg/L
- Does not meet the criteria of other classifications

The WQCC has also adopted site-specific standards for 49 well-field areas within the state (5 CCR 1002-42).

4.2.2 Dolores River Basin Classifications and Standards

The Basic Standards and Classifications, including the basis and purpose of the standards and classifications can be found in CDPHE WQCD, 2002, . Water quality standards for stream segments within the *Project area* are presented in **Tables 4.2 through 4.5**. **Table 4.2** (pages 1 through 3) provides the water quality standards applicable to the *Project area* by segment. There are new revisions as per the recent CWQCC triennial hearing (refer to **Appendix D**). **Table 4.3** provides the specific equations (or TVS – Table Value Standards) referred to in **Table 4.2**. These first two tables provide the standards protective of aquatic life, with some potable supply values integrated within them. **Table 4.1** provided the remaining standards applicable to 'agricultural' and 'potable or domestic' supply specifically (that are not already presented in **Tables 4.2 and 4.3**). Currently, there are certain numeric standards being revised for the segments associated with the *Project area* (CDPHE, CWQCC, 2006). A summary of changes that will become effective by December, 2006 is provided in **Table 4.4** (current standards documents are provided on CDPHE, 2006 http;//www.cdphe.state.co.us/op/regs/waterqualityregs.asp) and within **Appendix D**. These adjustments have been accounted for in the water quality data analysis presented in later subsections of this Section.

Streams within the *Project area* are classified for protection of cold water aquatic life (Class 1), recreation (Class 1 and 2), water supply and agricultural uses. The following segment is designated as 'Outstanding Waters', and thus, does not allow degradation of water quality:

> *Dolores River Segment 1: All tributaries to the Dolores River and West Dolores River, including all wetlands, tributaries, lakes, and reservoirs, which are within the Lizard Head Wilderness area.*

The above segment pertains to waters specifically associated with the Wilderness area and does not encompass the entire *Project area*. The remaining *Project area* segments are encompassed by the following segment designations by the WQCD:

> *Dolores River Segment 2: Mainstem of the Dolores River from the source to a point immediately above the confluence with Horse Creek.*
>
> *Dolores River Segment 3: Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek.*
>
> *Dolores River Segment 8. Mainstem of Horse Creek from the source to the confluence with the Dolores River.*
>
> *Dolores River Segment 9. Mainstem of Silver Creek from a point immediately below the Town of Rico's water supply diversion to the confluence with the Dolores River.*

There are no "Use-Protected" segments which indicate all waters within the *Project area* are subject to the State's antidegradation review as it is applied to discharge permit holders and 401 certification.

There are portions of the *Project area* that have been listed for impairment for one or more parameters on Colorado's 2002 303(d) list. Stream segments proposed for listing via the 2004 303(d) list and the accompanying Monitoring and Evaluation list (a list of sites for water bodies in which information suggests impairment, but supporting documentation does not meet the standards for credible evidence (CDPHE, 2002)) are described in Colorado WQCC regulations 93 and 94 (CDPHE, 2002; 2004). The state's 2004 proposed 303(d) list includes portions of Silver Creek (for cadmium, and zinc) as well as McPhee and Narraguinnep Reservoirs (mercury) (CDPHE CWQCC, 2004; CWCB, 2004). The TMDL status of these segments has adjusted over time. For instance, there was currently a temporary modification for zinc (refer to **Table 4.4**) for upper Silver Creek. This modification was reviewed and amended as per findings from the CWQCC Rulemaking Hearing (June 12, 2006; CDPHE CWQCC, 2006). It will be documented within the CWQCD Standards documents by December, 2006. In addition, based upon review of information, the State (in accordance with USEPA approval) removed manganese as a parameter of concern for the *Project area* segments. Also, Phase I TMDL efforts have been completed for the segment associated with McPhee Reservoir (CDPHE, 2006).

Specific information pertaining to the TMDL designations related to these areas is presented in **Table 4.5**. This information dictates that these stream segments require a TMDL, and the State must quantify the pollutant sources and allocate allowable loads to the contributing sources, both point and nonpoint, so that water quality standards can be attained for that segment. This process involves five basic steps:

1. Select the pollutant to consider (i.e. Cd and Zn),
2. Estimate the water body assimilative capacity (not completed – can be achieved by a loading/water quality analysis- refer to **Section 8**)
3. Identify the contribution of that pollutant from all significant sources (not completed – can be achieved by a loading/water quality analysis- refer to **Section 8)**
4. Analyze information to determine the total allowable pollutant load (not completed – can be achieved by a loading/water quality and ecological risk analysis- refer to **Section 8**),
5. Allocate (with a margin of safety), the allowable pollution among the sources so that water quality standards can be achieved (not completed – can be achieved by a loading analysis and ecological risk analysis- refer to **Section 8**).

Implementation of the TMDL is the final step. It requires participation from all the stake holders as TMDL's are not self implementing. The Waste Load Allocation portion of the TMDL can be implemented through effluent limits in discharge permits. In the case of

nonpoint sources, voluntary controls or locally enacted controls are necessary to implement the Load Allocations. The State relies on the authority already granted by the CWA to implement TMDLs.

The State representative (Aimee Konowal/CDPHE) has communicated with the author of this document in regards to collaboration with the Town of Rico and others, for the TMDL development. This document will assist in a 'data gaps' analysis for the TMDL effort and is being completed concurrent with this document. It is important that the Town take an active role and participate in this process so as to keep on top of the regulatory process and its implication to the Town setting.

4.3 Water Quality Data

This Section outlines water quality data available in the *Project area*. To date, a comprehensive watershed-scale or basin-wide water quality database and geographic information system (GIS) are not available. A thorough review of available sources was completed (i.e. review of all listed sources as provided by CGS, 2003). The primary sources of water quality data for the project were derived from independent sources who were researching different facets of the system. These sources include;

- CDPHE and USEPA historic studies of mining district areas within and around the Town of Rico (CDPHE, dates; USEPA, dates[most are compiled within USEPA's STORET Data Warehouse (USEPA, 2006 a through 2006c)
- SEH datasets – generated as part of the St. Louis Tunnel monitoring program.
- Water quality data from USEPA's STORET database
- USGS Flow Data and some water quality data,
- CGS data and studies (CGS, 2000; Neubert, 2000)

The information gained from these various entities needs to be scrutinized closely. The purpose for the collection of each piece of information is distinct and can be taken out of context if not thoroughly understood and put into perspective. For instance, various studies served the purpose of characterizing 'worst case' conditions of known contaminant releases. These results therefore provide only a snap shot of water quality conditions within a very confined spatial and temporal timeframe. Where possible, the uncertainties associated with the interpretation of these various data packages were taken into account. As a result, the interpretation has caveats that describe the extent of certainty associated with a drawn conclusion.

4.3.1 Introduction

A number of sources of water quality information for the *Project area* are available. Most were designed to answer a specific question and do not provide a 'basin wide' perspective of the water quality condition. The report used all available validated data in order to construct as-best-as-possible, a basin-wide review of the water quality conditions. Numerous studies as previously mentioned had a focused purpose and thus a

limited usefulness to this report. Summaries of the data obtained from these previous studies are provided below.

4.3.2 Historic Evaluations

The historic mining district and its associated features of adits, waste piles etc. have often been the focus of various water quality investigations. Some 'baseline' work has been completed by others that attempt to characterize the watershed as a whole. While yet others have completed studies to describe unique setting characteristics such as residential soils, geothermal water quality etc. This project relied on all of these pieces of information in order to try to characterize the watershed as a whole, over time. Of course, given such a heterogeneous data set there ends up being gaps in the information and the whole story can not be told. As a result, a 'data gaps' analysis was completed in order to identify the critical pieces of information that need to be gathered before a comprehensive characterization can be completed.

A chronology of the events that have taken place that have lead to the various types of studies was previously documented by the Matrix Design Group (2004) and is summarized herein. Additional studies beyond those described by Matrix were located as a part of this effort. They were integrated into the following chronology where appropriate.

Figure 4.1 depicts the timeline and chronology of studies completed in the Rico area and their associated purpose. As shown in this figure, there was an era focused upon the soils and sediment conditions and the mining impacts to these media (and possible risks to human health and the environment). There were a number of 'site investigation efforts associated with the USEPA evaluation of the area (USEPA, 1994). The information from these previous investigations is of some use, but has the limitation of being historic and of questionable use given the focus of these investigations. There has long been an interest in water quality in the area, but a surge of activity was noted in the 1990s likely in response to the following events:

- The St. Louis Ponds were the site of lime neutralization and gravity sedimentation during mining operations. These were the preferred techniques for the treatment of the acid mine drainage; however, the neutralization process was discontinued and the plant dismantled after the sale of the property to Rico Renaissance during the 1990s. The history of the St. Louis tunnel and a water treatment plant at the site is complex. The information presented in the following is summarized from file records kept by the Town of Rico. There may be some 'gaps' in the information, therefore the following information has some uncertainty associated with it. Atlantic Richfield Corporation (AR), now a subsidiary of British Petroleum, bought mines from Rico Argentine containing the world's second largest known deposit of molybdenum (the largest is in Crested Butte). Molybdenum is used mixed with metal alloys to harden steel. AR determined,

however, that it was not feasible to mine and turned around and sold everything to Rico Development Corporation in 1980. That sale also passed on to RDC the obligation of maintaining the water treatment plant at the St. Louis tunnel subject to a national pollution discharge elimination permit (NPDES). RDC ran the water treatment plant from 1988 to 1994, when they entered into negotiations to sell all their holdings to Rico Renaissance a development company. Rico Renaissance did not however, buy any liability properties, including the water treatment plant. After RDC received payment from Rico Renaissance, they 'walked away' from Rico and allowed the corporation to lapse. In November 1996, the state dissolved the corporation. The Colorado Department of Justice filed a suit against RDC in 1999. When AR realized RDC wasn't going to reassume responsibility, they stepped in to pay Colorado for a water quality assessment and began a voluntary approach to clean up the river. (L.Lance, 2003). A brief regulatory history in regards to the St. Louis Tunnel and associated ponds is as follows;

- In 1980, the CDPHE WQCD issued a Notice of Violation NOV) and a Cease and Desist Order (CDO) because of problems in meeting compliance limitations (USEPA, 1984).
- The NOV and CDO were amended on December 17, 1981 and specified exceedances of zinc and copper standards. This led to the development of a water treatment system using slaked lime at the St. Louis Tunnel Adit (WMD, 1994).
- A NOV was issued by CDPHE for cadmium permit standard violations in November and December, 1984 (USEPA WMD, 1994).
- A NOV and CDO were issued in 1990 for violations of lead and silver standards. Un permitted discharge from the Blaine Tunnel on Silver Creek was also reported in 1990, which resulted in construction of a concrete dam by RDC to plug the Blaine Tunnel (USEPA WMD, 1994).
- A NOV was filed in 1993 for silver violations (USEPA WMD, 1994)

- In the mid-1990's the Atlantic Richfield Company (AR) enlisted in the Colorado Voluntary Cleanup and Redevelopment Act (VCUP) in order to address sites with remediation needs. By addressing these sites through the VCUP program, they would be remedied without receiving a 'Super Fund' designation by the USEPA. The process involved the assessment of several sites within the Silver Creek and Dolores River drainages including the Argentine Tails, Columbia Tails, Grandview Smelter, Santa Cruz and Silver Swan mine sites. An evaluation of the contaminants associated with these sites was completed by AR (and previously by others; i.e. USEPA, 1994. Upon review of site contaminant conditions, AR developed a variety of remedy strategies that would be appropriate for the curtailment of contaminant concerns. Certain sites were found to pose little to no risk concern and were therefore recommended for a 'no action determination' (NAD), while others required remedy efforts (ESA Consultants Inc., 1999). A summary of the NAD and VCUP sites addressed by AR is provided in **Table 4.6**.The verification of the effectiveness of the remedies was completed by conducting water sampling above, within and below the site areas. A series of

reports documenting the VCUP actions, surface water monitoring activities and maintenance efforts are on file within the Town of Rico records (refer to the ESA Consultants Inc., 1999 report for a comprehensive listing).

- In 1999 CGS conducted a reconnaissance level investigation of NOAMS areas which included the Horse Creek tributary of the *Project area*. It was determined that the geothermal and natural mineralization characteristics to the area have leant to measured elevated metals concentrations in Horse Creek. This information is useful to understand the potential range of metals concentrations that can occur as 'background' to the *Project area* (Neubert, 2000).

- In 2001, the WQCD of CDPHE performed a water quality assessment at the request of AR, to assess potential permit limits for the Rico-Argentine mine drainage. The assessment collected new data and compiled previously collected surface water data from locations within the *Project area*. The assessment included seven point-source discharges in the area. Results indicated that during times of low flow, zinc can pose a water quality concern. The results were also quantified in terms of 'load' to determine which point sources were of most concern (**Table 4.7**). These results were contested by AR. As a result, AR continues to sample and analyze metals content in surface water settings at distinct points in the area. The sampling is completed by SEH Consultants and continues to this day. [**As per information provided by AR upon review of this document: "This assessment was a draft document containing numerous assumptions given the significant data gaps at that time. Since release of the 2001 draft, substantial additional data and related analysis have filled many of those data gaps. These analysis indicate that discharges other than the St. Louis Ponds are not directly relevant to the Water Quality Analysis (refer to SEH, no date) for the Dolores River at the St. Louis Ponds that that the river water quality will be protected by the anticipated discharge permit limits at the St. Louis Ponds.]**

- CDPHE and the Town of Rico became interested in the possibility of property redevelopment opportunities that can be provided through the Brownfield's program. The Brownfield's program is a state and federal program that facilitates the redevelopment of former industrial areas that has limited or no redevelopment due to environmental concerns. There were two areas (the Street Maintenance Garage and the St. Louis Tunnel Area) that were felt to fall within the potential Brownfield's arena. As a result, a soils and groundwater studies were completed in order to identify constituents of concern.

The types of studies completed fall into three investigation-type categories of soil, sediment and water (refer to **Figure 4.1**). The soils and sediment studies involved the characterization of lead in soils and sediments from the former mining operations. The water studies were also typically related to the mining operations. The water studies specifically served various objectives including the characterization of the acid mine

drainage neutralization process within the St. Louis settling ponds, water quality issues related to the capped tailings along the Dolores River and Silver Creek. These studies were completed by USEPA, CDPHE, AR and others and are summarized as follows;

USGS has completed sporadic surface and groundwater investigations within the *Project area*. **Table 4.8** provides a summary of the types of data gathered by location. This information was gathered as a part of the USGS routine monitoring programs completed at their gauging station and monitoring well locations (summary of Dolores county information provided on USGS, 2006a and b). For Dolores County, the USGS has historically had 29 water quality sampling locations, six of which occur within the *Project area*. Similarly, there were 25 groundwater locations within Dolores County, three of which occur within the *Project area*. Summary information describing these sampling locations (relevant to the *Project area*) are provided in **Table 4.8**. The samples collected serve the purpose of characterizing a site setting as a whole, and were not biased towards characterization of an impacted area or other. However, the suite of variables analyzed for were extremely limited. The most robust type of data gathered was 'flow' as measured at the gauging station located below the Town. Sampling at the USGS locations has been discontinued. The only ongoing USGS investigations involve the collection of flow data from the gauging station 09165000 (Dolores River, below Rico).

USEPA has performed investigations beginning in 1984 through to 2003. In 1984 the USEPA collected surface water and sediment associated with the Argentine Mine adjacent to Silver Creek. Results indicated that sediment was contaminated downstream of the tailings and settling ponds, however, only manganese occurred at elevated levels in surface water (downstream of the tailings and settling ponds) (Ecology and Environment, 1985).
In 1986 the USEPA completed a soil and sediment study throughout the Town of Rico. Results indicated elevated lead levels occur throughout the area. No other information regarding other metals was summarized. In 1994, Prior to VCUP activities, an inventory of sources of mine-related contamination and their source areas were completed by the USEPA (USEPA, 1994). Since that inventory, numerous activities including the removal of residential soils and VCUP actions on several mine-waste sources have been completed. At the time of the USEPA, 1994 historic site investigation, an estimated 75 acres of tailings piles and settling ponds occurred along both the Dolores River and Silver Creek, with an unknown amount of tailings moved into town as street cover. The source areas were estimated to contain 400,000 tons of material. In 2003, the USEPA evaluated if mine waste material was impacting the Dolores River, Silver Creek, and ground-water potable supply aquifer areas. A human health risk evaluation was completed. Results indicated that lead occurs at elevated levels in the Dolores River corridor and in certain neighborhoods near the historic smelters. As a result of the studies findings, AR submitted a voluntary cleanup up (VCUP) for soils investigation, remediation and restoration throughout the town of Rico.

The USEPA also maintains a comprehensive water, sediment, biological and habitat database (STORET) that is linked to a GIS mapping system (EnvirroMapper). These databases contain some, but not all of the records described herein.

The **U.S. Department of Interior, Bureau of Reclamation** conducted surface water and sediment sampling in the Dolores River and its tributaries between 1989 and 1993. The results showed Silver Creek to be a major, but not the only, source of mercury and other heavy metals in the upper Dolores River Basin. This report was not locatable during this effort and only summarized references were obtained (Bureau of Reclamation, no date; as referenced in URS/USEPA, 1996).

An 'Analytical Results Report' of the Rico-Argentine site was prepared **by URS Operating Services in coordination with the USEPA Superfund Technical Assessment and Response Team**. The report summarizes the field work and analytical findings from a site investigation effort completed from September 11 through the 15, 1995 and encompassed surface water, sediment, residential soil and groundwater sampling. Samples were collected within the Rico Argentine mine site, and additional characterization measures (i.e. flow) were captured from non-site areas (such as Scotch Creek, etc.) Results indicated:

- Surface water had elevated levels of metals in locations associated with tailings.

- Sediment from the settling ponds had elevated levels of some metals, in particular, calcium demonstrated an elevated trend.

- Groundwater did not contain any organic compounds, but had detectable concentrations of barium, calcium, magnesium, manganese, potassium, sodium and zinc. These detections however did not indicate that contamination had occurred from the Rico-Argentine site.

Water quality characteristics of the geothermal springs has been studied by others. Water quality measured in 1995 indicates that the two springs have a common source (**Table 4.9**). Water flowing from these springs is depositing calcium carbonate and iron about the springs and there are visible geothermal deposits between the springs and the town of Rico (URS 1995a; URS 1995c) Previous studies also indicates that there are elevated levels of arsenic within these springs as well (E.Heil, no date).

In 1998, the **CGS** summarized their findings from a comprehensive evaluation of abandoned mine features (adits, waste or tailing piles, etc.) associated with federal lands. The CGS completed site investigations of 'hazards' associated with each feature by reviewing the history, setting, exposure conditions to human and ecological receptors and the potential contaminant concentrations. As a result of

the culmination of these findings, the CGS would rank each feature within a site using 'Environmental Degradation Ratings (EDRs) of extreme, significant, potentially significant, slight, or none; and sites with Physical Hazard Ratings (PHRs) of extreme danger, or dangerous. Private (patented) land in-holdings, were found to often contain the largest mines and were only investigated when evidence indicated that environmental degradation emanating from these sites affected USFS-managed lands. All the features associated with a site were evaluated.

The sites associated with the *Project area* that were addressed by CGS, their features and associated EDR rankings are summarized in **Table 4.10. Figure 4.2** demonstrate the location of each Site within the *Project area*. The ranking was based upon the EDR and PHR feature values associated with each Site. The Sites were compared to each other, and ranked. Those Sites elevated (ranked with the lowest numbers) represent the Sites requiring the most immediate attention in order to control contamination issues and/or physical hazards. Only those Sites associated with the *Project area* are listed. There are other Sites within other watersheds which were ranked within this CGS report but are not important to this evaluation. The definitions for the EDR and PHR values are as follows;

EDR Value Definitions
1) Extreme
2) Significant
3) Potentially Significant
4) Slight
5) None

PHR Value Definitions
1) Extreme Danger
2) Dangerous

Results of the CGS findings indicate that there are a number of mine sites with mixed ownership (both private and federal) that create environmental hazards and require further attention. This may mean that further study is required, or that a potential remedy is essential in order to control the hazards created by the feature. These Sites are further described and evaluated within **Sections 7 and 8** of this report.

The **US Department of Interior, Bureau of Reclamation (BOR)** conducted a Dolores river basin study of mercury to determine the source of mercury in fish tissue samples. A summary of findings was located within the USEPA, 1994 report, but an original copy of the BOR report could not be located, therefore there is uncertainty with the following information. For the BOR effort, Fish tissues samples were collected from September 1989 through March 1991, at the McPhee and Narranguinnep Reservoirs. Tissue results were found to contain high

levels of mercury (E&E, 1991a and 1991b as cited in USEPA, 1994). In turn, the BOR began surface water and sediment sampling in 1989 along the upstream reaches of the Dolores River and its tributaries to determine potential sources of the mercury. The sampling continued periodically every year through 1993. The sediment data show Silver Creek to be the major source of heavy metals, including mercury in the upper Dolores River basin. The April 1992 water samples indicate that, in addition to Silver Creek there are numerous sources of mercury in the upper Dolores River basin and many of them are located well downstream from Silver Creek. The study also shows metal loading from various mine drainages which contribute to contamination of the Dolores River (BOR, 1994 as cited in USEPA, 1994.

Walsh Environmental completed Phase I and II Environmental Site assessments for Rico Renaissance on approximately 3,000 acres of land in and around Rico in 1995. A limited number of soils and surface water samples were taken. Results indicated that there are elevated lead levels primarily related to former mining operations. Walsh categorized different types of areas where waste rock and tailings were evident. Results of the metals analysis as compared to these categories of areas indicated that areas with mine tailings, slag or spoils in surface or subsurface soils, had elevated concentrations of metals. In addition to the sampling efforts, Walsh characterized several potential nonpoint sources of pollution associated with distinct properties. These included septic tanks and a leach line at an Assay Building, a leaking UST and other wastes associated with various buildings. The most relevant information gathered from these studies includes the samples of soil and surface water which are described in further detail in **Appendix E** to this report. The results from these analysis were not integrated into the water quality dataset evaluated within this report, but rather, provide supporting lines of evidence for the overall evaluation of the site setting.

As part of the AR VCUP/NAD program, ***AR*** has submitted approximately thirteen VCUP or No Action Determination (NAD) applications to manage tailings piles and slag piles in around the town of Rico (from 1995 to present). **Table 4.6 previously** summarized the VCUP or NAD application and the status of the request. Under the VCUP program, AR has removed and/or stabilized, or capped mine tailings that had previously been located in or adjacent to Silver Creek and the Dolores River. The former tailing piles were re-contoured and capped to limit the amount of surface water infiltration.

In 1996 ***Titan*** conducted a geological and geochemical mapping of the soils in Rico to characterize metals concentrations in relation to the mineralogy of the source material and historic mining and processing operations. Results indicated that concentrations of certain metals (including lead) in surficial deposits are derived predominantly from geologic processes acting on natural sources.

Also in 1996, CDPHE and AR conducted a soils study in Rico in order to document the sources of lead found in residential soils. Results include:

- Natural sources of elevated lead levels are present in and around Rico. The exposure and weathering are the cause of naturally occurring lead in the soils near surface mineral bearing ore bodies.

- Man-made sources with elevated lead concentrations are present in the area. The sources include mine waste rock, mill tailings, and smelter slag.

- Long term impacts on soil properties as a result of the acid plant operation appear to be minimal.

- Efforts to identify smelter products were inconclusive and more study is required to assess historic smelter impacts.

Kathleen S. Paser performed an analysis of treatment alternatives for the St. Louis tunnel discharge in 1996 as part of her Master's requirements for the Colorado School of Mines, Chemical Engineering and Petroleum Refining program (Paser, 1996). Ms. Paser evaluated the (then) current technologies that may suitably treat the St. Louis acid mine discharge. Her findings indicated;

- There is approximately 40% loss of water through the pond system due to loss through recharge to the subsurface.
- There is only marginal success using this treatment technology for the removal of CDPHE permitted metals (cadmium, copper, lead, silver, and zinc).
- 98% of the solids in the treated drainage settle in the upper ponds closest to the mine and the solids primarily settled are iron and calcium.
- The upper ponds are at 75% of their designed capacity due to the buildup of sediment resulting channelized flow. This has caused a 74% reduction in the residence time in the upper ponds needed to facilitate sedimentation and a spillover of solids into the lower ponds.

Recommendations from Ms. Paser's report include;

- Dredging of the upper ponds as a short-term extension of the existing treatment system while other alternatives are evaluated.
- Possible alternative technologies include: Lime neutralization with sludge recycling, biogenic H_2S sulfide precipitation using municipal sewage as an electron donor, and constructed wetlands.

In 1999, ***CGS*** conducted a reconnaissance-level investigation of naturally degraded surface waters associated with hydrothermal alteration in Colorado. Many of the study areas were previously identified as having 'natural' degraded

surface water quality as a result of an abandoned mine inventory conducted by the CGS and the USFS from 1991 to 1998 (Sares, 1996) During the 1999 study, filtered and unfiltered water samples were taken from areas with naturally degraded conditions. The Horse Creek tributary to the *Project area* was investigated as part of this study. 'Ferruginous springs' (iron enriched) were reported in the northern and western branches of upper Horse Creek and in lower Horse Creek. These springs have deposited limonite in swampy areas of the stream valley. Although mines are present in these basins, limonite deposits were recorded as early as 1900 (Harrer and Tesch, 1959). The limonite deposits are probably not a result of upstream mines. The CGS found three locations within the Horse Creek sub-basin (referred to as locations NW-80, NW-81 and NW-82). Results are summarized by location as follows;

- Sample NW-80 was near the headwaters of Horse Creek. Flow was 150 gpm, pH was 7.86, and conductivity was 198 uS/cm. Despite the weakly altered rock above the site, the CGS found this water to be relatively clean and did not exceed standards in any of the tested parameters (**Table 4.11**).

- Sample NW-81 was from one of several springs emerging in and adjacent to a natural iron bog on the south side of Horse Creek. Flow was estimated at 100 gpm for the series of springs. At the sample site, pH was 4.18 and conductivity was 298 uS.cm. Manganese, aluminum and copper significantly exceeded standards; and zinc, cadmium, and iron also slightly exceeded standards (**Table 4.11**).

- Sample NW-82 was collected from a seep along a steep gulch that borders the east side of the iron bog. This area was mapped as a landslide deposit and had altered rocks which were bleached, chalky and crumbly. Flow was 23 gpm, pH was 7.12 and conductivity was 449 uS.cm. Hardness was high with a level of 449 mg/L. Manganese concentration was 50 times higher than the state standard. Sulfate was elevated, but within standards. Zinc and cadmium were also elevated, but within their hardness-related standards (**Table 4.11**). The CGS noted that this located formed precipitates, and the results indicate that aluminum and iron occur as suspended solids (Neubert, 2000).

In 2001, ***CDPHE WQCD*** performed a water quality assessment at the request of AR, to assess potential permit limits for the Rico-Argentine mine drainage. The assessment collected new data and compiled previously collected surface water data from locations within the *Project area*. The assessment included seven point-source discharges in the area. Results indicated that during times of low flow, zinc can pose a water quality concern. These results were contested by AR. **Table 4.7** presented the loading estimates provided by CDPHE for the seven point-source discharges The findings of the assessment indicate that the combined point source discharge contributions exceed the stream's assimilative

capacity (of 4.95 lbs/day) by 31.6 lbs/day. The sampling was performed during low flow conditions of the Silver Creek and Dolores River, and indicated that the capping performed by AR on the various former tailings piles has not eliminated the leaching from these former tailings piles and is still contributing metals loading under low flow conditions. AR has disagreed with the CDPHE findings and no permit application has been submitted for the adit discharge to date. The data collected by CDPHE was integrated into SEH's comprehensive data set.

The ***United States Fish and Wildlife Service (USFWS)*** reviewed the CDPHE water quality assessment and prepared a memorandum to address their own concerns regarding the metals concentrations in Silver Creek and the Dolores River in and near the Town of Rico. The memorandum documented their recommendation to study the contaminated sediment that may have accumulated over time and potentially be causing harm to exposed aquatic life. They recommended further collection of water and sediment from collection areas such as wetlands and depositional habitats.

In 2002, **Short Elliott Hendrickson Inc. (SEH Inc.).** began a water quality/loading evaluation of locations within the Upper Dolores drainage, Silver Creek and focused locations associated with the St. Louis tunnel. As part of their efforts, they compiled available existing information from historic studies that gathered water quality information for the same, and other similar locations. A fairly cohesive dataset was established and lent to Grayling Env. for the completion of this report. Several of the datasets described within this subsection were integrated into the SEH dataset for comparison purposes only. A summary of the types of samples analysis completed by location that occur within the SEH dataset are provided in **Table 4.12 and Table 4.13**. SEH has produced documents describing the results of their water quality and loading measurements for 2002 (SEH, 2002a and 2002b). Reports for the follow-on years are pending.

In 2003, ***CDPHE*** conducted a Phase I Brownfield's Assessment of two potential redevelopment sites in Rico: the Street Maintenance Garage area located within the Town of Rico, and the St. Louis Tunnel Area. The findings of the assessment did not identify elevated levels of any specific constituent; however the maintenance garage site is also the location of the former power plant which is a potential source of polychlorinated biphenyls (PCBs) and no assessment of PCBs was completed as part of this effort. The St. Louis ponds area (north of the actual ponds) was evaluated, yet no constituents of concern were identified in this area.

CFAR, 2005 "Monitoring of the upper Dolores River" was begun in 2002 by a local citizen's group (CFAR) in response to concerns about the impact of increasing development on the Dolores River Valley. Results on biological toxicity assessment (using aquatic snails) and water quality testing up to the end of 2003 are summarized in the 2005 document. Further data are forthcoming in

progress reports. Measurements of water quality and biologic assessments of toxicity (exposure of aquatic snails to site sediments or soils) were conducted in the Dolores River from mining areas around Rico and Dunton near the watershed rim in the San Juan Mountains, and for 45 miles downstream to McPhee Reservoir near the Town of Dolores. Quarterly monitoring was completed at 10 sites starting in Fall of 2003. The results from this study provide valuable lines of evidence in regards to the characterization of the *Project area*. The data was not integrated into the dataset used for the water quality interpretation within this document due to the incompatibility of objectives and methods. **Appendix E** provides a summary of the results pertinent to this document that were used as supportive lines of evidence.

URS, 2006 documents the analytical results of the Rico argentine Upper Dolores Watershed study which served the purpose of gathering information for the evaluation of the Dolores River watershed with regard to the aquatic ecosystem and fishery. Samples of surface water, phytoplankton, zooplankton, macroinvertebrates, fish tissue and ultra-clean surface water and sediment samples for mercury and methyl mercury analysis. Study objectives included the estimation of mercury loading from the Silver Creek, Bear Creek and West Dolores River mining districts, as well as determination of mercury concentrations associated with a high flow (summer rain event) condition. Results from the efforts are as follows;

- The CDPHE numeric standard of 0.01 ug/L (which is protective of aquatic life uses within surface water) for total mercury was not exceeded in any surface water sample collected during the Phase I sampling event. The numeric standard was exceeded in two surface water samples collected up-gradient of Rico on the Dolores River during the Phase II (high flow event) sampling event. These two locations are above Barlow Creek and above Silver creek.

- The CDPHE action level for mercury in fish of 0.5 mg/kg (protective of fish) was not exceeded in any of the 44 fish tissue samples collected from four reaches in the Dolores Watershed and analyzed for total mercury.

During the course of producing this document, a thorough research effort was completed in order to identify all possible sources of information. Certain entities often have datasets of use for water quality investigations; however it was found that minimal information was actually gathered in the *Project area*. Sources that were reviewed yet yielded a limited set of records include:

- ***CDOW*** has one recent year's worth of fisheries population survey data, and some data available for 1992 (CDOW, 2006; and CDOW, 1992 as cited in C. Derfus, 2001). The results were folded into the characterization of aquatic life within the *Project area*.

- ***Dolores Water Conservation District*** does not have any information in regards to water quality for the *Project area*. They have referred to Steve Harris/Harris Engineering for information pertaining to the proposed well-field for Rico's municipal supply.

- ***Trout Unlimited (TU)*** has been involved with the evaluation of water rights and the needs for viable fisheries in the lower reaches of the Dolores River. TU has provided information regarding their review of available flow data etc., on their web site (TU, 2006) and was reviewed in regards to information characterizing the fisheries habitat potential in the *Project area*.

- ***USGS QUALDAT*** **-** a groundwater quality investigation for pesticide occurrence) was reviewed by requesting a query through to the database manager (Arne Sjodin). The database was comprised of groundwater - water quality information that was never integrated into USEPA's STORET database. As per findings from A. Sjodin's query, there were no Dolores County wells inventoried, therefore no data pertinent to this project (A. Sjodin, pers. Comm.. 2006)..

The search for existing information continues during the process of this document being brought together. Conversation with regional USFS personnel indicate that there may be pieces of information gathered from their own studies, and an USEPA 'loading study' conducted several years ago (C. Zillich, pers. Comm.. 2006). To-date however, the points of contact have been unable to locate the information. When and if the information does become available, this document will be updated.

4.3.3 Ongoing Routine Data Collection

As per conversations with various water quality investigative agencies (USGS, CGS, USEPA, CDPHE and CDOW), there are no ongoing site investigations other than those conducted by SEH as part of the St. Louis tunnel area studies (Kelly, B., pers. Communication 2006). There is a proposed sampling effort to characterize soils throughout the river corridor in 2006 – 2007 that may include some stream-side sediment (USEPA). The format and design for the SEH ongoing studies will be the same as those completed in recent years (2002 through 2004) which served as the basis for much of the water quality evaluation within this document.

4.3.4 Ongoing Special Projects

There is an ongoing soils evaluation that is being correlated with resident blood-lead levels. There may be additional soils, and potential sediment studies for the characterization of lead in 2006 – 2007. There was a recent evaluation of mercury within the Upper Dolores River Basin that was made available and incorporated into this document (URS/USEPA, 2006).

4.4 Data Evaluation

The following Section reviews the pertinent data sets available to determine potential water quality impacts associated with the *Project area*. The types of datasets available were previously described (subsection 4.3). These datasets were compiled in this subsection, and interpreted to understand the magnitude of potential water quality issues.

Upon review of the available information, it was determined that the compiled SEH dataset integrates the results from other investigations over time from key locations throughout the *Project area*. This makes the SEH dataset extremely useful for the purposes of this document in order to complete an evaluation of the water quality condition. A summary of the types of sample analysis completed over-time, that are within the SEH dataset were shown in **Tables 4.12 and 4.13**.

In order to be able to characterize the water quality within the *Project area*, it is necessary to have information from locations throughout the watershed that represent the watershed background, tributaries, the possible contaminant sources, and from down-gradient areas. It is also necessary to know the water quality at these locations during unique flow periods such as spring-melt (or high flow) and fall (low flow) in order to understand flow influences to water quality. Once these pieces of information are pulled together, a 'watershed scale' view of water quality over distance, and time can be viewed.

A watershed-scale view of water quality (concentration and load) can help identify data gaps, contaminant sources, seasonal influences etc. For the purposes of this document, it was important to be able to obtain a watershed scale view of conditions. However, as shown within the SEH summary tables, there are 'data gaps' for a number of years, and for a number of locations. Upon review of the available information, it appears that there are fairly robust datasets available for the following years: 1997, 1998, 2002, 2003, and 2004 (refer to **Tables 4.12 and 4.13**). The results for 2005 and 2006 are pending, and further review of 1997 indicates substantial inconsistencies in the suites of analysis completed by site. Therefore, for the purposes of this document, SEH datasets from years 1998, 2002, 2003 and 2004 were relied upon. There are significant uncertainties associated with these datasets however, which are further described in subsection 4.4.3 which presents the data interpretation results.

4.4.1 Introduction

As summarized in subsection 4.3, numerous datasets of varying sizes with differing purposes exist for the *Project area*. An objective of this Watershed Plan, was to review these datasets and determine which contains appropriate information for use in the evaluation of water quality conditions. Many datasets were very 'focused' and served the purpose of an individual study. Thus, they have some, but little overall value in helping to describe a watershed-wide condition. After having reviewed the available information, it was determined that the SEH (2004) comprehensive data set provided the most useful and comprehensive information for the purposes of this document. **Figure 4.3** depicts

the locations typically studied by SEH. Other datasets (such as those collected by USEPA, CDPHE, USGS and others) were actually folded into the SEH dataset (SEH), therefore it appears that as much information as is available, is actually present within the SEH data set. A review of individual datasets that were not evaluated as part of this plan are summarized as follows;

- The data sets obtained from each of the **USGS** sites had limited information. Typically, only physical parameters were measured and the results of any analysis were 'averaged', thereby limiting their value. It appears that the USGS data was gathered as part of an ore-body exploration process, and not part of a water quality investigation. Pertinent information (discharge rates from gauging station 09165000 have been integrated into the SEH database. Therefore the pertinent USGS dataset is accommodated by the SEH dataset.

- The available information from the **USEPA STORET Data Warehouse** is comprised of data obtained from various CDPHE and CDOW Riverwatch investigations. The locations with information within the STORET database are shown in **Figure 4.4**. Comparison of the samples results within STORET vs the SEH dataset indicates that the SEH dataset encompasses all of the available information from the CDPHE studies. **Figure 4.5** depicts the CDPHE study locations which overlap with SEH study locations (refer to **Figure 4.3**). The CDOW Riverwatch studies did not have any reportable values and appear to have been gathered from studies conducted within the Dolores area, outside of the *Project area* (**Figure 4.6**). Therefore the results from these efforts were not appropriate to this plan, and were not evaluated.

- The special studies completed by CGS, CFAR and K. Paser were designed to meet specific study goals, and did not lend to being integrated into the water quality dataset compiled for this document. The results from these studies however, provide useful lines of evidence that describe the water quality setting. As such, their conclusions and results are drawn into the evaluation where appropriate.

- There are a number of 'soils' data sets that have useful information from which to characterize the terrestrial setting (Wash Env [1995], AR and CDPHE). This information could be used to estimate the potential soils overland flow impacts to receiving systems. Soils could be transported to streams by *Stormwater* and snow melt discharges. These soils in turn could become a source of sediment and sediment contamination, if the soils have contaminant issues. Simplistic models could be applied to determine if this pathway is of potential concern, but is beyond the scope of this document. The analysis of this potential pathway is a 'recommendation for next steps' as identified in **Section 7**.

In summary, it appears that the available water quality information relevant to the *Project area* is best represented by the SEH dataset. As previously mentioned, the most

comprehensive datasets available occur in the years of 1997, 2002, 2003 and 2004. The data available from these years was evaluated by two general methods; 1) water quality comparison to criteria and 2) metals loading analysis to determine the gain or loss of metals over time and distance. The specific methods to these approaches are described in detail in subsection 4.4.3.

4.4.2 Water Quality Discussion

As shown by the abundance and type of data collected over the years, there are distinct features within the watershed that have captured the attention of others. These features create point or nonpoint sources of pollutants to the watershed and have raised a concern with private and regulatory and resource agencies. The list of some of the features that have created concern and have water quality issues associated with them include;

- The St. Louis Tunnel discharge adit: CDPHE and others have extensively studied this feature. At times the metals load from this adit comprises upwards of 80% of the total metals load within the Dolores River within the Rico area.

- Newman Hill area – Syndicate tunnel and Lexington mine dump – seeps out of the mine dumps etc. demonstrate mineral deposition (calcite deposits)

- Columbia tailings – which are located within the Dolores River Corridor, have been capped as per a VCUP action (1996). Of potential concern however, is the proximity of these tailings to the river which has been identified as an ongoing hazard (Matrix) since the flows from the river have compromised the cap and exposed tailings which are reaching the river, and due to the potential for groundwater infiltration into these tails that can become degraded and subsequently impact water quality within the adjacent surface waters of the Dolores River. This site has been dedicated to the town and will be the location of future development for a hotel site.

- Propatriot Mill Site which is located immediately adjacent to the river corridor, has been tested by the USEPA and others and has metals enriched soils as a result of historic smelting operations. It is unknown the contribution of water quality concern associated with this site since data are lacking and the site is physical ‘set back’ from the drainage path. There is the potential for overland flow of contaminated soil into the receiving drainage, and groundwater infiltration, degradation and subsequent impact to the surface water of the Dolores River. Potential future development activities on this property (the area may become the site for a River lodge, hot springs, facility, green house and other features) may provide a protective step towards severing water quality impact pathways. With the placement of impervious cover, the potential for overland flow of contaminants will be minimized. The potential for groundwater impacts however, will remain.

- Rico Boy and Santa Cruz Adits have had a VCUP which included consolidation of mine waste, capping and routing of adit flows. The flows are combined, routed to a single settling pond and eventually release to a wetlands area associated with the Dolores River. There are metals associated with this release that do reach the Dolores River.

- Silver Swan Adit has had a VCUP involving the consolidation of mine waste, capping and routing of adit flows to a wetland associated with the Dolores River. The site occurs below gradient to the Rico Boy/Santa Cruz site. The site does contribute metals load to the Dolores River.

- Mountain Springs Mine was identified by the CGS/USFS as presenting an environmental hazard due to hazardous constituent characteristics associated with the waste and adit flows. The flows do reach the Dolores River during portions of the year. There is little to no further information available for the Site.

- Within the Silver Creek Catchment there are a number of mine features as yet unstudied. An unnamed adit located below the overhead tramway (identified by SEH) contributes significant amounts of metals to the Silver Creek flows. The Argentine tunnel and waste pile site has a seep that contributes to the metals within Silver Creek as well. The flows and metals load associated with this Site are seasonally affected.

- The Blaine Tunnel feature had an historic adit release up until it was plugged thereby rerouting the adit discharge to the St. Louis. This tunnel currently has a slight seep which discharges as a nonpoint source to the Silver Creek basin. Current conditions of seep discharge water quality impacts to Silver Creek are unknown but considered to be slight given the low magnitude of release.

The sampling that has been conducted within the *Project area* is largely focused upon these above listed sites. There are other areas (i.e. Horse Creek and Scotch Creek) that have had singular sampling events for specific purposes. Otherwise, the amount of data available for the *Project area* is very focused and relatively confined to the historic mining district area.

4.4.3 Potential Effects to Designated Uses

If the surface water quality of a resource is degraded, the designated uses of that water body is impaired (and can lead to the listing of the impaired segment on the CWCB 303(d) list, as well as have other ramifications. The data compiled from the various sources was compared to standard criteria associated with the designated uses of the surface water bodies within the *Project area*. The designated uses of the in-stream flows are;

- Potable supply

- Irrigation/agricultural
- Class 1 coldwater fisheries

The 'class 1, cold water' standards from CWQCD are protective of aquatic life. These concentrations are similar to those for domestic drinking-water supplies but are more restrictive for elements such as copper and zinc that affect aquatic life more than human health, and more stringent than for agricultural use. Thus, if the measured concentrations of constituents fall below the aquatic life standards, typically the other designated uses are protected for as well.

Comparison of measured constituent concentrations to these standards is an 'inferential' method to determine the potential for an adverse effect. It is not a definitive expression of effects, rather an indicator that further evaluation is required. The composition of streams (biological components, habitat characteristics) is an indicator of impact and ecosystem health. In practice, it is much easier to determine water constituent concentrations than to measure biological communities such as benthic macroinvertebrates and fish which are a better indicator of 'designated use' achievement (Besser et al., 1998; Boyle and Bukantis, 1998; and Nash, 2002).

For the purposes of this evaluation, effects to the cold water, class 1 designated use were completed by two methods;

1) measured concentrations of dissolved metals were directly compared to hardness-derived AWQC values to identify possible constituents of concern, and

2) a copper-zinc index (CZI) was formulated using available data.

Since the designated use of the *Project area* surface water segments are protected by numeric standards, and not biological criteria, these two methods were considered as appropriate screening tools. If biological information were available, it would serve as a more direct and definitive measure. However, this information is largely absent and has current, limited usefulness. The following describes the methods and results of the two methods applied to determine effects to the *Project area* designated uses.

The direct comparison method utilized the 'hazard quotient' tool in which the measured concentration was divided by the appropriate chronic AWQC value. An HQ is expressed as the ratio of a potential exposure point concentration of a given metal to the criterion protective of chronic exposure for aquatic life receptors and is derived using the following equation:

Eqn. 4.1 HQ = [Metal in site water]/[Site-specific chronic AWQC]

Where;

HQ = hazard quotient (unit less),

The metal concentration in water is expressed in similar units (either ug/L or mg/L) as the comparative AWQC, and is representative of the appropriate ' fraction' (dissolved or total) as the AWQC, and

Site specific chronic AWQC values were developed for Silver Creek, St. Louis tunnel and the Dolores River locations, for the hardness-derived AWQC for cadmium, copper, lead, zinc; while drainage-specific AWQC were used for the remaining metals of arsenic, chromium, iron, manganese and selenium.

A second method applied within this assessment involved the development of a copper-zinc index (CZI). The CZI has been described by others (Besser, 2000) as an index that provides a simple number that describes the magnitude of copper and zinc concentrations in water samples in relation to aquatic life requirements as determined by toxicological tests. The intent of the CZI is to focus on two metals of prime concern to aquatic health typically associated with Colorado mining areas (NASH, 2002) while minimizing regulatory details of water-quality standards. The CZI is calculated as:

Eqn. 4.2 $$CZI = [(Cu \text{ in ug/L}/20) + (Zn \text{ in ug/L}/200)]/2$$

Where;

CZI = Copper-Zinc index (unit less)
Cu = the concentration of copper in ug/L
Zn = the concentration of zinc in ug/L

The values of 20 and 200, for copper and zinc respectively, are not precisely defined, but are essentially average values for tolerant and sensitive species in mortality tests and are similar in magnitude to the aquatic life standards. The sum is divided by two to conveniently make the index 1 for the break between healthy and unhealthy compositions: CZI values below 1 are 'good', and values above 1 are 'bad'.

Hazard Quotient Results

Summaries of the aquatic life criterion were provided in **Tables 4.2 through 4.4**. Site-specific criterion for certain metals were derived using site-specific hardness values. The remaining metals (not hardness dependent) had basin-specific standards from CWQCC table standards for the Upper Dolores segments. Therefore, in summary, the AWQC values presented in the HQ tables reflect site-specific and region-specific standards.

Tables 4.14 through 4.22 were drawn from SEH data set summaries from both high and low flow sampling events at the St. Louis Tunnel area, Silver Creek and along the Dolores River. Results from metals analysis are presented within these Tables, by location, and compared to appropriate chronic AWQC levels. An HQ less than one indicate that the metal alone is unlikely to cause adverse effects to exposed aquatic life.

An HQ of greater than one indicates the need for further evaluation since a toxicity potential exists.

CZI Results

The CZI results for each event(high and low flow) for each year was calculated by sampling location (**Table 4.23**). The results provide a conceptual indication of source areas that lend potentially toxic levels of copper and zinc. This metric is only a conceptual measure and not a true indication of toxicity.

Loading Results

The hydrogeologic interpretation of loadings in the setting of the *Project area* is complex. First off, accurate loadings require precise co-located measures of metals concentrations and flows. For the purposes of this effort, certain flows were absent, as well as certain metals constituents were erratically measured (they would be measured upstream, but not below etc), thus the key components were pulled together and at times, represent a 'piece meal' loading model. In addition, the calculated TOTAL load measured for the *Project area* is not attributable to a single or specific source. Flow paths of metal-rich water from adits, mine wastes and mill tailings at or near the stream course may appear straight forward, but the presence of the mine waste pile on the stream bank may mask a groundwater contribution from a fault or open adit that is concealed by the mine waste pile for example. Flow paths from anthropogenic sources located some distance from the stream (i.e. more than 1 km) may be even less certain. In general, our certainty about flow-paths from specific sources decreases as the distance between the assumed anthropogenic source and the stream increases.

4.4.4 General Trends

The following discusses trends in water quality as observed by the type of data analysis (hazard quotient, CZI, and loading). **Figures 4.7 through Figure 4.11** demonstrates the change in concentration for iron, manganese and zinc each year by location. A narrative description of the concentration trends is provided below.

Hazard Quotient Discussion

The following provides a review of the water quality findings for the St. Louis tunnel and outfall, Silver Creek and the Dolores River. Consistent data of high quality was available for these areas from 2002 through 2004. Trends were observed in concentrations of certain metals by location and season (samples were typically collected during high and low flow periods). The resulting information serves to identify possible source areas of degraded water quality that need further study or possible remedy.

<u>St. Louis Tunnel and Outfall</u>

Samples were routinely taken from the tunnel mouth and the outfall. The results provide an indication of the effectiveness of the settling ponds in regards to passive treatment of metals in solution. The settling ponds allow for 'time and distance' for the metals in solution to react with other water quality parameters (and solids) and either stay in solution (where they can be toxic to exposed organisms) or settle out as a precipitate in the bottom of the ponds.

- **For the year of 2002 – Table 4.14**: From the tunnel sampling location to the outfall, concentrations of arsenic, cadmium, chromium, copper, iron, lead, manganese and zinc decreased significantly, while hardness increased (indicating the establishment of buffering capacity) for both spring and fall .

- **For the year of 2003 – Table 4.15**: Data was available for fall, low flow conditions only. From the tunnel location to the outfall, concentrations of cadmium, chromium, copper, iron, lead, manganese and zinc decrease, while concentrations of mercury, nickel, selenium and silver increased (along with hardness). These increases were slight, yet highlight the unique water chemistry associated with these elements. It is possible that pH in the various ponds could have affected the solubility of these elements. It is also possible that the analytical results are at levels low enough to cause analytical error. Regardless, the released concentrations of mercury, nickel, selenium and silver at the outfall are not of concern in regards to their concentration and thus, potential effect to aquatic life. [An additional note as provided by Atlantic Richfield's review of this information: "Mercury concentrations in sampling completed along the Dolores River and at the St. Louis Ponds have been reviewed in relationship to detection of mercury in field blanks. It should be noted that the level of mercury in the St. Louis Ponds discharge has actually been less than that in associated blanks which according to EPA guidance for Method 1631 ultra-low level analytical procedures employed, suggests that the slight rise noted in the above citation was based on invalid data].

- **For the year of 2004 – Table 4.16**: From the tunnel location to the outfall, concentrations of cadmium, copper, iron, manganese and zinc decreased significantly in spring and fall. Concentrations of selenium increased in spring, and concentrations of lead and silver increased in fall. Again, similar to the findings from 2003, the increases observed (for selenium, lead and silver) were slight. The concentrations of these metals at the outfall point of release were low and not of concern to exposed aquatic organisms. These increases may be the result of a dynamic equilibrium related to pond pH, the precipitates present, and/or due to analytical error.

Results indicate that the settling ponds are significantly affecting the amount of available metals in solution. The current operating conditions seem to be addressing a significant portion of metals associated with the tunnel. The water quality at the point of release (the outfall) from a concentration standpoint shows acceptable levels for aquatic life. The

amount of 'load' however, needs further evaluation. In addition, the potential settling pond sediment release is a point of consideration since over-topping, or breaching of the settling pond berms would release significant precipitated metals from the ponds to the Dolores River. This condition was previously observed (year) and remains a potential threat to the *Project area*. [Additional information provided by Atlantic Richfield's review of this document states "The focus of the ongoing water quality assessment by DEPHE for the St. Louis Ponds has been to identify the metals loads that can be released under a discharge permit and still be protective of the Dolores River. This effort is anticipated to be completed sometime in 2007. Atlantic Richfield has taken steps to alleviate the potential for overtopping of the berms, enhance spillway protection and control beaver activity within the site.]

Silver Creek

The samples collected from Silver creek were somewhat erratic. In general, samples were taken during high and low flow periods from locations at points of potential mine-site water releases. On occasion, samples were taken above (SVS 1T) and at (SVS 1) the Town of Rico potable supply intake. In addition, a location at the terminus of Silver Creek, immediately prior to the confluence of the Dolores River was routinely evaluated. Comparison of water quality results from these locations provides an indication of potential degraded water quality source areas.

- **For the year of 2002 – Table 4.17**: Concentrations of cadmium and copper tended to 'spike' at location SVS 26 which is associated with a seeping mine adit during both spring and fall flow conditions. Similarly, concentrations of iron, manganese and zinc spike at SVS 12; the Argentine tails seep, and SVS 26 (the open adit) during both high and low flow conditions. During low flow, mercury, silver and nickel show spikes in concentrations (with SVS 26 and 12 depending upon the metal) indicating that the concentrations of these metals are subtle and can only be observed during low flow conditions when dilution is at a minimum. Concentrations of arsenic, selenium, cyanide and lead were erratic and difficult to understand in relation to source areas. Therefore, these metals were defined as showing 'no trend' for Silver Creek. In ALL CASES, the metals that demonstrated spikes at particular locations, eventually decreased in concentration as you progress down-gradient to the Dolores River. The water quality at the point of release to the Dolores River is good and had concentrations of metals of little to no concern to exposed aquatic life. There are data gaps however, that need to be resolved in order to understand the metals concentrations and release rates to the Dolores River.

- **For the year of 2003 – Table 4.18**: Only low flow, fall sampling was conducted. Therefore there is a data gap in understanding water quality conditions during high flow. Results from the low flow sampling indicate that SVS 22 (Silver Creek above Argentine tailings seep) and SVS 26 are source areas for metals. Concentrations of cadmium, copper, iron, lead and manganese all increase at

these two points. This data set has significant data gaps for certain metals including arsenic, silver, cyanide, mercury, nickel, selenium and zinc. No further analysis could be completed.

- **For the year of 2004 – Table 4.19**: Concentrations of cadmium, copper, iron, manganese and zinc spike at locations SVS 22 and SVS 26 during both spring and fall flow conditions indicating significant source areas. Lead also showed spiked (increased concentrations as compared to the location above) concentrations in the fall when there was less dilution associated with the Silver Creek flow. The actual amount of load contributed by SVS-26 constitutes a very small percentage of the total Silver Creek metals load. No trends were observed for silver and selenium, and chromium demonstrated fluctuating concentrations which were difficult to relate to any source area. There were data gaps for arsenic, cyanide, mercury and nickel. All of the metals that showed various increases (cadmium, copper, iron, lead, manganese and zinc) decreased in concentration at the lowest sampling location which is immediately prior to Silver Creek's release into the Dolores River (similar to the trend observed in 2002). This indicates that Silver Creek has an assimilative capacity created by increased flow (dilution) and buffering capacity (leant by travel time and distance, and increased hardness and possibly alkalinity).

Results of the Silver Creek hazard quotient analysis indicate that there are source areas within this catchment that are releasing metals into solution. These source areas seem to routinely be associated with the Argentine tailings seep area, and an unnamed adit below the Argentine, but above the Dolores River confluence. There is an assimilative capacity within the water quality of Silver Creek that provides significant dilution and buffering of these metals concentrations. Metals levels at the point of release are typically at levels of low to no concern. The only metal that poses a potential risk to aquatic life is zinc (which yields HQs of 3 to 8 as compared to chronic AWQC values). There are data gaps for certain metals and for certain flow regimes which makes these conclusions uncertain. There is the need for further analysis to delineate the source areas more thoroughly. [Additional information provided by Atlantic Richfield indicates that "Analyses performed as part of the St. Louis Ponds water quality assessment indicate that appropriate and protective permit limits can be established for the St. Louis Ponds discharge without specifically accounting for the metals loadings from Silver Creek to the Dolores River (like the minor seep/adit loadings discussed elsewhere). It is also recognized that there is a TMDL process initiated for Silver creek that will appropriately examine water quality issues and identify potential best management practices.]

Dolores River

The sampling locations along the Dolores River changed over time. In general, there were routinely available sample results from locations above, adjacent to and below the St. Louis ponds; above the Silver Creek confluence, directly associated with nonpoint and point releases associated with features such as the Columbia tailings, Santa Cruz adit,

Rico Boy adit and the Swan adit, and one location occurred below gradient that captured the water quality condition of the entire system. The locations sampled varied by year and appear to be associated with the work completed on the Columbia tailings, Santa Cruz and Rico Boy adits. The combined flows of the adits are routed into a settling pond, then a wetland. The locations sampled by year appeaer to vary depending upon where flow occurred within the pond and wetland setting. Results were evaluated by year as follows;

- **For the year of 2002- Table 4.20, and Figures 4.7 and 4.8** demonstrates the change in iron, manganese and zinc at each sampled location during high and low flow. The water quality 'above' the footprint of the mining area (which begins with the St. Louis tunnel and settling ponds) is of good quality, but contains low levels of cadmium, iron, manganese and mercury indicating natural sources of these metals. The St. Louis tunnel and settling pond outfall contributes iron and manganese to the Dolores River. These concentrations are slight however. Distinct spikes in iron, manganese and zinc are observed during both high and low flow conditions for the Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet, and the Silver Swan adit. Significant copper releases occur during high flow indicating a surface water carriage/source related condition, while cadmium demonstrates a chemistry that appears to be groundwater related (and of concern during low flow conditions). In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the Columbia, Rico Boy, Santa Cruz and Swan mine areas. There were no trends observed for cyanide and nickel, and there are data gaps for mercury and arsenic.

- **For the year of 2003 - Table 4.21 and Figure 4.9** demonstrates the change in iron, manganese and zinc at each sampled location during low flow. There was only data available for fall, low flow conditions. Water quality 'above' the footprint of the mining area is of good quality, but contains low levels of chromium, copper, iron, manganese, mercury, selenium and zinc indicating natural sources of these metals. The St. Louis tunnel and settling pond outfall contributes cadmium, chromium, iron, manganese, mercury and zinc to the Dolores River. Distinct spikes in iron, manganese and zinc are observed for the Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet, and the Silver Swan adit. Cadmium and zinc also demonstrate a spike at the Rico Boy/Santa Cruz combined flow outfall. Increased concentrations of copper were associated with the Columbia and Silver Swan adits. Copper and manganese demonstrate a steady gain during these low flow conditions, beginning at a location adjacent to the settling ponds. This indicates that there are several possible sources (natural, groundwater seepage and surface water carriage). In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the

Columbia, Rico Boy, Santa Cruz and Swan mine areas. There were no trends observed for chromium, lead, silver and selenium and there are data gaps for arsenic, cyanide, mercury and nickel.

- **For the year of 2004 – Table 4.22 and Figures 4.10 and 4.11** demonstrates the change in iron, manganese and zinc at each sampled location during high and low flow. The water quality above the footprint of the mining area is of good quality, but contains low levels of arsenic, iron, manganese, mercury, selenium and zinc indicating natural sources of these metals. The St. Louis tunnel and settling pond outfall contributes iron, manganese and zinc to the Dolores River. Distinct spikes in iron, manganese and zinc are observed during both high and low flow conditions for the St. Louis outfall, Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet(s), and the Silver Swan adit. Significant cadmium, copper, manganese and zinc releases occur during high flow from the Rico Boy/Santa Cruz mine. Cadmium and lead demonstrate a chemistry that appears to be groundwater related (and of concern during low flow conditions). In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the Columbia, Rico Boy, Santa Cruz and Swan mine areas. There were no trends observed for chromium, selenium and silver, and there are data gaps for lead, mercury, nickel and arsenic.

The results demonstrate some similar trends each year. Certain metals steadily gain during low flow conditions indicating a groundwater related source mechanism. These concentrations are subtle and of little to no concern to exposed aquatic life. There are distinct source areas and metals that are associated with them. For instance, copper and zinc are typically associated with both high and low flow releases from the Rico Boy/Santa Cruz combined flow. Iron and manganese are associated with the St. Louis outfall, Columbia, Rico Boy/Santa Cruz and Silver Swan. These trends were observed typically each year. There are data gaps for certain metals and inconsistent trends for others. The reach from the St. Louis to Silver Creek represents a data gap and an area that may be contributing groundwater related metals. The areas below Silver Creek to the Silver Swan appear well characterized and highlight source areas requiring further study.

CZI Discussion

Table 4.23 provides a summary of the calculated CZI values by sampling season (and year) and location. Values greater than 1 indicate the need for further evaluation, since the measured concentrations of copper and zinc occur above benchmarks protective of aquatic life. Results are described by drainage area (St. Louis tunnel and outfall, Silver Creek and the Dolores River) as follows;

- Results for the St. Louis outfall and tunnel indicate that copper and zinc levels are of potential concern at both the tunnel and the outfall. These results are consistent each year and coincide with the HQ results previously described.

- Results for Silver Creek highlight the need to further evaluate the unnamed adit (identified by SEH as being located below the overhead tramway) and the Argentine seep. Consistently elevated levels are associated with both of these locations.

- Results for the Dolores River sampling areas indicate that there is a need to evaluate the copper and zinc releases associated with the Rico Boy/Santa Cruz outfall areas. The measured values yield CZI levels above 1 every year where sufficient information was available.

In summary, the CZI findings support the Hazard Quotient (HQ) discussion in the previous subsection. The same source areas are highlighted for each drainage area. These results indicate the need for further evaluation of the water quality associated with these sources.

Loading Discussion

Loading was calculated for a data set from 1997, and the SEH datasets from 2002, 2003 and 2004. The data sets from 2002 forward were evaluated to determine current trends, and were compared to the 1997 data to determine temporal (change over time) trends. The individual sample analysis results in a given data set (i.e. from the low flow sampling of 2003) were used to determine load from specific sources and the trend of metals gain or loss over distance.

The following first describes 'temporal' trends as observed from 1997 to 2002, 2003 and 2004 data set comparisons, and then individual year loading analysis. For a loading analysis to be accomplished, co-located water sample results for metals and flow need to be gathered. Such was not always the case within these data sets. There were significant uncertainties associated with each data set. These uncertainties are described within each subsection. <u>There were enough combined uncertainties to lend to the formulation of the recommendation to gather a comprehensive watershed scale monitoring effort.</u>

<u>Temporal Trends</u>

Table 4.24 provides a comparison of individual metal loading units (lb per cfs) for iron, manganese and zinc from two locations within the Dolores River that occur above the Columbia tailings (DR-2-SW) and below the Swan adit (DR-4-SW). These two locations had consistently available data for the metals and for flow, and represent Dolores River water quality conditions. Unfortunately there were no consistent data further above within the Dolores River, or below; therefore this analysis brackets the load within the

impacted area of the Dolores River, and captures and load contributed by the St. Louis tunnel, and outfall and Silver Creek. None-the-less, this information does provide at least a snap shot of the potential changes that have occurred since 1997. Results indicate

- **Iron**: Comparison of iron load from the upstream (DR-2-SW) to the downstream (DR-4-SW) location has shown increased load during 1997, 2003 and 2004. The rates of increase for these years were comparable (0.31, 0.27 and 0.30) indicating that there has been little to no measurable decrease in load over this span of time. There was a slight decrease measured from upstream to downstream in 2002. This may be due to uncertainty associated with flow measurements, or low flow releases due to the drought conditions.

- **Manganese**: Comparison of manganese load from the upstream to downstream location has shown increased load during all years (1997, 2002, 2003 and 2004). The year 2002 demonstrated a significantly low rate of increased load. Similar to iron, this may be attributable to the affects related to the drought. The years 1997, 2003 and 2004 all had similar measures of load increase indicating that there has been little to no measurable decrease in load over this span of time.

- **Zinc**: Comparison of zinc load from the upstream to downstream location has shown increased load during all years (1997, 2002, 2003 and 2004). The year 2002 demonstrated a significantly low rate of increased load. Similar to iron and manganese, this may be attributable to the affects related to the drought. The years 1997 and 2003 had similar measures of load increase indicating that there has been little to no measurable decrease in load over this span of time.

Results from the temporal analysis indicate that that iron, manganese and zinc load has been erratic over the years. The comparison of these datasets does not demonstrate a trend towards depletion. The amount of these metals fluctuates significantly, and does not show any steady decline. This may demonstrate that metals load has not decreased as a result of any mine-related remedy efforts completed to-date need to further evaluate remedy efforts and construct additional remedy efforts to control these loads.

Individual Annual and Location Trends

Further analysis of load by location, by event and year is as follows;

- **For the year of 2002**: **Figure 4.7 and 4.8** demonstrates the change in iron, manganese and zinc load at each sampled location during high and low flow. There are uncertainties associated with the data sets from 2002 as follows;

  - ✓ **Both sampling events represent low flow conditions**. Flows during July, 2002 and October, 2002 are comparable. Therefore, there is no true

high flow sampling event within this data set. This may be due to the fact that this was a significant drought year which yielded very minimal spring-melt flows.

- ✓ **For the July, 2002 data set, there is a lack of flow information for key locations which bracket the water quality footprint of effects associated with the St**. Louis tunnel (missing flow data for DR 20, DR 2, DR 7, DR 6 and DR 3). This again, may be due to the fact that this was a significant drought year, and flows were at a minimum and perhaps difficult to measure.

Results from the 2002 sampling events were difficult to interpret due to the uncertainties associated with them for both the July and October sampling events. The results from the July effort did not capture the Upper Dolores setting surrounding the St. Louis tunnel (flow measures were lacking) therefore no conclusions were drawn. The July results from the lower Dolores River capturing the Rico Boy/Santa Cruz (combined adit release) and Silver Swan indicate that these two point sources are potentially significant sources of zinc load, however the percent contribution could not be determined due to a lack of flow measurements at points downstream of these releases. Results from the July Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient. It is unknown as to how much load Silver Creek contributed to the Dolores River due to the lack of flow data at the sampling location immediately down-gradient (DR-2-SW).

For the October, 2002 sampling event results for the upper Dolores which captures the St. Louis ponds were lacking information for sample points adjacent to the ponds. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. Due to the lack of zinc data below the outfall (from DR 7) the load contribution to the Dolores River could not be determined. Review of sample results around the confluence of Silver Creek identify an error in the flow measurements. There is roughly a 5 lb contribution of zinc that is unaccounted for between the Silver Creek outfall, and the sampling point representing the Silver Creek mixing zone (2-SW). The October results from the lower Dolores River capturing the Columbia tailings, Rico Boy/Santa Cruz (combined adit release) and Silver Swan indicate that these sources contain significant metals load, but it is controlled by the wetlands which buffer their release to the Dolores River. Results from the October Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient, but remains a

significant source to the Dolores River with a percent contribution of zinc at 25% 2.19 lbs of 8 lbs measured at DR-2-SW).

- **For the year of 2003**: **Figure 4.9** demonstrates the change in iron, manganese and zinc load at each sampled location during low flow. There are uncertainties associated with the data sets from 2003 as follows;

  - ✓ **Only one sampling event representing low flow conditions was captured**. This sampling event blended from October through December which introduces a temporal uncertainty. The sampling likely represents several time periods and may have limits to its comparability.

  - ✓ **For the 2003 data set, there is a lack of flow information for key locations which bracket the water quality footprint of effects associated with the St. Louis tunnel** (missing flow data for DR 20 and DR 2, and zinc analysis for DR 20 and DR 2).

  For the October through December, 2003 sampling event results for the upper Dolores which captures the St. Louis ponds were lacking information for sample points adjacent to the ponds. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. The background load of 0.59 lbs of zinc is significantly less than the zinc load of 3.65 lbs at DR 7 which occurs just below the St. Louis outfall. This increased load equates to an 83% zinc load contribution attributable to the St. Louis site. Review of sample results around the confluence of Silver Creek identify Silver Creek as a significant contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 5.65 lbs of the measured 11 lbs, contributing 51% of the load. The results from the lower Dolores River capturing the Columbia tailings seep, Rico Boy/Santa Cruz (combined adit release), and the Silver Swan indicate that these sources release are significantly diluted by Dolores River flows, but are contributing to the total load within the River. The wetlands area that captures the Rico Boy/Santa Cruz is essential to the control of metals releases from these combined adit flows which contain high concentrations and load of metals. Similarly, the Silver Swam flows and metals load are significantly controlled by the wetlands that occur between the adit and the Dolores River. These results emphasize the importance of the wetlands buffer zone associated with these point discharges. The load contribution attributable to the Columbia seems very slight, yet measurable. It is apparent that the tailings seep is an ongoing contributor to the zinc load. Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

- **For the year of 2004: Figures 4.10 and 4.11** demonstrates the change in iron, manganese and zinc load at each sampled location during high and low flow. There are uncertainties associated with the data sets from 2004 as follows;

  - ✓ **For the 2004 data set, there is a lack of flow information for key locations and some error in the flow measurements** (missing flow data for DR 2, and zinc analysis for DR 20 and DR 2). The measured flow levels are higher up-gradient than in down-gradient areas which indicate a possible error in the values.

  - ✓ **December was the determined time period from which low flow conditions were sampled. This time period does not represent true low flow conditions since snow melt can dilute the samples and affect measured flow rates.**

  - ✓ **The measured values of zinc from the locations within the Dolores River (specifically DR 1, DR 20 and DR 2) are suspect.** The results indicate below detection limit values for zinc, which is unlikely for this particular element. Further analysis of the analytical records needs to be conducted to determine if the detection limits were suitably low.

  Results from the 2004 sampling events were the most valuable dataset since there were two distinct flow events captured, with relatively comprehensive information being obtained. For the April, 2004 sampling event results for the upper Dolores - St. Louis ponds is lacking information from locations adjacent to the ponds. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. The background load of 6 lbs of zinc is significantly less than the zinc load of 16.8 lbs at DR 7 which occurs just below the St. Louis outfall. This increased load equates to 64% zinc load contribution attributable to the St. Louis site. Review of sample results around the confluence of Silver Creek identify Silver Creek as a potentially significant contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 17 lbs of zinc, however only 9.95 was measured at the confluence indicating a significant dilution provided by the Dolores River. The results from the lower Dolores River capturing the Columbia tailings seep, Rico Boy/Santa Cruz (combined adit release), and the Silver Swan indicate that these source releases are significantly diluted by Dolores River flows, but are contributing to the total load within the River. The wetlands area that captures the Rico Boy/Santa Cruz is essential to the control of metals releases from these combined adit flows which contain high concentrations and load of metals. Similarly, the Silver Swam flows and metals load are significantly controlled by the wetlands that occur between the adit and the Dolores River. The load contribution attributable to the Columbia seems very slight, yet potentially significant (with a load of 26 lbs associated with its flow). Of particular interest are the results from the lower-most Dolores River sampling location (DR-4-SW) which yielded very

elevated zinc load levels (53 lbs). Looking up-gradient, it is difficult to identify the sources with the information available. During a site visit, fluvial tailings were observed along this reach and may be a nonpoint source area. The results from DR-4-SW highlight the need for 'point of release' results for the Silver Swan, and from locations within the Dolores River channel above and below point releases. Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

For the December, 2004 sampling event results for the upper Dolores which captures the St. Louis ponds yielded below detection results for zinc for sample points adjacent to the ponds. Zinc is a common metal that typically occurs in most natural waters at detectable levels. These results may be accurate, but seem suspect. Further analysis of the original analytical records needs to be reviewed to determine if the analytical detection limits are suitably low. Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. The background load of 'non-detect levels' or '0' load lbs of zinc is significantly less than the zinc load of 24 lbs at DR 7 which occurs just below the St. Louis outfall. This increased load equates to 240% zinc load contribution attributable to the St. Louis site. Review of sample results around the confluence of Silver Creek identify Silver Creek as a minimal contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 1.38 lbs of the measured 29 lbs, contributing 5% of the load. This indicates that the high flow conditions within the Dolores (possibly due to snow melt), dilute the effects of the very low flows within Silver Creek, and carry the most significant load of zinc within the Dolores River flows themselves. This may be an artificial representation of true low flow conditions given the dilution created by the snow melt. The results from the lower Dolores River capturing the Columbia tailings seep, Rico Boy/Santa Cruz (combined adit release), and the Silver Swan indicate that these source releases are significantly diluted by Dolores River flows, but are contributing to the total load within the River. The wetlands area that captures the Rico Boy/Santa Cruz is essential to the control of metals releases from these combined adit flows which contain high concentrations and load of metals. Similarly, the Silver Swam flows and metals load are significantly controlled by the wetlands that occur between the adit and the Dolores River. The load contribution attributable to the Columbia seems very slight, yet measurable. Of particular interest are the results from the lower-most Dolores River sampling location (DR-4-SW) which yielded very elevated zinc load levels (40 lbs). Looking up-gradient, it is difficult to identify the sources with the information available. The results from DR-4-SW highlight the need for 'point of release' results for the Silver Swan, and from locations within the Dolores River channel above and below point releases. Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and

zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient.

Results of the above indicate the following trends by nonpoint and point source feature;

- The St. Louis settling ponds are losing water to either or both the Dolores River or the groundwater. As shown in **Tables 4.25 and 4.26** there are measured flow losses between the tunnel (DR 3) and the point of discharge (DR 6) to the Dolores River. As shown in **Table 4.25**, the amount of flow loss ranges from 38 to 85 % and indicates that the ponds are not capturing and containing all of the tunnel flows. It is unknown of the waters are seeping directly from the ponds to the Dolores River, or into the underlying groundwater which will also release to the Dolores River. This is a significant concern given the water quality associated with the tunnel water. These results indicate that the St. Louis tunnel and associated settling ponds are a potentially significant contributor of metals load to the Dolores River. As shown in **Table 4.26**, there is a metals load loss that is likely, largely attributable to the settling ponds, but also may be an indication of load lost to the Dolores River. These results indicate the need for addition remedy efforts to capture and control the tunnel water.

- The Rico Boy/Santa Cruz mine sites have had a VCUP action that has consolidated the mine waste, capped the materials and tried to control adit flows as well as run-on and run-off *Stormwater* flows. At the time of the production of this document, these sites were visited and observed during both high and low flow settings (further described in **Sections 6 and 7**). The adit flows from these two mines, are combined and routed into a singular settling pond. From there, the flows go into a well-vegetated wetland before entering the Dolores River. This setting creates a combination of both point and nonpoint sources of water contamination as related to these sites. The water quality information indicates that the settling pond and wetlands are serving as a good buffer to controlling metals releases from the mines to the River. Wetlands however, have a seasonal limitation during winter conditions when the vegetation dies back and can not serve as a buffering capacity. The water quality released from these mines is of concern and is causing degraded water quality within the Dolores River. This system needs to be further evaluated and reviewed in regards to the effectiveness of the current remedy.

- The Columbia tailings are a significant body of tailings that has had a VCUP associated with it. Historic information indicates that a side channel associated with these tails had significantly degraded water quality. The current conditions regarding this site are not known and need review. It is likely that the VCUP cap has curtailed a significant amount of nonpoint source from this feature, however

further study may be required in order to determine if any further action is needed.

- Silver Creek contains a number of mine-site related features requiring further evaluation and possible remedy. A significant amount of VCUP work has been completed with the Argentine tunnel and tailings. There remains however, a significant seep from the tailings that runs parallel and eventually reaches a confluence with Silver Creek. This seep is a source of metals and is a water quality concern. Further down-gradient, as per SEH study and findings, there is an unnamed adit that releases significantly degraded water quality into Silver Creek. The underground workings and setting related to this feature are unknown and require further evaluation. Silver Creek does appear to have an assimilative capacity in that a significant portion of the metals load from these up-gradient sources is abated over distance. This is likely due to increased flows creating dilution and perhaps due to improved buffering capacity. Further evaluation of the load contribution contributed by Silver Creek during different flow regimes is required.

- The Silver Swan Mine is similar to the Rico Boy/Santa Cruz mine sites in that it has received much attention in the form of VCUP actions and investigative studies. This site also is a mix of nonpoint and point source releases to the Dolores River. This Site has the capacity to release significantly degraded water quality to the Dolores River and does not have as much of a wetlands buffered capacity as the Rico Boy/Santa Cruz. Further study and evaluation of the VCUP remedy effectiveness is required.

- There are other potential mine-related nonpoint sources such as mines located above the St. Louis ponds, the Propatria Mill Site etc. that may be contributing slight metals load increases. A thorough loading analysis within the Dolores River Channel is needed in order to tease out the possible contributions associated with these sites.

Potential Future Issues

The potential future water quality issues are summarized as follows;

- Unless the mine-site related nonpoint and point sources are controlled or abated, the metals loading and resulting concentrations will continue and remain an issue. Of particular concern is the potential for the St. Louis ponds to breach their containment and release significant amounts of precipitated metals downstream into the Dolores River. Of secondary concern are the point sources related to the unnamed adit within Silver Creek, the Rico Boy/Santa Cruz outfall, and the Silver Swan, and the nonpoint sources related to the Argentine tailings seep (within Silver Creek) the Columbia tailings area and combined groundwater discharge to the Dolores River.

- There are other potential future impacts associated with the planned WWTP discharge (discussed in the following Section) as well as uncontrolled nonpoint sources related to stormwater releases (discussed in **Section 6**).

4.5 Summary of Recommendations

This Section served the purpose of locating and evaluating all available information that describes the water quality setting within the *Project area*. The Section began with an overview of the regulatory applications and presents the current water quality standards that apply to the designated uses and designated segments of streams and the Dolores River. As described, the regulations are still in a state of 'flux' and would benefit from the information provided within this document, as well as the contributions provided by the Town of Rico.

This Section goes on to compile the available information and use it to determine existing water quality conditions. As summarized previously, there have been a significant number of studies completed, however each served their own distinct purpose. It was only until the SEH data collection efforts were completed, that a more 'watershed-scale' level of information was obtained. It was these SEH data sets that were ultimately relied upon to characterize the water quality setting. These data sets however, were very focused in their footprint of activity (starting above the St. Louis ponds and terminating just below the Silver Swan adit) which leaves significant portions of the *Project area* without characterization (pending data gap).

Results of the SEH studies assisted significantly in the identification of metals-contaminant related source areas. As shown from the hazard quotient, CZI and loading analysis, The St. Louis ponds, and Silver Creek are significant contributors as a whole to the metals load within the Dolores River. Detailed analysis reveals that the ponds are very effective at controlling the amount of metals released to the River. Silver Creek has at least two uncontrolled source areas associated with the Argentine tailings seep and the unnamed adit below the overhead tramway. The Dolores River has several point sources (Rico Boy, Santa Cruz and the Silver Swan) and nonpoint sources (Columbia tailings and groundwater) of potential concern. The effect of these combined sources to downstream areas is unknown due to the lack of available data.

The recommendations for the Town of Rico as a result of these findings are as follows;

- The Town needs to retain their involvement with ongoing private and CDPHE investigative studies that will fold into regulatory applications (closure of the St. Louis, further mine site study and potential closure, TMDL development).

- A comprehensive watershed-scale monitoring program needs to be developed that characterizes the sub-basin watershed as a whole, and captures more up-gradient and down-gradient areas, as well as other tributaries (such as Horse Creek, Aztec gulch and others) that have known mining areas. There are also mine sites with seeps (Mountain Springs mine etc., which are described in **Sections 6 and 7**) that need further characterization. It is recommended that the Town formulate a field sampling plan for a comprehensive watershed characterization effort, to be completed during high and low flow conditions for years to come. The information will be invaluable in regards to regulatory processes (i.e. TMDL development, Section 208 and 319 requirements) and public information.

- This Section identified the need to fill data gaps (such as those described in the previous bullet) that include the need to characterize sediment. Sediment analysis represents a significant data gap in the understanding of the condition of the *Project area*. Very little information has been gathered to-date in regards to this important medium that can act as a source of contaminant release, be a significant exposure medium to aquatic life, and present a concern to the overall health of the aquatic ecosystem. It is highly recommended that a sediment sampling regime be constructed so as to capture the sediment quality conditions throughout the watershed. This effort should be combined with the comprehensive watershed sampling effort described in the previous bullet, in order to capture co-located water and sediment quality characteristics. This information will be useful in understanding the relationship of water quality to sediment quality.

- The final recommendation is associated with focusing study and potential remedy efforts towards those source areas identified in the water quality characterization. It is possible for the Town to embark upon their own suite of studies, and potentially remedy efforts if desired. There are funding and regulatory resources available to pro-active community efforts. There are numerous examples of successful pro-active projects being completed throughout the State of Colorado, and there is currently legislature being passed that will enable pro-active efforts in the future. It is highly recommended that the Town take a proactive stance in addressing some of the identified source areas contributing metals load to the Silver Creek catchment and the Dolores River.

TABLES

Table 4.1 Agricultural and Domestic Water Supply Water Quality Standards (source; CDPHE, 2002).

Parameter	Agricultural Standards	Domestic Water Supply – Drinking Water Standards
Aluminum (Al)	5 mg/L	
Antimony (Sb)		0.006 mg/L
Arsenic (As)	0.1 mg/L	0.05 mg/L
Barium (Ba)		2.0 mg/L
Beryllium (Be)	0.1 mg/L	0.004 mg/L
Boron (B)	0.75 mg/L	
Cadmium (Cd)	0.01 mg/L	0.005 mg/L
Chromium (Cr)	0.1 mg/L	0.1 mg/L
Cobalt (Co)	0.05 mg/L	
Copper (Cu)	0.2 mg/L	1 mg/L
Cyanide [Free] (CN)		0.2 mg/L
Iron (Fe)	5 mg/L	0.3 mg/L
Fluoride (F)	2 mg/L	4.0 mg/L
Lead (Pb)	0.1 mg/L	0.05 mg/L
Manganese	0.2 mg/L	0.05 mg/L
Mercury [Inorganic] (Hg)	0.01 mg/L	0.002 mg/L
Nickel (Ni)	0.2 mg/L	0.1 mg/L
Nitrate (NO3)	100 mg/L as N	10.0 mg/L as N
Nitrite (NO2)	10 mg/L as N	1.0 mg/L as N
Selenium (Se)	0.02 mg/L	0.05 mg/L
Silver (Ag)		0.05 mg/L
Vanadium (V)	0.1 mg/L	
Thallium (Tl)	2 mg/L	0.002 mg/L
Zinc (Zn)		5 mg/L

Table 4.2. Stream Classifications and Water Quality Standards by Project Area Segment. (source; CWQCC, 2002) pg. 1/3.

Segment and Desig.	Classifications	Numeric Standards					
		Physical and Biological	Inorganic (mg/l)		Metals (ug/L)		
1. OW	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
2.	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac/ch)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
3.	Aq Life Cold 1 Recreation 1a Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ch)=100(Trec) Cd(ac)=TVS Cd(ch)=TVS CrIII(ch)=100(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
4.	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
5	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS

Table 4.2 Stream Classifications and Water Quality Standards by Project Area Segment. (source; CWQCC, 2002) pg. 2/3.

Segment and Desig.	Classifications	Numeric Standards					
		Physical and Biological	Inorganic (mg/l)		Metals (ug/L)		
6	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
7	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
8	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05 NO_3=10 Cl=250 SO_4=WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(tot) Ni(ac/ch)=TVS	Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
9	Aq Life Cold 2 Agriculture Nov. 1 to April 30, 2006 Recreation 2 May 1 to Oct. 31 Recreation 1a	D.O. = 6.0 mg/L D.O. (sp) = 7.0 mg/L pH = 6.5 – 9.0 Nov. 1 to April 30 F. Coli = 2000/100ml E. Coli = 630/100ml May 1 to Oct. 31 F. Coli = 200/100ml E. Coli = 126/100ml	NH_3(ac)=TVS NH_3(ch)=0.02 Cl_2(ac)=0.019 Cl_2(ch)=0.011 CN=0.005	S=0.002 B=0.75 NO_2=0.05	As(ac)=100(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=100(Trec) CrVI(ac/ch)=TVS	Cu(ac/ch)=TVS Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS

Table 4.2 Stream Classifications and Water Quality Standards by Project Area Segment. (source; CWQCC, 2002) pg. 3/3.

Footnotes

Segment Description

1. All tributaries to the Dolores River and West Dolores River, including all wetlands, tributaries, lakes, and reservoirs, which are within the Lizard Head Wilderness area.
2. Mainstem of the Dolores River from the source to a point immediately above the confluence with Horse Creek.
3. Mainstem of the Dolores River from a point immediately above the confluence with Horse Creek to a point immediately above the confluence with Bear Creek.
4. Mainstem of the Dolores River from a point immediately above the confluence with Bear Creek to the bridge at Bradfield Ranch (Forest Route 505, near Montezuma/Dolores County Line) includes McPhee Reservoir and Summit Reservoir.
5. All tributaries to the Dolores River and West Dolores River, including all wetlands, lakes and reservoirs, from the source to a point immediately below the confluence with the
   West Dolores River except for specific listings in Segments 1 and 6.
6. Mainstem of the Slate Creek and Coke Oven Creek, from their sources to their confluences with the Dolores River.
7. Mainstem of Coal Creek from the boundary of the Lizard Head Wilderness Area to the confluence with the Dolores River.
8. Mainstem of Horse Creek from the source to the confluence with the Dolores River
9. Mainstem of Silver Creek from a point immediately below the Town of Rico's water supply diversion to the confluence with the Dolores River.

BOLD – There is a temporary modification for this reach: An)ch) = 670; with no acute Zn. Expiration date of 12/31/05, in addition to a fish ingestion advisory.

OW - Outstanding Waters

Table 4.3 Table Value Standard Criteria. (source; CWQCC, 2002)		
Parameter	Table Value Standards	Footnotes
Ammonia	Cold Water Acute = 0.43/FT/FPH/2 in mg/L Warm Water Acute = 0.62/FT/FPH/2 in mg/L	Assumed variable values provided in CDPHE WQCC, 2002.
Cadmium	Acute = (1.13667-[(ln hardness)*(0.04184)])*$e^{(1.128[\ln(hardness)]-3.6867)}$ Acute(Trout) = (1.13667-[(ln hardness)*(0.04184)])*$e^{(1.128[\ln(hardness)]-3.828)}$ Chronic = (1.10167-[(ln hardness)*(0.04184)])*$e^{(0.7852[\ln(hardness)]-2.715)}$	
Chromium III	Acute = $e^{(0.819\ln(hardness)]+2.5736)}$ Chronic = $e^{(0.819[\ln(hardness)]+0.5340)}$	Unless the stability of the chromium valence state in receiving waters can be clearly demonstrated, the standard for chromium should be in terms of chromium VI.
Chromium VI	Acute = 16 Chronic = 11	
Copper	Acute = $e^{(0.9422\ln(hardness)]-1.7408)}$ Chronic = $e^{(0.8454[\ln(hardness)]-1.7428)}$	
Lead	Acute = (1.46203-[(ln hardness)*(0.145712)])*$e^{(1.273[\ln(hardness)]-1.46)}$ Chronic = (1.46203-[(ln hardness)*(0.145712)])*$e^{(1.273[\ln(hardness)]-4.705)}$	
Manganese	Acute = $e^{(0.3331\ln(hardness)]+6.4676)}$ Chronic = $e^{(0.3331[\ln(hardness)]+5.8743)}$	
Nickel	Acute = $e^{(0.846\ln(hardness)]+2.253)}$ Chronic = $e^{(0.846[\ln(hardness)]+0.0554)}$	
Selenium	Acute = 18.4 Chronic = 4.6	Selenium is a bioaccumulative metal and subject to a range of toxicity values depending upon numerous site-specific variables.
Silver	Acute = 1/2$e^{(1.72[\ln(hardness)]-6.52)}$ Chronic = $e^{(1.72[\ln(hardness)]-9.06)}$ Chronic(Trout) = $e^{(1.72[\ln(hardness)]-10.51)}$	
Uranium	Acute = $e^{(1.1021[\ln(hardness)]+2.7088)}$ Chronic = $e^{(1.1021[\ln(hardness)]+2.2382)}$	
Zinc	Acute = $e^{(0.8473[\ln(hardness)]+0.8618)}$ Chronic = $e^{(0.8473[\ln(hardness)]+0.8699)}$	

Table 4.4 Water Quality Criteria Adjustments to Pertinent Project Area River Segments as per the CWQCC Triennial Hearing Results. (source; CDPHE CWQCC, 2006).

River Segment	Parameter Affected	2006 CWQCC Triennial Adjustment
All	Cadmium – Table Value Standard.	Revised hardness-based algorithms as follows: Acute = $(1.136672-[\ln(hardness) \times (0.041838)] \times e^{0.9151[\ln(hardness)]-3.1485}$ Acute trout = $(1.136672-[\ln(hardness) \times (0.041838)] \times e^{0.9151[\ln(hardness)]-3.1485}$ Chronic = $(1.101672-[\ln(hardness) \times (0.041838)] \times e^{0.7998[\ln(hardness)]-4.4451}$
All	Zinc – Table Value Standard	Acute = $0.978\ e^{(0.8525[\ln(hardness)]+1.0617)}$ Chronic = $0.986\ e^{(0.8525[\ln(hardness)]+0.9109)}$ If hardness is less than 113 mg/L CaCO3, then Chronic (sculpin) = $e^{(2.227[\ln(hardness)]-5.604)}$
Segment 3	Metals	Arsenic acute = 340 Arsenic chronic = 7.6
Segment 9	Metals	Arsenic acute = 340 Arsenic chronic = 7.6 Temporary modification for zinc was eliminated and replaced by the new Zinc – chronic (sculpin) table value standard.

Table 4.5 TMDL Listed Segments Relevant to the Project Area. (source; CDPHE, 2002).					
WBID	Segment Description	Portion	Parameters	Proposed Priority	Basis
COSJDO04[1]	Dolores River, Bear Creek to Bradfield Bridge	McPhee Reservoir	Hg	High	Hg Fish Consumption Advisory
COSJDO05	Tributaries to Dolores River and West Dolores River	Silver Creek above Rico drinking water diversion	Cd, Zn	High	No new data, 1998 303(d) List
COSJDO09	Silver Creek from Rico's diversion to Dolores River	All	Zn	High	Zn amb=668 ug/L, n=26, std=232 ug/L @ 222 mg/L hardness, WQCD 10780 [2]

Footnotes:

WBID :Water Body Identification Number. This number is assigned by the WQCD and is used to group and identify water bodies with the same classifications and standards. The WBID system is the primary way the WQCD identifies and segregates differing water bodies (streams, lakes, and wetlands) from each other in the State of Colorado. Within the 8-10 character alpha-numeric WBID are included the state, major river basin (Arkansas, Rio Grande, Colorado etc..), minor river basin, and segment number. Example: COARUA01A = Colorado, Arkansas Basin, Upper Arkansas River Basin Segment # 1A. For the purposes of this project area, there are two TMDL segments within the project area;

- ✓ COSJDO05 = Colorado, San Juan River Basin, Dolores River, segment 05, and
- ✓ COSJDO09 = Colorado, San Juan River Basin, Dolores River, segment 09.

There is one segment outside of the project area[1] , downstream;

- ✓ COSJDO04 = Colorado, San Juan River Basin, Dolores River, segment 04.

Segment Description: Describes the location and extent of the segment.

Portion : Describes the portion of the segment that is impaired or impacted.

Parameters : Identifies the assigned classified use and/or specific parameter for which the waterbody does not attain standards.

Priority Level: Indicates the proposed priority for TMDL completion as either "high", "medium", or "low".

Basis : Indicates the reason the segment was included in the List. Most listings are due to non-attainment of one or more parameter-specific numeric standards. In regards to the COSJDO09 segment, the basis is due to the water quality within Silver creek as having an ambient zinc concentration of 668 ug/L, measured from a dataset with 26 samples. This measured value exceeds the derived ambient water quality criteria of 232 ug/L (using a site-derived hardness of 222 mg/L and the WQCD rules presented in document number 10780) which indicates a concern in regards to the protected value of aquatic life within this drainage.

Table 4.6 ARCO Prepared VCUPs/NADs and their Status. (source; Matrix Design Group, 2004)					
Site Name	Location	VCUP or NAD	Description of VCUP or NAD Activity	Approval or Withdrawn	Date of VCUP Completion Report
ARCO: Columbia Tails I	West of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO; Columbia Tails II	West of Rico	VCUP	Inhibit water infiltration and create drainage controls + revegetate.	Approval	9/17/1999
ARCO; Grandview Smelter I	North of Rico	VCUP	Inhibit water infiltration and create drainage controls + revegetate.	Approval	1/1997
ARCO: Grandview Smetlter II	North of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO; Santa Cruz I	West of Rico	VCUP	Move waste away from water, stabilize rock and route water through retention pond.	Approval	1/1997
ARCO; Santa Cruz II	West of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO; Silver Swan I	Southwest of Rico	VCUP	Move waste away from water, stabilize rock and route water through retention pond.	Withdrawn	
ARCO; Silver Swan II	Southwest of Rico	VCUP	Move waste away from water, stabilize rock and route water through retention pond.	Approval	1/1997
ARCO; Silver Swan III	Southwest of Rico	NAD	No Action Petition	Approval	12/10/1999
ARCO: Agentine Tails I	Northeast of Rico	VCUP	Consolidation of dispersed tails + cap.	Withdrawn	
ARCO; Argentine Tails II	Northeast of Rico	VCUP	Consolidation of dispersed tails + cap.	Approval	1/1997
ARCO: Argentine Tails III	Northeast of Rico	NAD	No Action Petition	Approval	12/10/1999

Table 4.7 Available Zinc Assimilative Capacities and Zinc Contributions – Provided by CDPHE (2001). (as cited in Matrix Design Group, 2004).	
Maximum Assimilative Loading, Background and Facility Contributions at the 85th percentile.	Loading in pounds (lbs/day)
Acute Maximum Assimilative Loading	4.95
Background Allocation	-0.95
St. Louis Ponds Point Source Contribution	-17.81
Blaine Adit Point Source Contribution	-8.01
Argentine Seep Point Source Contribution	-3.75
Columbia Tailings seep Point Source Contribution	-4.81
Rico Boy Adit Point Source Contribution	-0.39
Santa Cruz Adit Point Source Contribution	-0.35
Silver Swan Adit Point Source Contribution	-0.48
Deficit	-31.60

Table 4.8 Summary of USGS Sample Information for the Project Area. (sources; USGS, 2006a and 2006b).							
Site Number	Site Name	Lat. & Long.	Available Data (# of samples)				
			Years (From – To)	Nutrients(1)	Major Inorganics(2)	Trace Inorganics(3)	Physical Properties(4)
Water Quality Sites							
09165000	Dolores River below Rico	37°38'20" 108°03'35"	1959 - 2004	2	3	3	438
374052108020700	Silver Swan Mine at Rico	37°40'52" 108°02'07"	1975	1	1	1	1
374228108013900	St Louis Tunnel at Rico	37°42'28" 108°01'39"	1975	1	1	1	1
374202108003300	Blaine Tunnel at Rico	37°42'02" 108°00'33"	1975	1	1	1	1
374645107563400	Dolores River above Snow Spur Creek, near Coke Oven	37°46'45" 107°56'34"	1971	-	1	1	1
374608107584800	Barlow Creek at mouth near Coke Oven	37°46'08" 107°58'48"	1971	-	-	1	1
Ground Water Sites							
374212108014201 NB04001125	Dolores County, HUC 1403002	37°49'36" 108°43'00"	1973 - 1983	-	-	-	5
374242108020501 NB04001123DDA1	Spring	37°42'12" 108°03'35"	-	-	-	-	-
374241108021501 NB04001126AAB	Dolores County	37°51'06" 108°17'28"	1982	-	-	-	2

Parameters by Category
(1) Nutrients – Nitratie plus nitrite, orthophosphate and phosphorous
(2) Major Inorganics – Calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride and Silica
(3) Trace Inorganics – Arsenic, cadmium, cobalt, copper, iron, lead, manganese, nickel, silver, zinc, selenium.
(4) Physical Properties: Flow/discharge, depth to water, temperature, specific conductance, pH

Table 4.9 Geothermal Springs Water Quality in 1995.
(source; URS/USEPA, 1996).

Location	Water Temp (oF)	pH	Conductivity (uS/cm)	Flow (gal/min)
Hot Tub Spring	107.9	6.60	7,280	30-50
2nd Hot Spring	107.3	6.66	7,080	15-20

Table 4.10 Summary of CGS Abandoned Mine Lands Ranking of Sites within the Project Area. (source; CGS, 1989). Pg. 1 of 2.

Priority Ranking*	Site	Features Associated with the Site	Feature EDR Value	Feature PHR Value
1	Mountain Spring Mine	Mine Shaft	2 (completely flooded and releasing 30 gpm of degraded water)	2
		85,000 yd^3 dump	1 (associated with shaft flows, reaches the Dolores River)	
		800 yd^3	3 (effluent from shaft crosses the top of the pile)	
		2,500 yd^3	3 (presence of sulfides)	
2	Nora Lily Mine	Open/barricaded adit	2 (degraded water quality, close proximity to Dolores River)	na
		70 yd^3 dump	2 (acid generating)	
		150 yd^3 dump	3 (potential acid generation)	
		350 yd^3 dump	3 (potential acid generation)	
4	Revenue Mine Area	350 yd^3	2 (suspected mill tailings with pyrite exhibiting phytotoxicity)	2
		750 yd^3 dump	3 (high concentrations of sulfide materials)	
		1,750 yd^3 dump	3 (high sulfide content, seep that communicates with gw → Silver Creek)	
		1,900 yd^3 dump	3 (0.5 gpm seep, high sulfide content)	
5	ABG Mine	10,000 yd^3 dumo	2 (precipitates present, located within riparian, has a small seep)	na
		Collapsed Adit	3 (28 gpm with yellow – orange precipitate)	
6	Johnny Bull Mtn.	350 yd^3 dump	2 (significantly degraded water quality and presence of oxidized drainage channels)	na
		Collapsed Adit	3 (degraded water quality parameters and presence of oxidized drainage channels)	
7	West End of Horse Gulch	Caved Adit	3 (thick, orange precipitate)	na
		Caved Adit	3 (orange precipitate)	

Tabl 4.10 Cont. . Summary of CGS Abandoned Mine Lands Ranking of Sites within the Project Area. (source; CGS, 1989). Pg. 2 of 2.

Priority Ranking*	Site	Features Associated with the Site	Feature EDR Value	Feature PHR Value
8	Aztec Mine and Gulch	Caved Adit	3 (degraded water quality and associated mine dump)	na
		Caved Mine	3 (extremely high concentrations of zinc)	
		1,500 yd^3 dump	3 (associated with Aztec Gulch)	
		Caved Adit	3 (degraded water quality)	
		950 yd^3 dump	3 (specular hematite, pyrite, malachite and manganese oxides)	
9	Middle CHC Hill	50,000 yd^3 dump	3 (uphill of Mtn. Spring, likely connected underground)	na
		750 yd^3 dump	3 (dump agregate, high sulfide content)	
11	North of Horse Creek	Collapsed Adit	3 (degraded water quality)	2
		Caved Adit	3 (75 gpm effluent with degraded water quality)	
		Caved Adit	3 (20 gpm effluent, communicates with lower adit)	
		Caved Adit	3 (10 gpm effluent, phytotoxicity on associated pile)	
12	Sambo Mine Area	Caved adit	3 (10 gpm of flow, contains precipitates)	2
		Partially caved adit	3 (< 1gpm flow)	
13	South of Aztec Gulch – North of Bemis Flats	Caved adit	3 (elevated zinc and manganese concentrations)	2
15	Bridgehead Mines	Adit	3 (1 gpm effluent with degraded water quality, affects down-gradient water quality)	na

Table 4.11 Analytical Data for Samples Collected from the Horse Creek Sub-basin by CGS. (source; Neubert, 2000).						
Parameter	NW-80 Horse Creek		NW-81 Horse Creek South		NW-82 Darling Ridge North	
	Conc./Meas. (and load in gms/day)	Standard	Conc./Meas. (and load in gms/day)	Standard	Conc./Meas.(and load in gms/day)	Standard
Flow (gpm)	150	n/a	100.0	n/a	23.0	n/a
pH	7.86	n/a	4.18	n/a	7.12	n/a
Conductivity (uS/cm)	198.0	n/a	298.0	n/a	449.0	n/a
Alkalinity (mg/L $CaCO_3$)	50.00	n/a	-	n/a	22.0	n/a
Hardness (mg/L $CaCO_3$)	191	None	159	None	399	None
Aluminum (trec) ug/L	<50	None	2,700 (1,471.8)	None	2,300 (288.4)	None
Antimony (trec) ug/L	<1.0	6.00	<1.0	6.00	<1.0	6.00
Arsenic (trec) ug/L	<1.0	50.00	<1.0	50.00	<1.0	50.00
Iron (trec) ug/L	15 (12.3)	1,000.00	400 (218)	1,000.00	830 (104.1)	1,000.00
Thallium (trec) ug/L	<1.0	0.50	<1.0	0.50	<1.0	0.50
Zinc (trec) ug/L	11 (9.0)	2,000.00	360 (196.2)	2,000.00	270 (33.0)	2,000.00
Aluminum (diss) ug/L	<50	87.00	2,700 (1,471.8)	87.00	<50	87.00
Cadmium (diss) ug/L	<0.3	1.88	2.9 (1.6)	1.64	2.2	3.36
Calcium mg/L	68 (55,600.2)	None	51 (27,800.1)	None	140 (17,552.2)	None
Chloride mg/L	<20.0	250.00	<20.0	250.00	<20	250.00
Chromium (diss) ug/L	<10.0	11.00	<10.0	11.00	<10	11.00
Copper (diss) ug/L	<4.0	20.51	160.0 (87.2)	17.62	6.0 (0.8)	38.59
Fluoride mg/L	0.26 (212.60)	2.00	0.65 (354.3)	2.00	0.57 (71.5)	2.00
Iron (diss) ug/L	<10	300.00	380 (207.1)	300.00	130 (16.3)	300.00
Lead (diss) ug/L	<1.0	9.70	<1.0	7.54	<1.0	27.66
Magnesium mg/L	5.00 (4,088.3)	None	7.80 (4,251.8)	None	12.00 (1,504.5)	None
Manganese (diss) ug/L	<4	50.00	3,600 (1,962.4)	50.00	2,500 (313.4)	50.00
Nickel (diss) ug/L	<20	155.98	<20	136.27	<20	273.69
Potassium mg/L	<1.0	None	1.3 (708.6)	None	1.2 (150.4)	None
Silicon mg/L	1.3 (1,062.9)	None	14.0 (7,631.4)	None	8.4 (1,053.1)	None
Silver (diss) ug/L	<0.2	0.23	<0.2	0.17	<0.2	0.81
Sodium mg/L	0.69 (564.2)	None	3.4 (1,853.3)	None	2.50 (313.4)	None
Sulfate mg/L	42 (34,341.3)	250.00	120 (6,5412.0)	250.00	190 (23,820.9)	250.00
Zinc (diss) ug/L	<10	182.99	390 (212.6)	157.41	200 (25.1)	342.50

Table 4.12 Summary of Available Data for Locations withinSilver Creek.									
Year	Analysis Completed by Location and Year (source: SEH, 2002)								
	SVS-1	SVS-1T	SC-2	SVS-22	SVS-12	SVS-8	SVS-5	SVS-26	SVS-20
1980	M, CI, N, Wq	–	–	–	–	–	–	–	–
1981	M, CI, N, Wq	–	–	–	–	–	F	–	F
1982	M, CI, N, Wq	–	–	–	–	–	F	–	F
1983	M, CI, Wq	–	–	–	–	F	–	–	F
1984	M, CI, Wq	–	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–	–	–
1986	–	–	–	–	–	–	–	–	–
1987	–	–	–	–	–	–	–	–	–
1988	–	–	–	–	–	–	–	–	–
1989	–	–	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–	–	–
1991	–	–	–	–	–	–	–	–	–
1992	M, CI	–	–	–	–	F	–	–	F
1993	–	–	–	–	–	–	–	–	F
1994	–	–	–	–	–	–	–	–	–
1995	–	–	–	–	–	F	F	–	–
1996	–	–	–	–	–	F	F	–	–
1997	–	–	–	–	M, Wq	M, Wq	M, Wq	–	M, Wq
1998	–	–	–	–	–	–	F, M, Wq	–	M, Wq
1999	M, Wq	–	M, Wq	–	–	–	M, Wq	–	F, M, Wq
2000	F, M, Wq	–	F, M, Wq	–	–	–	M, Wq	–	–
2001	–	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	–	–	F, M, Wq
2002	–	F, M, Wq	–	F, M, Wq	F, Hg, M, Wq	F, M, Wq	–	F, Hg, M, Wq	F, Hg, M, Wq
2003	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	M, Wq
2004	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	M, Wq
2005	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***
2006	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***	***uk***

Locations:

SVS-1 - Silver Creek, just below Town of Rico Water Supply Diversion
SVS-1T - Silver Creek, above Town of Rico Water Supply Diversion
SC-2 Blaine Adit Discharge
SVS-22 - Silver Creek, just upstream of Argentine Tailings Seep
SVS-12 - Argentine Tailings Seep
SVS-8 - Silver Creek, below Argentine tailings, just below culvert outfall
SVS-5 Below Blaine Tunnel
SVS-26 - Tramway discharge on Silver Creek
SVS-20 - Silver Creek, just above confluence with Dolores River

Footnotes:

– No analysis completed
F - Flow
Hg - Mercury
M - Metals - Inorganic constituents such as Cd, Cu, Mn, Zn and others. The list of analyzed constituents varies by location and year.
CI - Common ions such as sulfate, phosphate and others
N - nutrients such as nitrogen (measured by nitrate and nitrite), phosphororus
Wq - Water quality - includes measures of hardness, pH, Total suspended solids, total organic carbon and others.
uk - the suite of analysis to be completed by SEH is unknown.

Table 4.13 Summary of Available Data for Locations within the Dolores River.

Year	Above	St. Louis Tunnel Pond System			Dolores River up- and down-stream of 002		Below Bridge	Columbia Tailings Area		Santa Cruz/Rico Boy Area						Silver Swan Area			USGS Gauge
	DR-1	DR-3	DR-6	DR-20	DR-2	DR-7	DR-2-SW	DR-1-SW	DR-26	DR-27	DR-9-SW	DR-10-SW	DR-8-SW	DR-16-SW	DR-18	DR-7-SW	DR-6-SW	DR-4-SW	DRG
1980	F	F	F	F	–	F	F	–	–	–	–	–	F	F	–	–	–	–	F
1981	F	F	F	F	F	F	F	–	–	–	–	–	F	F	–	F	–	F	F
1982	F	F	F	–	–	F	F	–	–	–	–	–	F	F	–	F	–	F	F
1983	F	F	F	F	–	F	F	–	–	–	–	–	F	F	–	F	–	F	F
1984	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1985	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1986	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1987	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1988	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1989	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1990	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1991	–	–	F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1992	F	–	F	–	–	F	–	–	–	–	–	–	–	F	–	F	–	–	F
1993	F	–	F	–	–	F	F	–	–	–	–	–	–	–	–	–	–	F	F
1994	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	F
1995	–	F	–	–	–	–	F	–	–	–	–	–	F	F	–	F	–	F	F
1996	–	–	–	–	–	–	F	–	–	–	–	–	F	F	F	F	–	–	F
1997	–	–	–	–	–	–	M, Wq	F, M, Wq	–	–	M, Wq	–	F, M, Wq	M, Wq	M, Wq	F, M, Wq	M, Wq	M, Wq	F
1998	M, Wq	–	–	–	–	M, Wq	F, M, Wq	F, M, Wq	–	–	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	M, Wq	M, Wq	F
1999	M, Wq	M, Wq	M, Wq	–	M, Wq	M, Wq	–	–	–	–	–	–	–	–	–	–	–	–	F
2000	F, M, Wq	M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	–	–	–	–	–	–	–	–	–	–	–	–	F
2001	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	–	–	–	–	–	–	–	–	–	–	–	–	F
2002	F, Hg, M, Wq	F, Hg, M, Wq	F, Hg, M, Wq	M, Wq	F, M, Wq	F, Hg, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, Hg, M, Wq	F, M, Wq	–	–	–	–	F, M, Wq	–	F, Hg, M, Wq	F, M
2003	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	–	–	–	–	F, M, Wq	F	F, M, Wq	F, M
2004	F, M, Wq	F, M, Wq	F, M, Wq	–	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	F, M, Wq	–	–	–	–	F, M, Wq	–	F, M, Wq	F, M
2005	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*
2006	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*	*uk*

Locations:

DR-1 - Dolores River, above St. Louis Ponds
DR-3 - Tunnel Discharge
DR-6 - St. Louis Ponds 002 Discharge
DR-1 - Dolores River above St. Louis Ponds
DR-20 - Dolores River west of Pond 14
DR-2 - Dolores River, just upstream of 002 discharge
DR-7 - Dolores River, Downstream of 002 discharge
DR-2-SW - Dolores River, just Downstream of bridge
DR-1-SW - Dolores River side channel / Columbia Tailings seep
DR-26 - Dolores River between Columbia tailings seep and Rico Boy/Santa Cruz wetlands
DR-9-SW - Santa Cruz / Rico Boy Wetlands, east discharge
DR-10-SW - Santa Cruz / Rico Boy Wetlands, west discharge
DR-7-SW - Silver Swan Adit Discharge
DR-26 - Dolores River, between Columbia Tailings seep and Santa Cruz Wetlands
DR-27 - Santa Cruz / Rico Boy combined adit discharge
DR-6-SW - Silver Swan Wetlands Discharge
DR-4-SW - Dolores River downstream of Silver Swan
DR-8-SW - Santa Cruz Adit
DR-16-SW - Rico Boy Adit
DR-18-SW - Dolores River between Santa Cruz and Silver Swan
DRG - USGS Gauging Station below Rico

Footnotes:

– No analysis completed
F - Flow
Hg - Mercury
M - Metals - Inorganic constituents such as Cd, Cu, Mn, Zn and others. The list of analyzed constituents varies by location and year.
Cl - Common ions such as sulfate, phosphate and others
N - nutrients such as nitrogen (measured by nitrate and nitrite), phosphororus
Wq - Water quality - includes measures of hardness, pH, Total suspended solids, total organic carbon and others.
uk - the suite of analysis to be completed by SEH is unknown.

Table 4.14 2002 Metals Results as Compared to AWQC using HQ Analysis for the St. Louis Ponds.

Sampling Timeline	Metals (ug/L)	DR-3			DR-6		
		Detect	Std.	HQ	Detect	Std.	HQ
July 18-19, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	1.70	7.60	0	u	7.60	uk
	Cadmium (d)	13.00	9.80	1	u	11.52	uk
	Chromium (t)	9.80	382.63	0	1.60	458.34	0
	Copper (d)	20.00	88.64	0	3.00	109.10	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk
	Iron (t)	13900.00	1000.00	14	390.00	1000.00	0
	Lead (d)	16.70	20.36	1	u	25.22	uk
	Manganese (d)	2050	3216	1	505	3461	0
	Mercury (t)	u	0.01	uk	na	0.01	uk
	Nickel (d)	u	283.41	uk	u	341.52	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk
	Silver (d)	u	10.06	uk	u	14.69	uk
	Zinc (d)	3430.00	686.27	5	410.00	828.15	0
	Hardness mg/L	742			925		
October 6-9, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	2.10	7.60	0	u	7.60	uk
	Cadmium (d)	13.80	9.99	1	1.70	10.81	0
	Chromium (t)	u	391.05	uk	u	426.84	uk
	Copper (d)	30.00	90.88	0	u	100.52	uk
	Cyanide (t)	u	5.00	uk	u	5.00	uk
	Iron (t)	12000.00	1000.00	12	300.00	1000.00	0
	Lead (d)	13.20	20.90	1	u	23.19	uk
	Manganese (d)	1830	3245	1	296	3362	0
	Mercury (t)	0.00	0.01	0	0.00	0.01	0
	Nickel (d)	10.00	289.86	0	u	317.31	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk
	Silver (d)	0.18	10.53	0	u	12.65	uk
	Zinc (d)	2970.00	702.01	4	400.00	769.01	1
	Hardness mg/L	762			848		

Std. - water quality standard
HQ - hazard quotient
u - undetected
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.15 2003 Metals Results as Compared to AWQC using HQ Analysis for the St. Louis Ponds.

Sampling Timeline	Metals (ug/L)	DR-3			DR-6		
		Detect	Std.	HQ	Detect	Std.	HQ
October through December, 2003 Analysis Results (SEH, 2003)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	28.40	9.68	3	4.60	11.34	0
	Chromium (t)	0.80	377.55	0	0.10	450.20	0
	Copper (d)	20.60	87.28	0	6.40	106.87	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk
	Iron (t)	11600.00	1000.00	12	290.00	1000.00	0
	Lead (d)	17.40	20.04	1	0.60	24.69	0
	Manganese (d)	2170	3199	1	685	3436	0
	Mercury (t)	u	0.01	uk	0.0003	0.01	0
	Nickel (d)	u	279.53	uk	10.00	335.26	0
	Selenium (d)	0.20	4.60	0	0.90	4.60	0
	Silver (d)	u	9.78	uk	0.80	14.15	0
	Zinc (d)	5190.00	676.80	8	1120.00	812.87	1
	Hardness mg/L	730			905		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.16 2004 Metals Results as Compared to AWQC using HQ Analysis for the St. Louis Ponds.

Sampling Timeline	Metals (ug/L)	DR-3			DR-6		
		Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	19.96	6.22	3	7.73	6.22	1
	Chromium (t)	u	230.67	uk	u	230.67	uk
	Copper (d)	27.30	49.52	1	9.50	49.52	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk
	Iron (t)	3200.00	1000.00	3	302.00	1000.00	0
	Lead (d)	u	10.94	uk	u	10.94	uk
	Manganese (d)	1830	2618	1	1070	2618	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	u	168.04	uk	u	168.04	uk
	Selenium (d)	u	4.60	uk	1.39	4.60	0
	Silver (d)	u	3.47	uk	u	3.47	uk
	Zinc (d)	4180.00	405.26	10	1690.00	405.26	4
	Hardness mg/L	738			817		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	0.80	7.60	0	nd	7.60	uk
	Cadmium (d)	24.50	6.22	4	15.00	6.22	2
	Chromium (t)	0.50	230.67	0	u	230.67	uk
	Copper (d)	18.50	49.52	0	7.60	49.52	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk
	Iron (t)	11000.00	1000.00	11	1370.00	1000.00	1
	Lead (d)	u	10.94	uk	0.20	10.94	0
	Manganese (d)	2230	2618	1	2080	2618	1
	Mercury (t)	u	0.01	uk	u	0.01	uk
	Nickel (d)	u	168.04	uk	u	168.04	uk
	Selenium (d)	3.00	4.60	1	u	4.60	uk
	Silver (d)	u	3.47	uk	0.06	3.47	0
	Zinc (d)	4200.00	405.26	10	3140.00	405.26	8
	Hardness mg/L	680			732		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.17 2002 Metals as Compared to AWQC using HQ Analysis for Locations along Silver Creek.

Sampling Timeline	Metals (ug/L)	SVS-22			SVS-12			SVS-8			SVS-26			SVS-20		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
July 18-19, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	nd	7.60	0	0.80	7.60	0	nd	7.60	0	u	7.60	uk	nd	7.60	0
	Cadmium (d)	4.00	2.73	1	4.00	9.21	0	3.00	3.44	1	16.00	6.06	3	4.00	3.97	1
	Chromium (t)	u	92.46	uk	u	357.09	uk	0.10	119.40	0	u	224.04	uk	u	139.79	uk
	Copper (d)	2.00	17.30	0	2.00	81.87	0	2.00	23.21	0	51.00	47.88	1	2.00	27.83	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk
	Iron (t)	u	-	na	5780.00	-	na	90.00	-	na	14800.00	-	na	10.00	-	na
	Lead (d)	0.50	3.37	0	1.70	18.74	0	u	4.71	uk	40.70	10.55	4	0.50	5.78	0
	Manganese (d)	u	1805	uk	7200	3127	2	648	2003	0	10800	2587	4	12	2135	0
	Mercury (t)	u	0.01	uk	u	0.01	uk	nd	0.01	0	nd	0.01	0	u	0.01	uk
	Nickel (d)	u	65.35	uk	20.00	263.90	0	u	85.11	uk	u	163.05	uk	u	100.16	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.12	uk	u	2.04	uk	u	0.20	uk	u	0.77	uk	u	0.28	uk
	Zinc (d)	420.00	156.48	3	6110.00	638.67	10	940.00	204.19	5	8050.00	393.13	20	470.00	240.61	2
	Hardness mg/L	131			682			179			386			217		
October 6-9, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	nd	7.60	uk	u	7.60	uk	nd	7.60	uk	u	7.60	uk	u	7.60	uk
	Cadmium (d)	1.20	2.93	0	0.80	9.89	0	1.20	5.39	0	11.50	6.26	2	1.50	5.66	0
	Chromium (t)	u	99.91	uk	u	386.42	uk	u	196.56	uk	u	232.09	uk	u	207.75	uk
	Copper (d)	u	18.91	uk	u	89.65	uk	u	41.19	uk	70.00	49.87	1	u	43.90	uk
	Cyanide (t)	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk
	Iron (t)	80.00	-	na	4720.00	-	na	130.00	-	na	15200.00	-	na	20.00	-	na
	Lead (d)	1.00	3.73	0	u	20.60	uk	0.50	8.95	0	u	11.03	uk	0.30	9.59	0
	Manganese (d)	12	1863	0	5760	3229	2	269	2453	0	11400	2624	4	56	2509	0
	Mercury (t)	nd	0.01	uk	u	0.01	uk	nd	0.01	na	0.0006	0.01	0	0.0003	0.01	0
	Nickel (d)	u	70.80	uk	10.00	286.32	0	u	142.43	uk	30.00	169.10	0	u	150.81	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.14	uk	u	2.41	uk	u	0.58	uk	0.08	0.83	0	u	0.65	uk
	Zinc (d)	290.00	169.62	2	5070.00	693.36	7	490.00	343.07	1	8120.00	407.85	20	390.00	363.42	1
	Hardness mg/L	144			751			329			403			352		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
- no set standard
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value
na - HQ value does not apply because there is no set standard

Table 4.18 2003 Metals as Compared to AWQC using HQ Analysis for Locations along Silver Creek.

Sampling Timeline	Metals (ug/L)	SVS-1T			SVS-1			SVS-22			SVS-12			SVS-8			SVS-26			SVS-20		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
October through December, 2003 Analysis Results (SEH, 2003)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.56	uk	u	2.65	uk	2.20	3.06	1	0.40	9.31	0	1.60	3.14	1	9.70	6.58	1	1.60	3.86	0
	Chromium (t)	u	86.05	uk	0.10	89.56	0	0.40	105.00	0	0.20	361.38	0	0.20	107.80	0	0.10	245.68	0	0.20	135.55	0
	Copper (d)	0.60	15.93	0	0.80	16.68	0	3.10	20.02	0	6.10	83.00	0	3.00	20.64	0	187.00	53.24	4	2.60	26.86	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	u	-	na	u	-	na	350.00	-	na	3830.00	-	na	50.00	-	na	16300.00	-	na	20.00	-	na
	Lead (d)	u	3.07	uk	u	3.23	uk	0.30	3.99	0	u	19.01	uk	0.30	4.13	0	0.50	11.84	0	0.30	5.56	0
	Manganese (d)	u	1753	uk	u	1782	uk	59	1901	0	6480	3142	2	149	1921	0	9460	2686	4	48	2109	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	0.0004	0.01	0	0.0009	0.01	0
	Nickel (d)	nd	60.68	uk	nd	63.24	uk	nd	74.53	uk	nd	267.17	uk	nd	76.58	uk	nd	179.34	uk	nd	97.03	uk
	Selenium (d)	0.10	4.60	0	0.20	4.60	0	0.10	4.60	0	nd	4.60	uk	nd	4.60	uk	u	4.60	uk	0.30	4.60	0
	Silver (d)	u	0.10	uk	u	0.11	uk	u	0.16	uk	nd	2.09	uk	nd	0.16	uk	u	0.93	uk	u	0.27	uk
	Zinc (d)	u	145.20	uk	30.00	151.37	0	640.00	178.62	4	nd	646.65	uk	nd	183.58	uk	6530.00	432.74	15	560.00	233.02	2
	Hardness mg/L	120			126			153			692			158			432			209		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
- no set standard
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value
na - HQ value does not apply because there is no set standard

Table 4.19 2004 Metals as Compared to AWQC using HQ Analysis for Locations along Silver Creek.

Sampling Timeline	Metals (ug/L)	SVS-1T			SVS-1			SVS-22			SVS-12			SVS-8			SVS-26			SVS-20		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	nd	hard nd	uk	u	2.05	uk	2.16	2.34	1	1.74	12.01	0	2.32	2.65	1	10.52	6.08	2	3.05	3.48	1
	Chromium (t)	nd	hard nd	uk	u	67.37	uk	u	77.74	uk	u	480.14	uk	u	89.56	uk	0.40	224.99	0	u	121.04	uk
	Copper (d)	nd	hard nd	uk	2.95	12.02	0	7.10	14.17	1	4.70	115.09	0	5.15	16.68	0	509.00	48.12	11	7.10	23.58	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	nd	-	na	22.60	-	na	480.00	-	na	3720.00	-	na	504.00	-	na	16100.00	-	na	304.00	-	na
	Lead (d)	nd	hard nd	uk	0.204	2.22	0	0.20	2.68	0	0.70	26.63	0	0.10	3.23	0	3.74	10.61	0	0.41	4.80	0
	Manganese (d)	nd	hard nd	uk	u	1587	uk	81	1682	0	8340	3527	2	116	1782	0	9430	2591	4	86	2014	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	nd	hard nd	uk	nd	47.12	uk	nd	54.63	uk	nd	358.31	uk	nd	63.24	uk	nd	163.76	uk	nd	86.31	uk
	Selenium (d)	nd	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	0.95	4.60	0
	Silver (d)	nd	hard nd	uk	u	0.06	uk	u	0.08	uk	u	3.80	uk	u	0.11	uk	u	0.77	uk	u	0.21	uk
	Zinc (d)	nd	hard nd	uk	18.40	112.55	0	424.00	130.63	3	6140.00	869.20	7	433.00	151.37	3	5610.00	394.87	14	565.00	207.10	3
	Hardness mg/L	nd			89			106			979			126			388			182		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.30	uk	u	2.05	uk	2.30	2.30	1	0.60	10.00	0	2.30	2.88	1	13.30	5.53	2	2.50	4.28	1
	Chromium (t)	u	76.54	uk	u	67.37	uk	u	76.54	uk	0.10	391.47	0	0.40	98.20	0	u	202.41	uk	u	152.33	uk
	Copper (d)	u	13.92	uk	u	12.02	uk	0.70	13.92	0	2.60	91.00	0	1.00	18.54	0	53.90	42.61	1	1.30	30.72	0
	Cyanide (t)	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	u	-	na	40.00	-	na	160.00	-	na	3600.00	-	na	160.00	-	na	18900.00	-	na	60.00	-	na
	Lead (d)	u	2.63	uk	u	2.22	uk	0.80	2.63	0	u	20.92	uk	0.70	3.65	0	6.70	9.28	1	0.20	6.46	0
	Manganese (d)	u	1671	uk	u	1587	uk	49	1671	0	7140	3246	2	170	1850	0	7800	2482	3	70	2211	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	0.0002	0.01	0	u	0.01	uk
	Nickel (d)	nd	53.76	uk	nd	47.12	uk	nd	53.76	uk	nd	290.19	uk	nd	69.55	uk	nd	146.81	uk	nd	109.46	uk
	Selenium (d)	4.00	4.60	1	2.00	4.60	0	2.00	4.60	0	u	4.60	uk	u	4.60	uk	3.00	4.60	1	1.00	4.60	0
	Silver (d)	u	0.08	uk	u	0.06	uk	u	0.08	uk	u	2.47	uk	u	0.14	uk	u	0.62	uk	u	0.34	uk
	Zinc (d)	u	128.53	uk	u	112.55	uk	450.00	128.53	4	5910.00	702.79	8	570.00	166.60	3	7110.00	353.71	20	730.00	263.11	3
	Hardness mg/L	104			89			104			763			141			341			241		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
- no set standard
hard nd - no standard calculated because standard is dependent on hardness detection which is nd
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value
na - HQ value does not apply because there is no set standard

Table 4.20 2002 Metals Results as Compared to AWQC using HQ Analysis for Locations along the Dolores River.

Sampling Timeline	Metals (ug/L)	DR-1			DR-20			DR-2			DR-7			DR-2-SW			DR-1-SW			DR-26			DR-9-SW			DR-27			DR-7-SW			DR-4-SW		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
July 18-19, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	u	7.60	uk	nd	7.60	uk	nd	7.60	uk	u	7.60	uk	5.10	7.60	1	nd	7.60	uk
	Cadmium (d)	3.00	2.78	1	u	2.99	uk	u	4.02	uk	u	4.30	uk	u	4.39	uk	u	4.52	uk	u	4.40	uk	u	6.22	uk	u	6.22	uk	u	6.22	uk	u	4.91	uk
	Chromium (t)	u	94.19	uk	0.10	102.18	0	0.10	141.90	0	1.70	152.85	0	1.30	156.46	0	u	161.59	uk	1.40	156.97	0	u	230.67	uk	u	230.67	uk	1.50	230.67	0	1.40	177.26	0
	Copper (d)	u	17.67	uk	u	19.41	uk	2.00	28.31	0	1.00	30.84	0	2.00	31.68	0	3.00	32.88	0	1.00	31.80	0	2.00	49.52	0	10.00	49.52	0	2.00	49.52	0	1.00	36.57	0
	Cyanide (t)	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk
	Iron (t)	50.00	1000.00	0	90.00	1000.00	0	90.00	1000.00	0	170.00	1000.00	0	120.00	1000.00	0	530.00	1000.00	1	160.00	1000.00	0	1690.00	1000.00	2	10.00	1000.00	0	14700.00	1000.00	15	120.00	1000.00	0
	Lead (d)	u	3.46	uk	u	3.85	uk	0.30	5.90	0	u	6.49	uk	0.20	6.69	0	u	6.97	uk	u	6.72	uk	u	10.94	uk	u	10.94	uk	1.30	10.94	0	u	7.85	uk
	Manganese (d)	13	1819	0	79	1880	0	307	2148	0	316	2214	0	210	2235	0	188	2265	0	229	2238	0	9060	2618	3	86	2618	0	2690	2618	1	21	2352	0
	Mercury (t)	u	0.01	uk	nd	0.01	uk	nd	0.01	uk	u	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	u	0.01	uk	u	0.01	uk	nd	0.01	uk
	Nickel (d)	u	66.62	uk	u	72.46	uk	u	101.72	uk	u	109.84	uk	u	112.52	uk	u	116.34	uk	u	112.91	uk	u	168.04	uk	u	168.04	uk	u	168.04	uk	u	128.01	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.53	uk	u	0.63	uk	u	1.25	uk	u	1.46	uk	u	1.54	uk	u	1.65	uk	u	1.55	uk	u	3.47	uk	u	3.47	uk	0.20	3.47	0	u	2.00	uk
	Zinc (d)	20.00	159.53	0	20.00	173.63	0	20.00	244.38	0	20.00	264.05	0	50.00	270.54	0	580.00	279.78	2	80.00	271.47	0	40.00	405.26	0	920.00	405.26	2	880.00	405.26	2	10.00	308.08	0
	Hardness mg/L	134			148			221			242			249			259			250			425			942			1040			290		
October 6-9, 2002 Analysis Resutls (SEH,2002)	Arsenic (t)	u	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	u	7.60	uk	nd	7.60	uk	nd	7.60	uk	u	7.60	uk	6.60	7.60	1	u	7.60	uk
	Cadmium (d)	u	2.56	uk	u	2.65	uk	u	2.87	uk	u	3.25	uk	0.20	3.12	0	2.60	4.82	1	0.20	3.68	0	0.20	3.98	0	10.00	6.22	2	u	6.22	uk	u	3.34	uk
	Chromium (t)	u	86.05	uk	u	89.56	uk	u	97.63	uk	u	112.25	uk	u	107.24	uk	u	173.75	uk	u	128.61	uk	u	140.32	uk	u	230.67	uk	u	230.67	uk	u	115.56	uk
	Copper (d)	u	15.93	uk	u	16.68	uk	u	18.42	uk	u	21.62	uk	u	20.52	uk	u	35.74	uk	u	25.29	uk	u	27.95	uk	u	49.52	uk	u	49.52	uk	u	22.36	uk
	Cyanide (t)	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk	u	5.00	uk
	Iron (t)	110.00	1000.00	0	100.00	1000.00	0	120.00	1000.00	0	180.00	1000.00	0	230.00	1000.00	0	480.00	1000.00	0	180.00	1000.00	0	1120.00	1000.00	1	80.00	1000.00	0	13700.00	1000.00	14	190.00	1000.00	0
	Lead (d)	u	3.07	uk	u	3.23	uk	u	3.62	uk	u	4.35	uk	u	4.10	uk	0.20	7.65	0	u	5.19	uk	0.20	5.81	0	0.10	10.94	0	1.10	10.94	0	u	4.52	uk
	Manganese (d)	15	1753	0	45	1782	0	115	1845	0	135	1953	0	130	1917	0	229	2333	0	163	2064	0	1180	2139	1	56	2618	0	2640	2618	1	143	1976	0
	Mercury (t)	0.0009	0.01	0	nd	0.01	uk	nd	0.01	uk	0.0010	0.01	0	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	u	0.01	uk	0.0003	0.01	0	0.0011	0.01	0
	Nickel (d)	u	60.68	uk	u	63.24	uk	u	69.13	uk	u	79.85	uk	u	76.17	uk	u	125.39	uk	u	91.90	uk	u	100.55	uk	u	168.04	uk	u	168.04	uk	u	82.28	uk
	Selenium (d)	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.44	uk	u	0.48	uk	u	0.57	uk	u	0.77	uk	u	0.70	uk	u	1.92	uk	u	1.02	uk	u	1.22	uk	u	3.47	uk	0.19	3.47	0	u	0.81	uk
	Zinc (d)	u	145.20	uk	u	151.37	uk	u	165.60	uk	u	191.48	uk	40.00	182.59	0	850.00	301.73	3	60.00	220.61	0	30.00	241.55	0	690.00	405.26	2	760.00	405.26	2	50.00	197.36	0
	Hardness mg/L	120			126			140			166			157			283			196			218			879			1060			172		

Std. - water quality standard
HQ - hazard quotient
u - undetected
nd - no existing data for the analyte at this site during this sampling event
HQ 2-10 indicates an uncertain potential for risk
HQ >10 indicates the potential for risk and the need for further evaluation
uk - unknown HQ value

Table 4.21 2003 Metals Results as Compared to AWQC using HQ Analysis for Locations along the Dolores River.

Sampling Timeline	Metals (ug/L)	DR-1			DR-20			DR-2			DR-7			DR-2-SW			DR-1-SW			DR-26			DR-9-SW			DR-27			DR-7-SW			DR-4-SW		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
October through December, 2003 Analysis Results (SEH, 2003)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.78	uk	nd	hard nd	uk	u	3.68	uk	0.20	4.23	0	0.30	4.15	0	2.50	4.91	1	0.80	4.61	0	u	6.22	uk	2.00	6.22	0	1.00	6.22	0	0.60	4.54	0
	Chromium (t)	0.10	94.19	0	nd	hard nd	uk	u	128.61	uk	0.20	150.26	0	0.20	147.13	0	0.10	177.26	0	0.20	165.15	0	0.20	230.67	0	0.20	230.67	0	u	230.67	uk	u	162.61	uk
	Copper (d)	0.80	17.67	0	nd	hard nd	uk	1.60	25.29	0	2.00	30.24	0	2.40	29.52	0	3.30	36.57	0	0.60	33.72	0	2.20	49.52	0	18.30	49.52	0	4.60	49.52	0	2.60	33.12	0
	Cyanide (t)	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	70.00	1000.00	0	nd	1000.00	uk	80.00	1000.00	0	150.00	1000.00	0	120.00	1000.00	0	1900.00	1000.00	2	210.00	1000.00	0	900.00	1000.00	1	10.00	1000.00	0	7730.00	1000.00	8	170.00	1000.00	0
	Lead (d)	u	3.46	uk	nd	hard nd	uk	u	5.19	uk	u	6.35	uk	u	6.18	uk	u	7.85	uk	0.50	7.17	0	u	10.94	uk	0.20	10.94	0	0.20	10.94	0	0.10	7.03	0
	Manganese (d)	29	1819	0	nd	hard nd	uk	292	2064	0	305	2199	0	276	2180	0	416	2352	0	371	2285	0	6480	2618	2	203	2618	0	1810	2618	1	317	2271	0
	Mercury (t)	0.0012	0.01	0	nd	0.01	uk	nd	0.01	uk	0.0005	0.01	0	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	0.0003	0.01	0	u	0.01	uk
	Nickel (d)	u	66.62	uk	nd	hard nd	uk	nd	91.90	uk	u	107.92	uk	nd	105.60	uk	nd	128.01	uk	nd	118.99	uk	nd	168.04	uk	nd	168.04	uk	nd	168.04	uk	nd	117.09	uk
	Selenium (d)	0.50	4.60	0	nd	4.60	uk	0.50	4.60	0	0.50	4.60	0	0.50	4.60	0	0.50	4.60	0	0.60	4.60	0	u	4.60	uk	u	4.60	uk	0.30	4.60	0	0.50	4.60	0
	Silver (d)	u	0.53	uk	nd	hard nd	uk	u	1.02	uk	u	1.41	uk	u	1.35	uk	u	2.00	uk	u	1.72	uk	u	3.47	uk	u	3.47	uk	u	3.47	uk	u	1.67	uk
	Zinc (d)	10.00	159.53	0	nd	hard nd	uk	u	220.61	uk	40.00	259.39	0	130.00	253.78	1	1230.00	308.08	4	0.20	286.21	0	70.00	405.26	0	1830.00	405.26	5	840.00	405.26	2	110.00	281.62	0
	Hardness mg/L	134			nd			196			237			231			290			266			426			1000			1090			261		

Std. - water quality standard

HQ - hazard quotient

u - undetected

nd - no existing data for the analyte at this site during this sampling event

hard nd - no standard calculated because standard is dependent on hardness detection which is nd

HQ 2-10 indicates an uncertain potential for risk

uk - unknown HQ value

Table 4.22 2004 Metals Results as Compared to AWQC using HQ Analysis for Locations along the Dolores River.

Sampling Timeline	Metals (ug/L)	DR-1			DR-20			DR-2			DR-7			DR-2-SW			DR-1-SW			DR-26			DR-6-SW			DR-9-SW			DR-27			DR-7-SW			DR-4-SW		
		Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ	Detect	Std.	HQ
High Flow April 26-27, 2004 Analysis Results (SEH, 2004)	Arsenic (t)	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.10	uk	nd	hard nd	uk	0.34	2.69	0	0.13	2.59	0	u	2.22	uk	4.33	5.17	1	nd	hard nd	uk	1.11	4.62	0	0.97	4.71	0	13.70	6.22	2	1.41	6.22	0	0.42	2.99	0
	Chromium (t)	u	69.22	uk	nd	hard nd	uk	u	90.72	uk	u	87.23	uk	u	73.51	uk	u	187.71	uk	nd	hard nd	uk	u	165.66	uk	u	169.21	uk	u	230.67	uk	u	230.67	uk	u	102.18	uk
	Copper (d)	u	12.40	uk	nd	hard nd	uk	4.60	16.92	0	u	16.18	uk	3.60	13.29	0	7.70	39.07	0	nd	hard nd	uk	1.70	33.84	0	3.85	34.67	0	84.60	49.52	2	8.55	49.52	0	3.85	19.41	0
	Cyanide (t)	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	370.00	1000.00	0	nd	1000.00	uk	171.00	1000.00	0	506.00	1000.00	1	310.00	1000.00	0	2900.00	1000.00	3	nd	1000.00	uk	43.40	1000.00	0	317.00	1000.00	0	251.00	1000.00	0	1240.00	1000.00	1	224.00	1000.00	0
	Lead (d)	u	2.30	uk	nd	hard nd	uk	0.12	3.29	0	u	3.12	uk	0.52	2.49	0	0.54	8.44	0	nd	hard nd	uk	0.49	7.20	0	0.10	7.39	0	0.38	10.94	0	3.17	10.94	0	0.21	3.85	0
	Manganese (d)	8	1604	0	nd	hard nd	uk	75	1791	0	72	1763	0	46	1644	0	738	2407	0	nd	hard nd	uk	30	2288	0	315	2308	0	874	2618	0	789	2618	0	114	1880	0
	Mercury (t)	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk
	Nickel (d)	u	48.46	uk	nd	hard nd	uk	u	64.09	uk	u	61.53	uk	nd	51.57	uk	nd	135.81	uk	nd	hard nd	uk	nd	119.37	uk	18.60	122.01	0	nd	168.04	uk	nd	168.04	uk	nd	72.46	uk
	Selenium (d)	u	4.60	uk	nd	4.60	uk	u	4.60	uk	0.81	4.60	0	u	4.60	uk	u	4.60	uk	nd	4.60	uk	1.07	4.60	0	0.87	4.60	0	u	4.60	uk	1.59	4.60	0	0.99	4.60	0
	Silver (d)	u	0.28	uk	nd	hard nd	uk	u	0.49	uk	u	0.45	uk	u	0.31	uk	u	2.25	uk	nd	hard nd	uk	u	1.73	uk	u	1.81	uk	u	3.47	uk	u	3.47	uk	u	0.63	uk
	Zinc (d)	8.95	115.77	0	nd	hard nd	uk	nd	153.42	uk	29.20	147.26	0	20.00	123.24	0	1570.00	327.00	5	nd	hard nd	uk	235.00	287.13	1	317.00	293.53	1	3630.00	405.26	9	464.00	405.26	1	110.00	173.63	1
	Hardness mg/L	92			nd			128			122			99			311			nd			267			274			946			777			148		
Low Flow December 6-8, 2004 Analysis Results (SEH,2004)	Arsenic (t)	0.60	7.60	0	0.90	7.60	0	0.90	7.60	0	1.00	7.60	0	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk	nd	7.60	uk
	Cadmium (d)	u	2.56	uk	u	2.56	uk	0.10	2.97	0	0.90	3.58	0	0.90	3.86	0	1.60	4.17	0	nd	hard nd	uk	nd	hard nd	uk	0.40	5.10	0	1.70	6.22	0	0.40	6.22	0	0.90	3.94	0
	Chromium (t)	u	86.05	uk	u	86.05	uk	u	101.61	uk	u	124.83	uk	0.10	135.55	0	u	147.65	uk	nd	hard nd	uk	nd	hard nd	uk	0.20	184.74	0	u	230.67	uk	u	230.67	uk	0.20	138.73	0
	Copper (d)	u	15.93	uk	u	15.93	uk	u	19.28	uk	1.40	24.43	0	1.00	26.86	0	1.10	29.64	0	nd	hard nd	uk	nd	hard nd	uk	0.90	38.35	0	10.30	49.52	0	1.30	49.52	0	1.10	27.59	0
	Cyanide (t)	u	5.00	uk	nd	5.00	uk	u	5.00	uk	u	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk	nd	5.00	uk
	Iron (t)	70.00	1000.00	0	130.00	1000.00	0	110.00	1000.00	0	290.00	1000.00	0	150.00	1000.00	0	1600.00	1000.00	2	nd	1000.00	uk	nd	1000.00	uk	650.00	1000.00	1	30.00	1000.00	0	10300.00	1000.00	10	280.00	1000.00	0
	Lead (d)	u	3.07	uk	0.10	3.07	0	u	3.82	uk	u	5.00	uk	u	5.56	uk	u	6.21	uk	nd	hard nd	uk	nd	hard nd	uk	u	8.27	uk	u	10.94	uk	u	10.94	uk	u	5.73	uk
	Manganese (d)	19	1753	0	40	1753	0	150	1875	0	279	2039	0	235	2109	0	414	2183	0	nd	hard nd	uk	nd	hard nd	uk	2450	2392	1	175	2618	0	1580	2618	1	289	2129	0
	Mercury (t)	0.0005	0.01	0	0.0005	0.01	0	nd	0.01	uk	0.0003	0.01	0	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	nd	0.01	uk	u	0.01	uk	0.0005	0.01	0
	Nickel (d)	u	60.68	uk	u	60.68	uk	u	72.05	uk	u	89.11	uk	nd	97.03	uk	nd	105.99	uk	nd	hard nd	uk	nd	hard nd	uk	u	133.59	uk	nd	168.04	uk	nd	168.04	uk	nd	99.38	uk
	Selenium (d)	1.00	4.60	0	u	4.60	uk	3.00	4.60	1	3.00	4.60	1	2.00	4.60	0	u	4.60	uk	nd	4.60	uk	nd	4.60	uk	1.00	4.60	0	u	4.60	uk	u	4.60	uk	u	4.60	uk
	Silver (d)	u	0.44	uk	u	0.44	uk	u	0.62	uk	u	0.96	uk	u	1.14	uk	u	1.36	uk	nd	hard nd	uk	nd	hard nd	uk	u	2.18	uk	u	3.47	uk	u	3.47	uk	u	1.19	uk
	Zinc (d)	u	145.20	uk	u	145.20	uk	u	172.63	uk	170.00	213.87	1	180.00	233.02	1	790.00	254.71	3	nd	hard nd	uk	nd	hard nd	uk	100.00	321.62	0	1850.00	405.26	5	650.00	405.26	2	200.00	238.71	1
	Hardness mg/L	120			120			147			189			209			232			nd			nd			305			968			993			215		

Std. - water quality standard

HQ - hazard quotient

u - undetected

nd - no existing data for the analyte at this site during this sampling event

hard nd - no standard calculated because standard is dependent on hardness detection which is nd

HQ 2-10 indicates an uncertain potential for risk

uk - unknown HQ value

Table 4.23 Dolores River, Silver Creek, and St. Louis Ponds Copper- Zinc Indicies (CZI).

Site		July 2002			Oct 2002			Oct - Dec 2003			April 2004			Dec 2004		
		Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI	Detected Cu (ug/L)	Detected Zn (ug/L)	CZI
Dolores River	DR-1	u	20.00	uk	u	u	uk	0.80	10.00	0	u	8.95	uk	u	u	uk
	DR-20	u	20.00	uk	u	u	uk	na	na	uk	na	na	uk	u	u	uk
	DR-2	2.00	20.00	0	u	u	uk	1.60	u	uk	4.60	na	uk	u	u	uk
	DR-7	1.00	20.00	0	u	u	uk	2.00	40.00	0	u	29.20	uk	1.40	170.00	0
	DR-2-SW	2.00	50.00	0	u	40.00	uk	2.40	130.00	0	3.60	20.00	0	1.00	180.00	0
	DR-1-SW	3.00	580.00	2	u	850.00	uk	3.30	1230.00	3	7.70	1570.00	4	1.10	790.00	2
	DR-26	1.00	80.00	0	u	60.00	uk	0.60	0.20	0	na	na	uk	na	na	uk
	DR-6-SW	na	na	na	na	na	uk	na	na	uk	1.70	235.00	1	na	na	uk
	DR-9-SW	2.00	40.00	0	u	30.00	uk	2.20	70.00	0	3.85	317.00	1	0.90	100.00	0
	DR-27	10.00	920.00	3	u	690.00	uk	18.30	1830.00	5	84.60	3630.00	11	10.30	1850.00	5
	DR-7-SW	2.00	880.00	2	u	760.00	uk	4.60	840.00	2	8.55	464.00	1	1.30	650.00	2
	DR-4-SW	1.00	10.00	0	u	50.00	uk	2.60	110.00	0	3.85	110.00	0	1.10	200.00	1
Silver Creek	SVS-1T	na	na	uk	na	na	uk	0.60	u	uk	nd	nd	uk	u	u	uk
	SVS-1	na	na	uk	na	na	uk	0.80	30.00	0	2.95	18.40	0	u	u	uk
	SVS-22	2.00	420.00	1	u	290.00	uk	3.10	640.00	2	7.10	424.00	1	0.70	450.00	1
	SVS-12	2.00	6110.00	15	u	5070.00	uk	6.10	nd	uk	4.70	6140.00	15	2.60	5910.00	15
	SVS-8	2.00	940.00	2	u	490.00	uk	3.00	nd	uk	5.15	433.00	1	1.00	570.00	1
	SVS-26	51.00	8050.00	21	70.00	8120.00	22	187.00	6530.00	21	509.00	5610.00	27	53.90	7110.00	19
	SVS-20	2.00	470.00	1	u	390.00	uk	2.60	560.00	1	7.10	565.00	2	1.30	730.00	2
St. Louis Ponds	DR-3	20.00	3430.00	9	30.00	2970.00	8	20.60	5190.00	13	27.30	4180.00	11	18.50	4200.00	11
	DR-6	3.00	410.00	1	u	400.00	uk	6.40	1120.00	3	9.50	1690.00	4	7.60	3140.00	8

CZI - Copper-Zinc Index
>1 CZI - indicator of requiring further evaluation
uk - unknown
na - not analyzed
u - undetected

Table 4.24. Temporal Change in Load as Observed for 1997, 2002, 2003 and 2004.

Metal	Year	Calculated lb/cfs by Location		Change in lbs between Locations (DR-4-SW – DR-2-SW)
		DR-2-SW	DR-4-SW	
Iron	1997	13.6/70 = 0.19	28.96/57.7 = 0.50	+ 0.31
	2002	43.59/35.12 = 1.24	36.13/35.23 = 1.02	-
	2003	9.89/15.27 = 0.65	15.64/17.05 = 0.92	+ 0.27
	2004	23.79/29.39 = 0.81	55.31/36.6 = 1.51	+ 0.30
Manganese	1997	64.98/70 = 0.92	75.36/57.7 = 1.31	+ 0.39
	2002	24.64/35.12 = 0.7	27.19/35.23 = 0.77	+ 0.07
	2003	22.75/15.27 = 1.48	29.17/17.05 = 1.71	+ 0.23
	2004	37.27/29.39 = 1.27	57.09/36.6 = 1.56	+ 0.29
Zinc	1997	40.05/70 = 0.57	51.69/57.7 = 0.89	+ 0.32
	2002	7.58/35.12 = 0.22	9.51/35.23 = 0.27	+ 0.05
	2003	10.71/15.27 = 0.70	10.21/17.05 = 0.59	+ 0.29
	2004	28.55/29.39 = 0.97	39.51/36.6 = 1.07	+ 0.10

Table 4.25 Summary of Flow Loss Observed for the St. Louis Settling Ponds.				
Year	Sampling Event	DR-3 (St. Louis Tunnel)	DR-6 (Settling pond outfall)	Flow Loss (cfs and % of total)
2002	July	Not available	Not available	Unknown
	October	1.03	0.15	0.88 (85%)
2003	October -- December	0.73	0.30	0.43 (59%)
2004	April	1.37	0.46	0.91 (66%)
	December	1.41	0.87	0.54 (38%)

Table 4.26 Summary of Zinc Load Loss Observed for the St. Louis Settling Ponds.				
Year	Sampling Event	DR-3 (St. Louis Tunnel)	DR-6 (Settling pond outfall)	Flow Loss (cfs and % of total)
2002	July	Not available	Not available	Unknown
	October	1.03	0.15	0.88 (85%)
2003	October -- December	0.73	0.30	0.43 (59%)
2004	April	31	4.2	26.8 (86%)
	December	32	15	17 (53%)

FIGURES

Figure 4.1. Timeline of Water Quality Studies Completed within the Project Area.

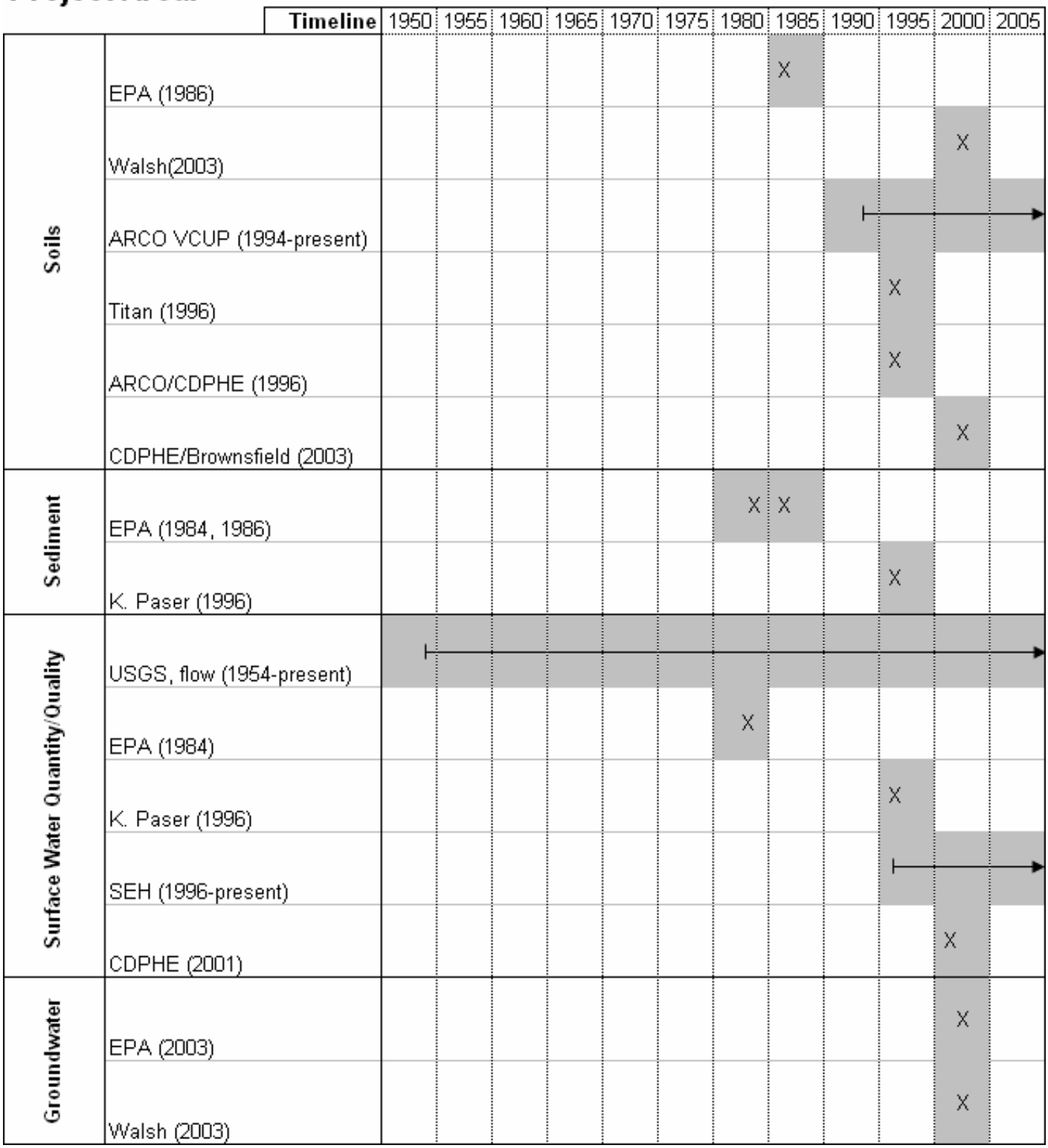
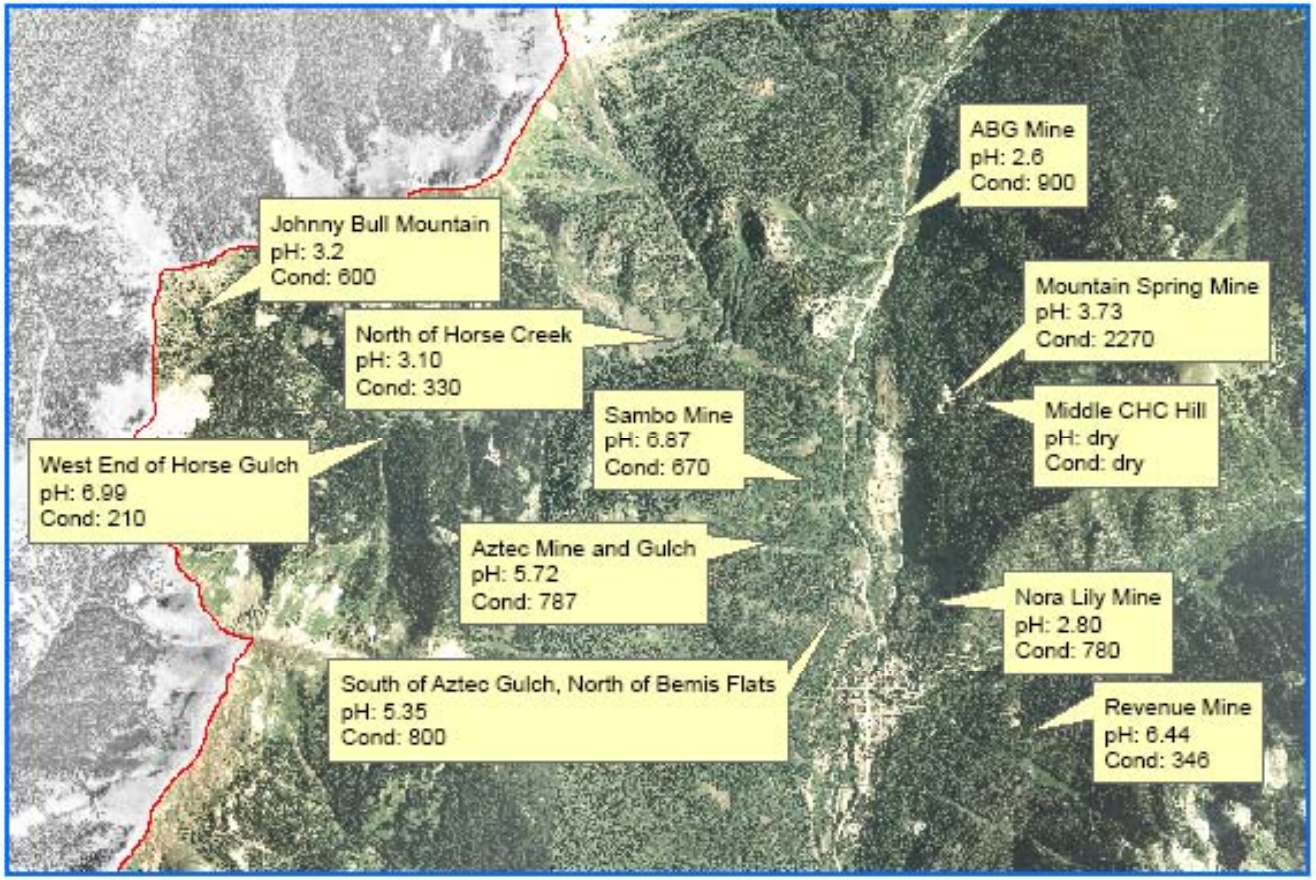


Figure 4.2. CGS AML Site Locations within the Project Area.



Upper Dolores River Watershed

0 0.5 1 2 Miles

1:45,000

DR-1
DR-3
St. Louis Adit
Pond 18
Pond 16
Pond 15
DR-20
Pond 14
Pond 13
Pond 12
Pond 11
Pond 9
Pond 10
Pond 8
Pond 7
Pond 6
Pond 5
DR-2
DR-6
(Pond System Outline/Outfall 002)
DR-7
Argentine Mill
Argentine Tunnel
Argentine Tailings
Pond 1
Blaine Adit
Argentine Seep
North Face
SVS-12
SVS-22
East Fork
SVS-8
3" Parshall Flume
Silver Creek
SVS-20
Approx. location
SVS-26
DR-2-SW1
Rico Boy Adit
DR-27
Santa Cruz Adit
Columbia Tailings
Wetlands
DR-1-SW
East Drainage
West Drainage
DR-26
DR-10-SW
DR-9-SW
Wetlands
Silver Swan Adit
DR-7-SW
DR-4-SW
N
0 1000 2000 3000
Feet

Figure 4.3

SEH Sampling Locations

August 8, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- DR-4-SW — SEH Sampling Locations
- Silver Swan Adit — Adits

Prepared By:

K. King
Aquatic Toxicologist

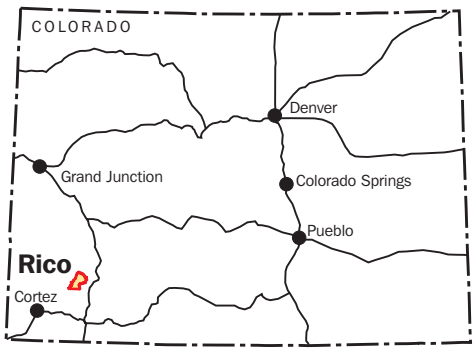


Figure 4.4. USEPA STORET Sampling Locations.

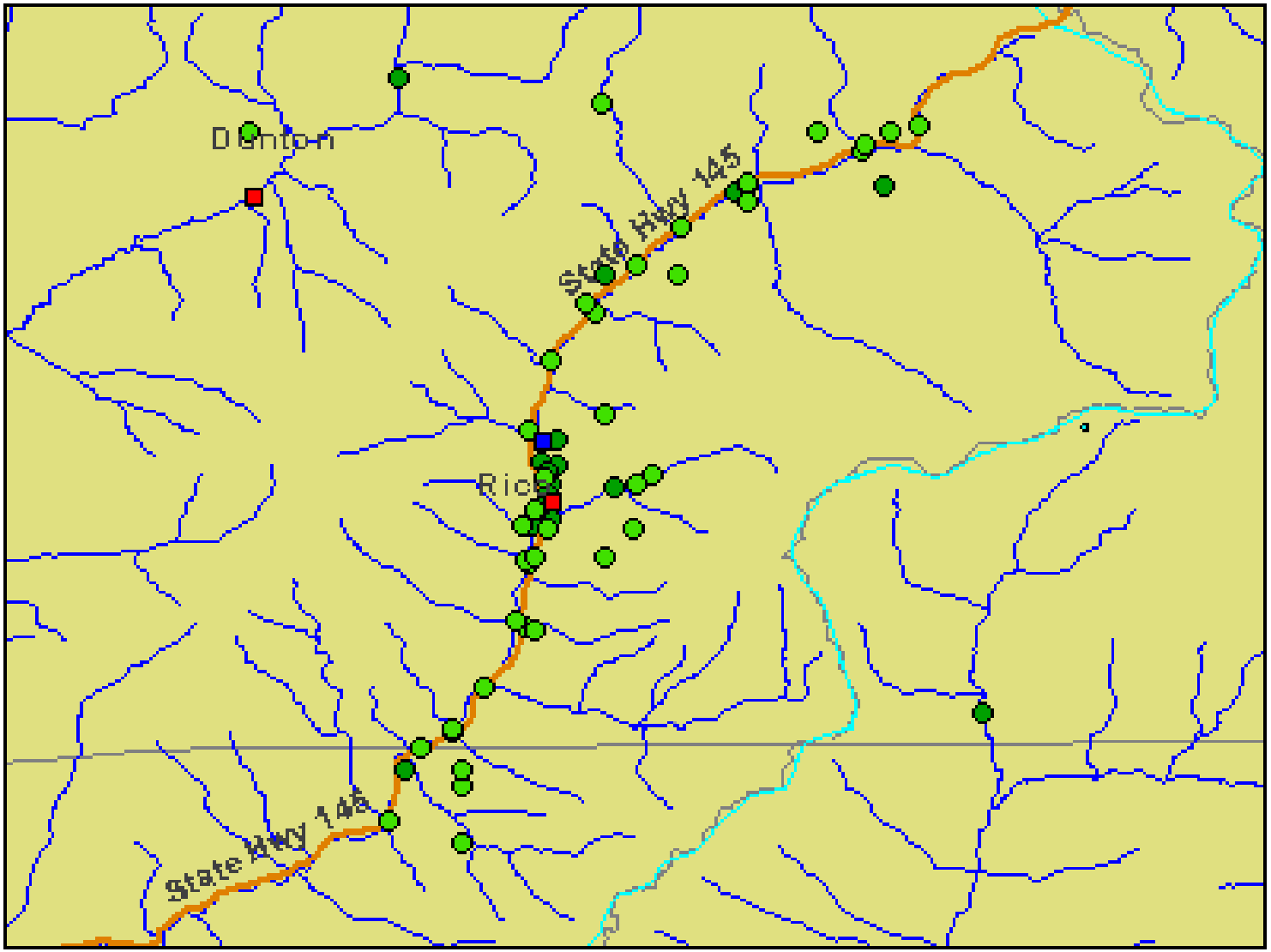


Figure 4.5. CDPHE Sampling Locations.

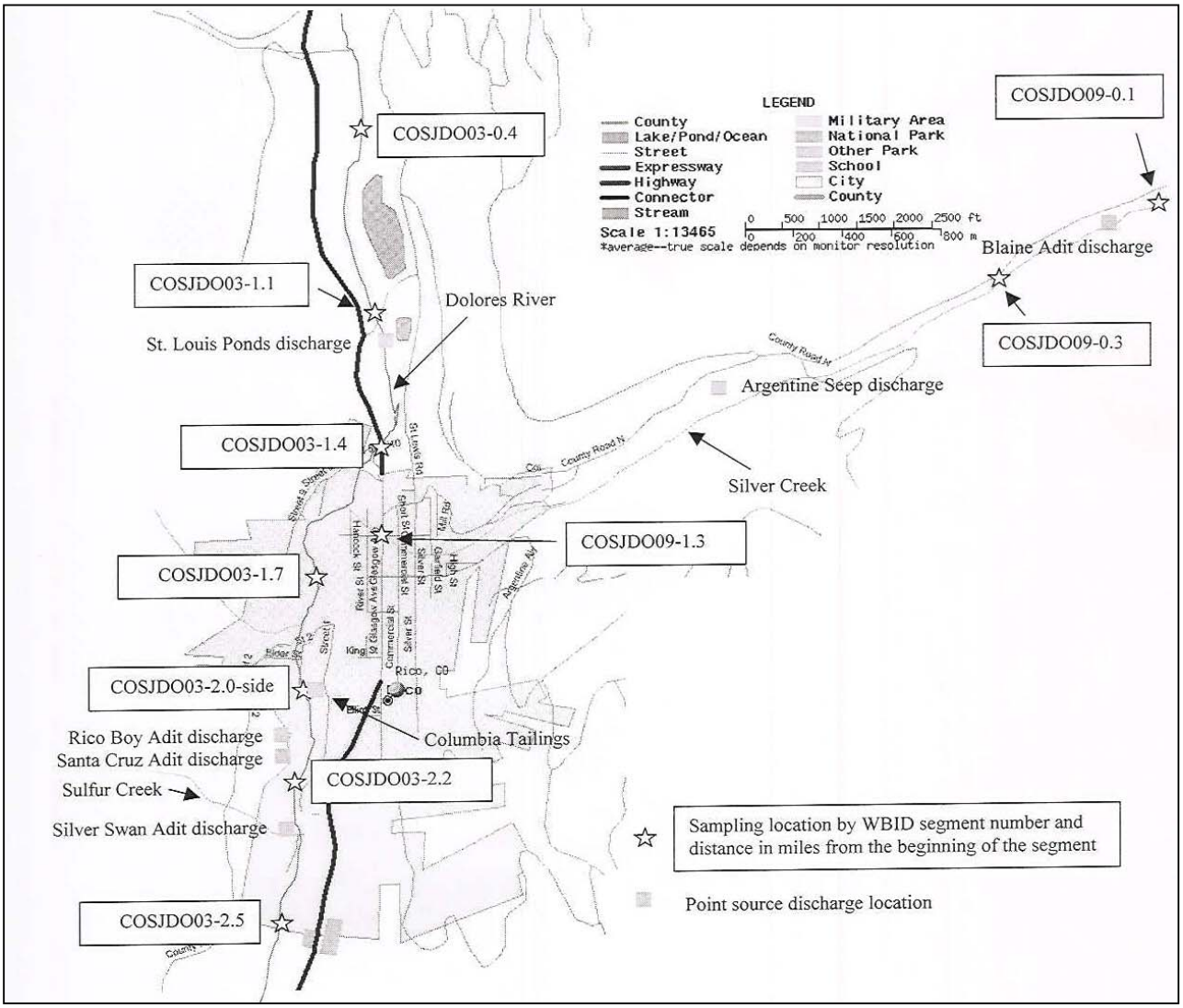


Figure 4.6. CDOW Riverwatch Sampling Locations.

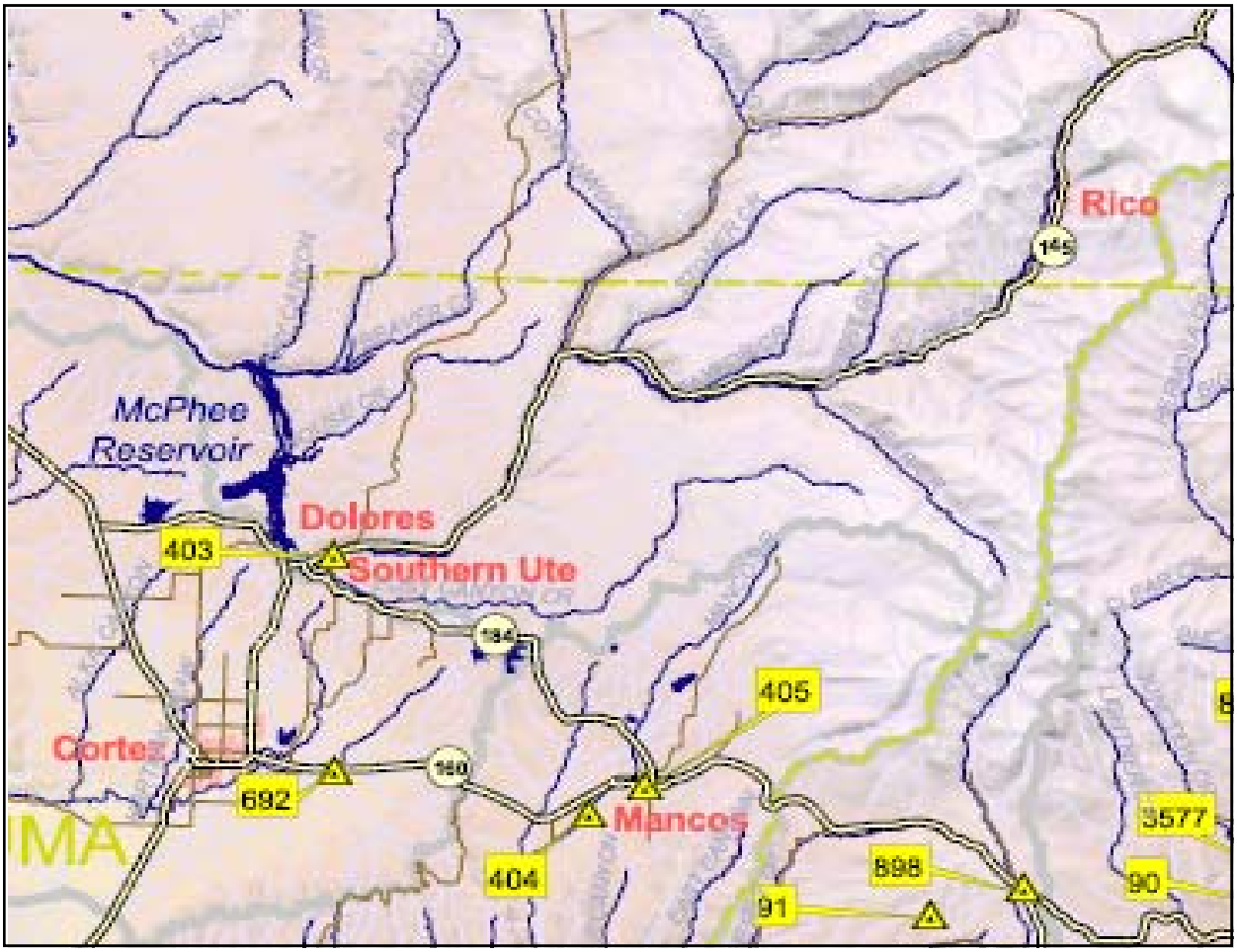


Figure 4.7. July 18-19, 2002. Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.

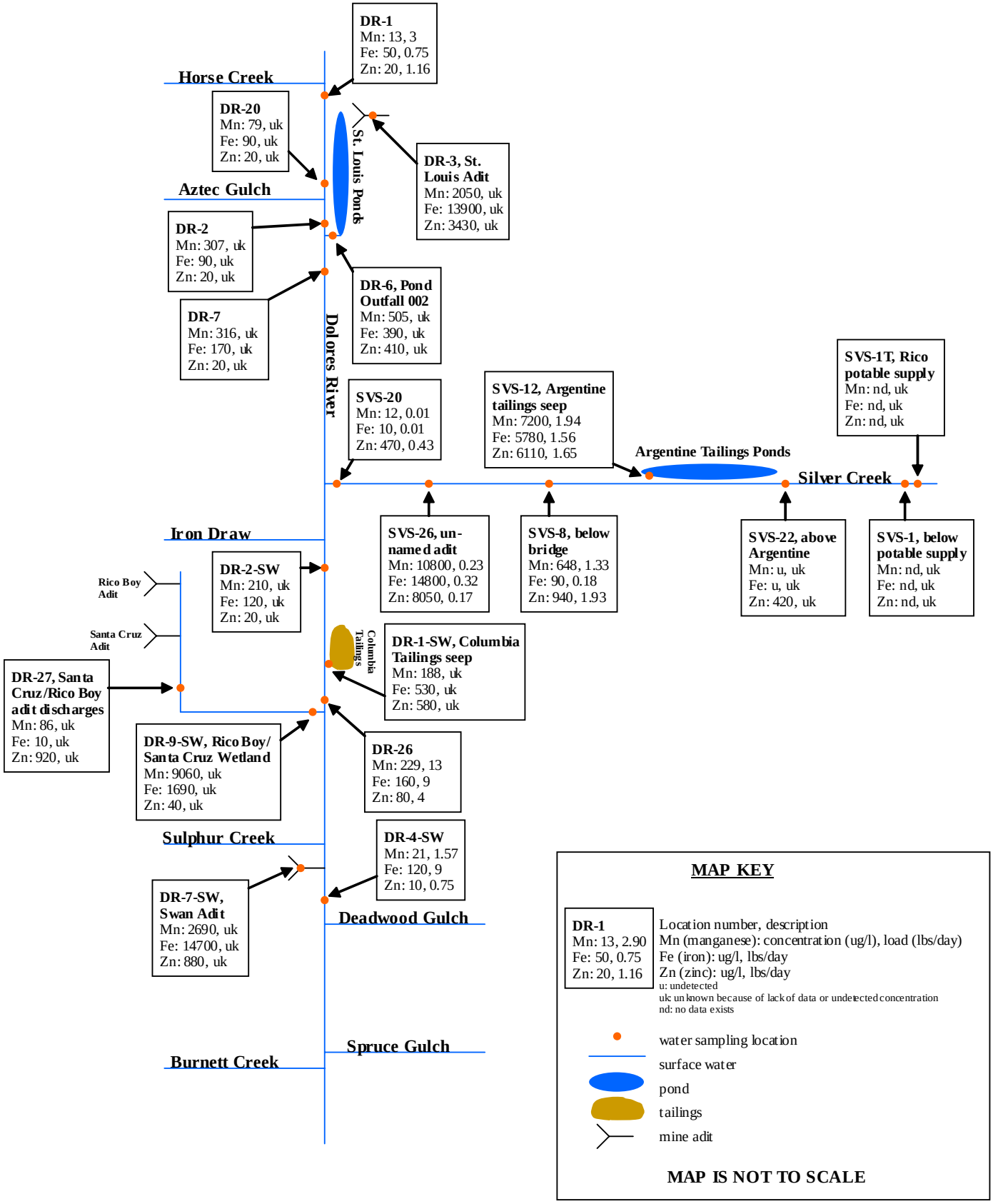


Figure 4.8. October 6-9, 2002. Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.

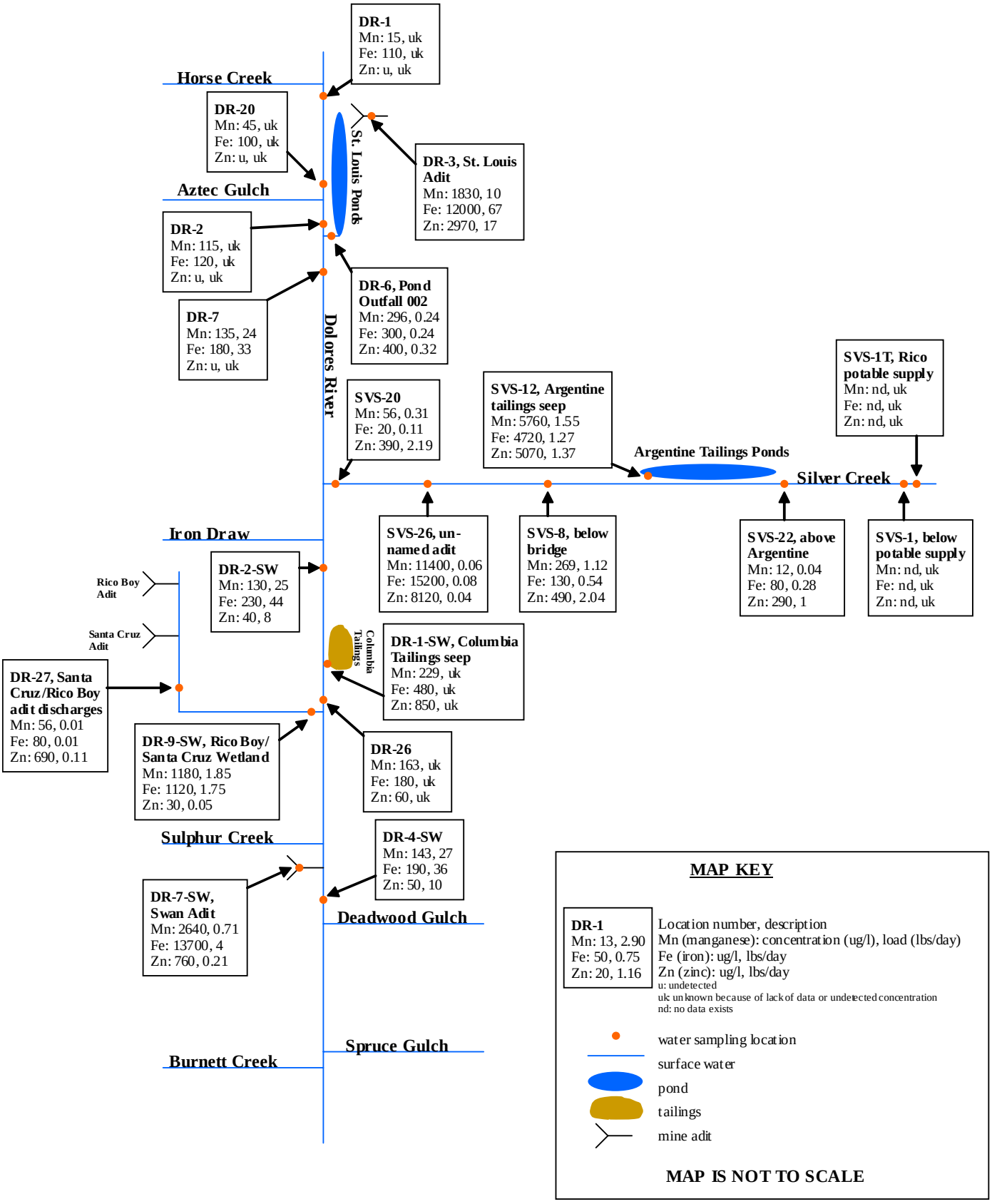


Figure 4.9. October through December, 2003. Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.

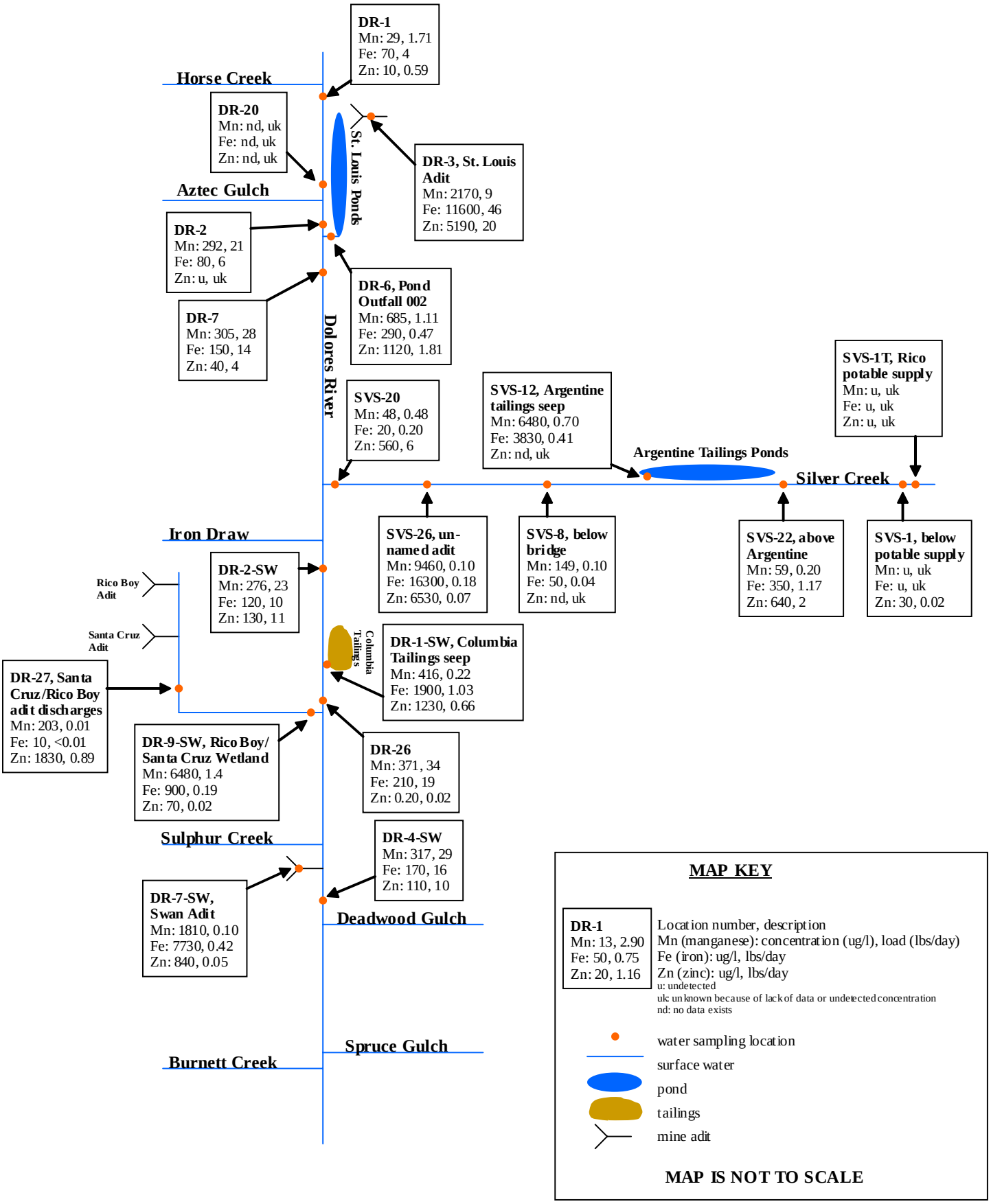


Figure 4.10. April 26-28, 2004. Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.

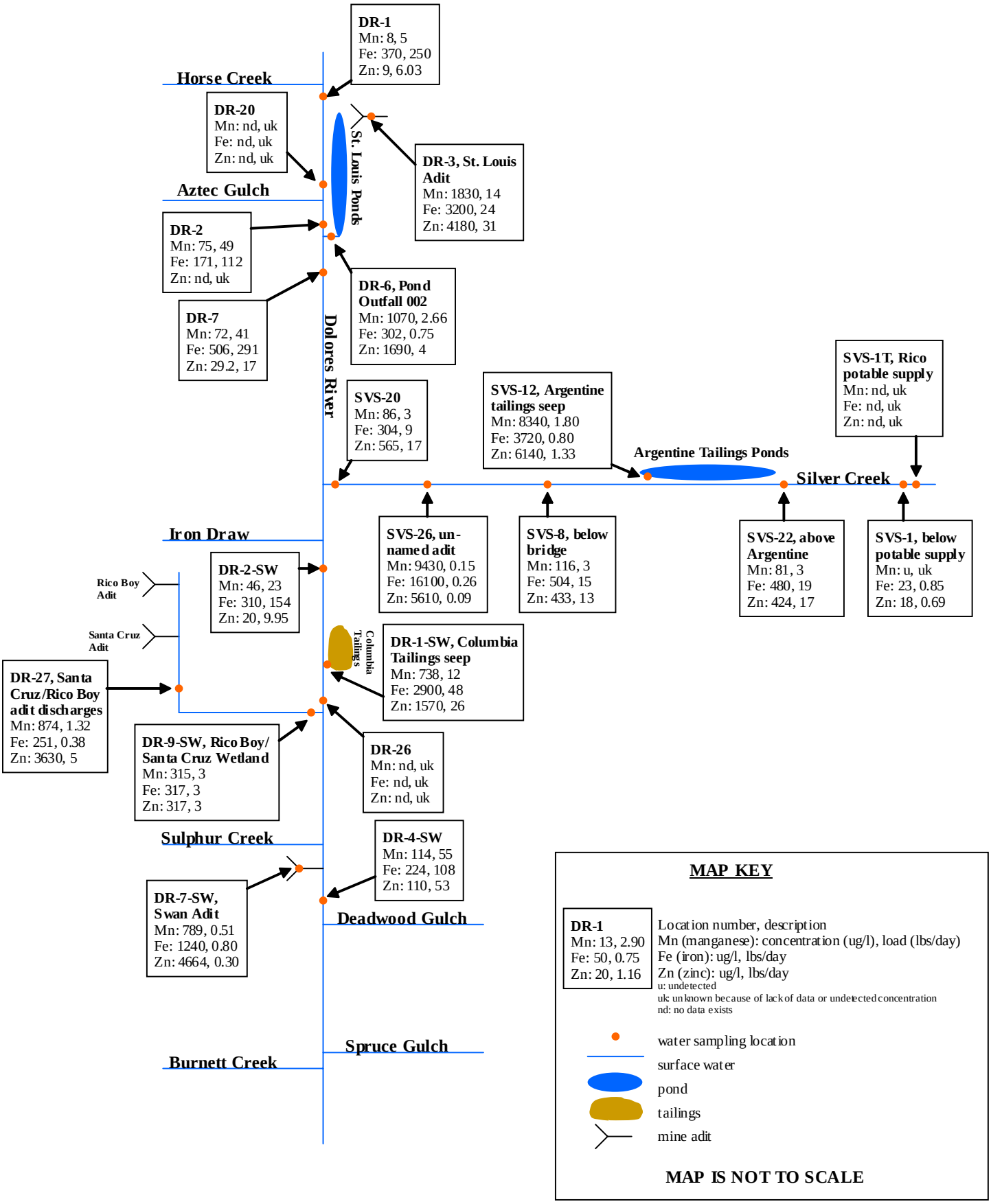
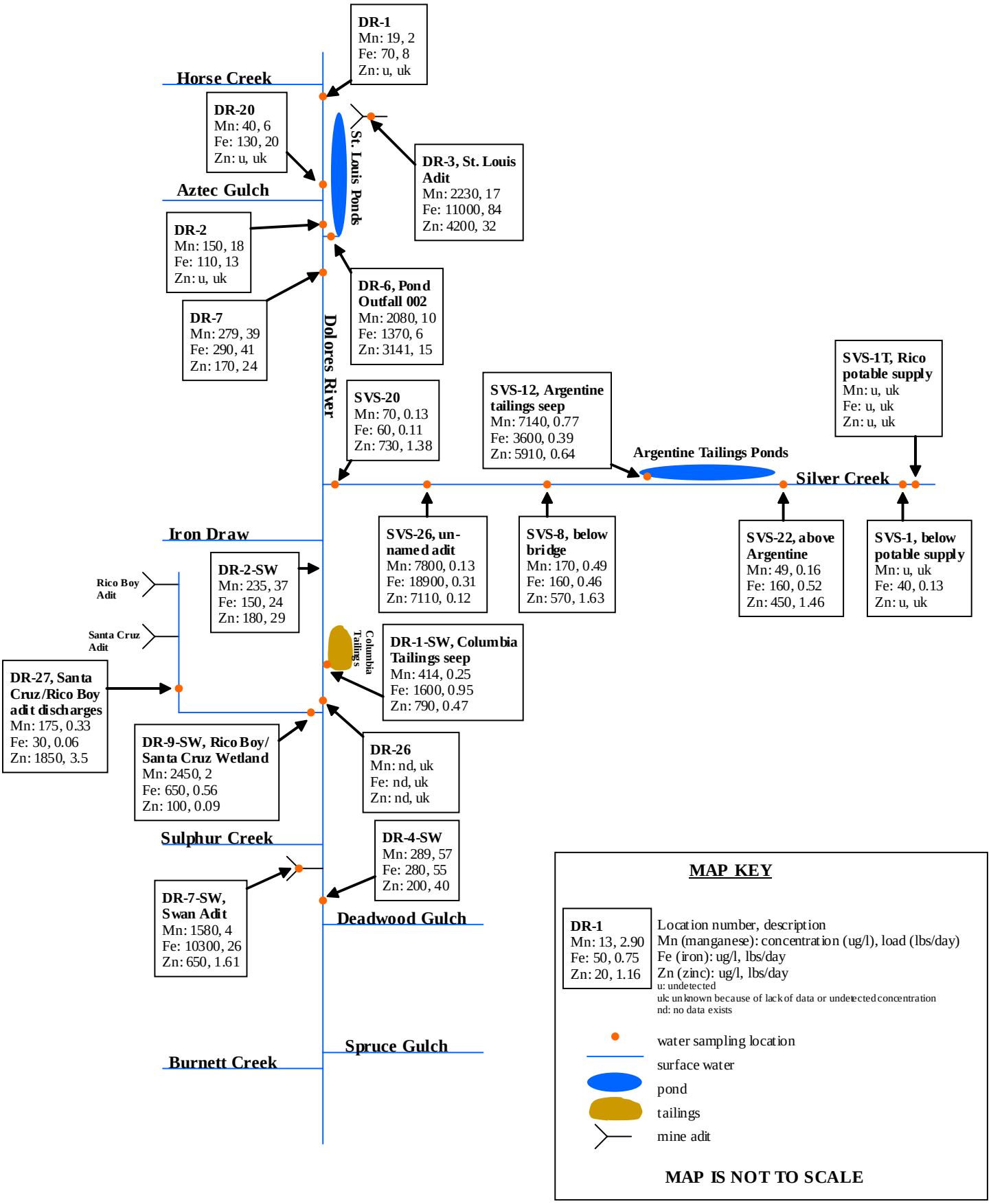


Figure 4.11. December 6-8, 2004 . Conceptual Diagram of the Metals Concentrations (ug/L) and Loading (lbs/day) within the Project Area.



SECTION 5

5 WATER AND WASTEWATER FACILITIES

5.1 Introduction

This Section is a standard component of a Section 208 watershed plan, and provides an inventory of public water systems and domestic and industrial wastewater facilities within the *Project area*. It also contains recommendations for cooperative projects for the monitoring of these discharges and projects associated with them (the St. Louis tunnel specifically). It does not characterize the point-source discharges from mine adits since these are not permitted nor associated with treatment facilities. These point sources were discussed in Section 4 as part of the water quality evaluation. The objective of this Section is to describe proposed public water systems and wastewater facilities in terms of impacts or considerations to the watershed water quality/quantity characteristics.

5.2 Point Source Discharge

A point source discharge can be defined as discharge of water from a discernible, confined, and discrete conveyance, such as a pipe, ditch, channel or conduit, from which pollutants are, or may be discharged. Point sources do not include irrigation return flows. Point sources within the *Project area* can fall within three sources which are permitted by the WQCD under the Colorado Discharge Permit System (CDPS). These sources are municipal dischargers, industrial dischargers, and construction activities. A summary of the permits held within the *Project area* are as follows;

- **Current Permits**: Presently there are no permitted point discharges within the *Project area*. There is only one current National Point Discharge Elimination System (NPDES) permit within all of Dolores County which occurs for the Town of Dove Creek WWTP (permit number COG582039) (Source: CDPHE – NPDES permit inventory system : Loretta Houk). The municipal supply for the Town of Rico does not have a discharge permit associated with it since it is an acquired water source from Silver Creek.

- **Historic Permits**: There was an historic discharge permit associated with the St. Louis tunnel issued in 1990 by Colorado Department of Health (Colorado Discharge Permit system -Permit No. CO-0029793 – establishes the limits for the St. Louis discharge set forth by CDPHE). However, due to negligence exhibited by the original permit holder, all rights and responsibilities associated with the permit were abandoned, and therefore the permit was not renewed as documented in **Appendix F** which provides the chronology of events related to the discharge and the associated regulatory actions.

- **Potential Future Permits:** The only anticipated future point discharge is anticipated with the Town of Rico WWTP, and perhaps for the St. Louis tunnel if

a treatment plant were to be installed. Specifics regarding this permit are unknown at the time of this plan, however the site approval process and permissible exposure limits are currently being addressed by the CDPHE.

Construction activities, which disturb more than five acres of land, are considered to be an industrial activity under the CWA and require a stormwater discharge permit. As the activity is required to be permitted, it is considered a point source discharge, although the requirements of the permit are generally BMPs directed towards controlling nonpoint source pollutants and hazardous materials spill prevention. These permits are issued by the WQCD. Any future development activities that fall within this size category would be required to obtain this permit.

Phase II of the Federal USEPA stormwater regulations require municipalities meeting the Phase II criteria to apply for a stormwater permit by March 2003. There are likely no populated centers in the *Project area* that were required to obtain a stormwater permit under those rules. However, construction sites of 1 acre in size or greater will be required to have coverage under the generic permit for construction activities, issued by the WQCD, by July 2002. Under Phase I regulations, only construction sites over 5 acres needed coverage of the State permit. In most cases, it will be up to the local governments, counties, Federal and State agencies that own/manage land, and private landowners whether they will adopt practices, or whether there are any local requirements, to control nonpoint sources of pollution.

5.3 Facility and Master Planning

Currently there are 220 households within the Town of Rico area. Anticipated future development could include 700 additional units in various areas, in addition to a possible 300 units associated with Rico Renaissance sites for a total of 1000 additional units. The current conditional right to Silver Creek water is 3 cfs (0.28 is abs). At total build out projections (with the 1000 new units) it was anticipated that the Town of Rico may need 1 to 1.5 cfs as a future right (E. Heil, 2005)

The Town of Rico recently made improvements to its water system, enabling it to serve an estimated total of 450 water taps. Additional improvements to the water treatment system anticipate replacement of the bag filtration treatment system as well.

Currently, all properties are on septic systems. In 2000, Rico voters approved property tax increase to design, construct and operate a waste water treatment system. Voters subsequently overwhelmingly approved an additional assessment for construction of the sewer system in 2005. Detailed design and construction have been funded and are anticipated to start in 2006.

In summary, the Town of Rico has the current water source and treatment related issues as shown in **Figure 5.1** (E. Heil, no date);

- The Town of Rico has a 3 CFS water right on Silver Creek that is senior to CWCB's in-stream flow right (2.78 CFS conditional/.28 CFS absolute). CWCB has a 20 CFS in-stream flow right on the Dolores River that is more than natural winter flows (16-17 CFS average in winter). Town is pursuing watershed planning and river restoration program in cooperation with USEPA and CWCB. CWCB could be satisfied by either pumping lower alluvium for augmentation or "injuring with mitigation". The Town is currently joining DWCD through the statutory petitioning process.

- The Town of Rico's current water system utilizes bag filtration to treat a surface diversion from Silver Creek. The system is obsolete and fails to meet Safe Water Drink Act standards and the Silver Creek basin is insufficient to supply Town during drought years. Town and DWCD have partnered to drill test wells in an alluvium on the Dolores River 2 miles north of Rico. Test results indicate this is a superior quality potential drinking water source. Dolores River has 10 times the flow of Silver Creek and could address the Town's potable supply needs. .

- The Town of Rico has approved new regional master plan for future development with Rico Renaissance, the owner of 1,400 acres of surrounding vacant land. The new plan includes clustered development of 325 home sites on 300 acres and dedication of 60 acres of property to Town for the Rico River Park. All new development will be annexed into Town and will be served with municipal water and sewer. At full build-out, the Town will serve approximately 1,000 equivalent residential units (includes hotels, condos and apartments). Town plans to serve new growth with superior quality and quantity water supply on Dolores River while enhancing the river corridor to provide a unique amenity for residents and visitors.

5.3.1 Town of Rico Municipal Watershed

One of the most compelling issues in Colorado today is the availability of long-range water supply. Historically, development throughout the semi-arid West has been dependent upon the availability of water resources. Groundwater resources currently supply approximately 18 percent of our state's needs and its development is continuing at a fast pace (CGS, 2003). In regards to the Upper Dolores watershed, there are very few groundwater fed potable supplies. A recent inventory of the Colorado Division of Water Resources well permit informational databases (client applications + ArcView overview database) identified 8 permitted wells within the *Project area* (CDWR, 2006). These fell within the categories of potable in-home supply, augmented agricultural supply and monitoring hole uses. A summary of the records obtained, and copies of the well lots are provided in **Appendix C** to this report.

Residents and businesses within the Town of Rico receive their potable water from Silver Creek at a location approximately 0.75 miles from Hwy 145 up the drainage. Water flows by gravity into two 100,00 gallon steel tanks protected with over flows. The water is treated through infiltration galleries and chlorinated (E&E, 1984). At a point 150-ft west of the Atlantic Cable shaft just on the north of Soda Street, there exists a double-disk gate valve on a 6 in. main which serves five residences to the north. The system utilizes bag filtration to treat the surface water. This system is obsolete and fails to meet SDWA

standards. In addition, Silver Creek is insufficient to supply the Town during drought years (Heil, E., No date).

A summary of the available water quality conditions, permit issues and system status is tracked by the USEPA Safe Drinking Water Information System (SDWIS). The water system ID for the town of Rico water supply is CO 0117700, and is projected to be able to serve a population capacity of 350. Review of the SDWIS system indicates that the USEPA has documented violations due to the treatment technique (violations noted August, 2001; May, 2001) and for the lack of regular monitoring (January, 2002) (USEPA SDWIS, 2006).

The Town of Rico is in the formative stages of obtaining a water rights diversion in order to obtain their potable supply from an alluvial aquifer within the upper reach of the Dolores River (adjacent to Margarite Creek). Well testing for yield and water quality has already been completed, with results indicating that this alluvial aquifer would be sufficient for the Town's needs (Heil, E., no date) [point of contact: Steve Harris with Harris Water Engineers). This point of diversion is being negotiated with the CWCB.

5.3.2 Town of Rico Wastewater Treatment Plant

Concurrent with the re-establishment of the Town's potable supply point of diversion, a significant amount of effort has been focused towards the completion of a wastewater treatment plant for the Town. The Town has long recognized that the existing septic systems are a potential concern, and the anticipated future growth of the Town can not be served by septic system facilities. As a result, significant strides have occurred since the year 2000 to secure property, funds and the necessary information to begin construction. It is estimated that approximately 25% of the individual septic systems within the Town limits are not working properly or have cesspool type systems which do not meet minimum engineering requirements (M. England pers. Comm.., 2006). Based upon these statistics, it is very apparent that the Town is in need of a combined sewer system. The most recent environmental assessment (Town of Rico, 2006) highlighted the facility characteristics, capacity, location etc. which is briefly revisited herein.

The Town considered various size capacity systems for the initial treatment system. The RBC allows for flexibility in design and "modular" expansion of the system. An initial treatment system capacity of either 40,000 gallons per day ("g/p/d") or 60,000 g/p/d was considered. 40,000 g/p/d initial treatment capacity was considered too small (Town of Rico, 2006). The latest estimate of population per household in the Town of Rico is approximately 2.5 persons. The CDPHE recommends that 100 gallons per capita per day be used as a minimum design value for estimating residential wastewater flows, which is very conservative. Based upon metered water use rates of 4,672,000 gallons for residential use the average daily wastewater flow from a residence for planning purposes would be 250 gpd. Based on this rate, the new wastewater treatment facility should initially receive between 16,160 and 50,500 gpd. With the estimated total build-out (of 1000 equivalent dwelling units) would require a load between 80,000 and 250,000 gpd.

At the time of the initial project scoping, the Town of Rico had 215 residential (160 active) and 21 commercial (16 active) water taps. The Town's total metered water use in the Town during 2002 was 5,897,000 gallons with residential use accounting for 4,672,000 gallons of the total. Based on the metered water use, the current number of equivalent dwelling units (EDUs) for the Town of Rico is 202. Recent Town of Rico statistics identify 247 water taps with 220 that use water and 27 not being used since there are no structures associated with these remaining 27 taps (M. England, pers. Comm.., 2006).

The latest estimate of population per household in the Town of Rico is approximately 2.5 persons. The CDPHE recommends that 100 gallons per capita per day be used as a minimum design value for estimating residential wastewater flows, which is very conservative. Based on the metered water use figures given above, the average daily wastewater flow from a residence is 80 gallons per day (gpd). Based on the CDPHE minimum design value and the estimate of population per household given above, the average daily wastewater flow from a residence would be 250 gpd.

Based on the range of average daily wastewater flows and the number of EDUs calculated above and assuming that all existing water users will be connected to the central sewer in the first year, a new wastewater treatment facility should initially receive between 16,160 and 50,500 gpd. For planning purposes, an initial hydraulic design flow of 60,000 gpd has been selected for the proposed new treatment facility, which will accommodate inflow/infiltration (I/I) flows and some additional in-fill development in the *Project area*.

An estimate of the total build-out of the potential regional service area is approximately 1,000 EDUs. Based on the assumptions above, 1,000 EDUs would result in a total hydraulic load between 80,000 and 250,000 gpd to the proposed treatment facility. For planning purposes, we have assumed a total hydraulic load of 180,000 gpd to the treatment facility when the potential regional service area is completely developed.

5.4 Point Source Recommendations

Currently there are several mine-related point sources, but no municipal-related point sources within the *Project area*. However, in the near future (anticipated Spring 2008) the Town of Rico will have a point source discharge associated with their new wastewater treatment plant (WWTP). There are a number of innovative ideas that the Town could embark upon since they are on the fore-front of their WWTP planning. For instance, WWTP effluent can be effectively treated through the use of oxidative wetlands. These wetlands (if planned appropriately) could provide habitat areas in an affected portion of the river corridor. These 'additional' layers of treatment have also been found to be effective with relatively recent WWTP effluent concerns referred to as 'endocrine disruptors' and may also be of benefit to control mine-waste related releases. Further discussion regarding these possible combined projects are described as follows;

- WWTP releases contain elevated organic constituents. Organic material, which is carbon based, provides buffering capacity to the water chemistry which can help control (by absorption) elemental type contaminants such as metals. Co-mingling of the WWTP effluent with mine-related releases may afford a certain amount of buffered treatment. This opportunity needs to be tested with the use of 'desk-top' or 'bench-scale' tests where WWTP effluent is mixed with the types of released mine-waste related water to observe changes. This opportunity should be explored in light of the fact that the proposed WWTP is closely located to several mine-related point source discharges.

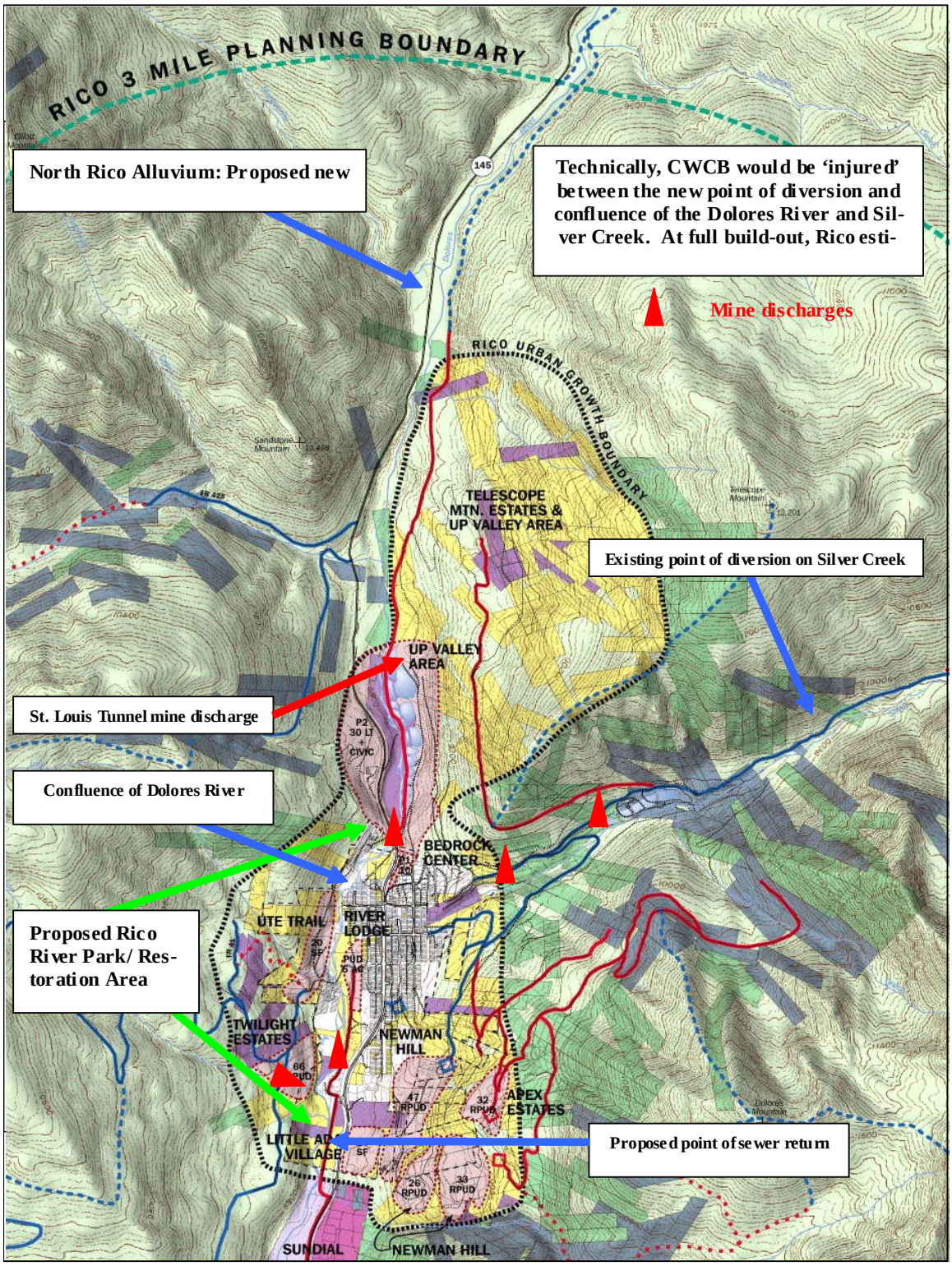
- Endocrine disruptors represent a class of chemicals with known steroidal impacts to receiving environments. These artificially released disruptors are produced as a result of un-metabolized pharmaceutical compounds from domestic waste streams. The effects of endocrine disruptors on the environment are still being explored (Sosiak, A. and T. Hebben, 2005). However, WWTP are being brought up to speed so as to accommodate for this new found environmental issue. Therefore, as an initial recommendation related to the WWTP point source, it is recommended to give consideration to unique treatment methods that will make a benefit out of the effluent and perhaps control potential contaminant issues related to the WWTP process itself.

In addition, it is highly recommended that baseline water quality and biological conditions above, within and below the point discharge area be monitored before the WWTP construction, during construction, and after (annually in perpetuity) establishment. The information gathered will help determine if any water quality impacts are attributable to the discharge. Recommendations for the design of the monitoring effort are further described in **Section 8** of this plan.

Once the WWTP is complete, and an understanding of the water release rates and water quality impacts are known, this plan will be updated to accommodate these new characteristics.

FIGURES

Figure 5.1. Summary of Water Issues for the Town of Rico (source; E. Heil, no date).



SECTION 6

.

6 NONPOINT SOURCE POLLUTION

6.1 Introduction

Nonpoint source pollution is defined as a "*source of water pollution that originates from a broad area, such as agricultural chemicals applied to fields or acid rain* (CGS, 2003)". The distinction between a point vs. a nonpoint source of pollution is the inability to identify a single point of release attributable to nonpoint sources. Nonpoint pollution can affect both surface and groundwater quality. Examples of nonpoint sources include septic system releases, spills of chemicals or leaks from tanks, agricultural releases (fertilizer, pesticides etc), stormwater from impervious surfaces etc.

Legislation is in place to address most un-intentional discharges via spill reporting, containment and mandatory cleanup. However, some nonpoint sources, such as road de-icing salt and agricultural uses are not tightly regulated due to the widespread nature of application (many miles of roads and acres of land under cultivation). Stormwater is managed from a 'pro-active' standpoint with the implementation of best management practices (BMPs) at the time of construction activities. Stormwater controls are also required for populated centers so that flows are captured within stormwater culverts and allowed to passively be treated through gravity and phase separation, or are piped to WWTPs.

Stormwater becomes a nonpoint pollution issue when it comes into contact with exposed soil and pollutant materials (road salt, metals that have deposited on roads from air emissions from fossil fuels etc.). Construction activities have been considered one of the most significant contributors to rainfall erosion and sediment transport via stormwater. The CWA and State regulations require that the best practical measures be used during construction activities in order to reduce offsite impacts on water quality (CDPHE and USEPA *Stormwater* regulations).

The Town of Rico has certain nonpoint issues of potential concern including those issues related to inactive mines, septic systems and stormwater. There is minimal agricultural/silvicultural activities of potential concern. The mine-related nonpoint sources represent the most critical, while the combined effects attributable to out-dated septic systems would be the second-most concerning. Stormwater represents an ongoing and potentially significant concern. The Town of Rico does not have a stormwater management system, which may pose as a significant concern in the future as growth continues and the amount of stormwater flows will increase. There is also the potential for stormwater related concerns in regards to the amount of river-adjacent construction proposed as part of the Town's economic development steps.

The purpose of the following Section is to describe the potential or known nonpoint pollutant sources to the *Project area*, and provide initial/general recommendations for their control.

This Section provides an overview of nonpoint concerns, while **Section 4** already provided a water quality analysis of some of these concerns (mine-related), and later Sections (**Sections 8 and 9**) provide distinct project specific recommendations and possible funding sources.

6.2 Potential Nonpoint Source Impacts

Potential sources of nonpoint pollution may result from either planned or unplanned discharges and can be categorized as waste- and non-waste derived. Examples of discharges of wastes into subsurface environments that can affect groundwater (and subsequently surface water), that are relevant to the *Project area* include septic systems, buried or capped mine waste piles and materials, and land disposal of residential soil/lead materials at the repository located North of Town. Waste related sources disposed at the surface that can affect groundwater (through leaching) and surface water directly (through overland flow to a receiving system) include the surface water settling ponds associated with the St. Louis ponds, and exposed mine waste materials. It should be noted; "runon/runoff controls (including surface grading, ditches, berms, etc.), compaction of near surface soils, and reclamation of the surfaces by revegetation or the placement of 'rock mulch' as implemented under previous VCUP actions have significantly reduced the leaching and transport of metals from 'capped mine waste piles and materials' to underlying groundwater. In the case of the soil lead repository, the geocomposite liner (GCL) and pipe drain system installed at the base of the repository intercepts any leachate from the pile and conveys it to the Ponds system for treatment (AR Comments – provided in Appendix H of this report)."

Non-waste related nonpoint sources to subsurface environments could include leaking underground storage tanks, and contaminated groundwater from subsurface mine workings. Non-waste related nonpoint sources to surface environments include stormwater carriage of road sand and salt (and some metals) from roads and other impervious surfaces (i.e. hardened river-bank areas affected by human disturbance), and chemicals from incidental spills or herbicide/pesticide/fertilizer use.

There are also certain 'natural' nonpoint sources of elements (metals and nonmetals) that occur within the *Project area* that are related to naturally enriched groundwater (due to the geology) and the geothermal hot springs. The water quality of these nonpoint sources is laden with enriched levels of common ions, elements and heavy metals. The contribution of these natural nonpoint sources needs to be taken into account when evaluating other nonpoint source contributions (i.e. those related to mine-related sources).

In summary, the types of nonpoint sources relevant to the *Project area* include;

- Subsurface waste disposal practices including septic systems, soil/lead disposal and mine-waste disposal buried or capped.

- Surface wastes of mine water settling ponds and mine-waste.

- Subsurface non-waste sources of contaminated groundwater from mine workings, potentially leaking underground storage tanks

- Surface non-waste sources from stormwater carriage of sediment, salts and metals, and materials from incidental spills or direct application of herbicides/pesticides/fertilizers.

- Natural nonpoint sources related to enriched groundwater and geothermal springs.

The above types of nonpoint pollution fall into two broad categories of 1) land use, development and disturbance related nonpoint sources, and 2) inactive mine-related sources. The following subsections describe the potential water quality issues associated with these two types of nonpoint sources.

6.2.1 Land Use, Development, and Disturbance

Nonpoint sources of pollution attributable to land use and disturbance include;

- historic landfill areas,

- septic systems,

- potentially leaking underground storage tanks and above ground storage stanks (USTs/ASTs),

- materials from incidental spills or direct application of herbicides/pesticides/fertilizers.

- stormwater carriage of sediment, salts and metals as related to construction/development, impervious surfaces, human activity etc.

Historic Rico Town Dump

An assessment of the historic Rico Town Dump was completed by Walsh Environmental in 1995 as part of the Phase I and II Environmental Site Assessment efforts. The landfill occurs at the southern terminus of River Street (south of Newman Street) within the Group Tract mine claim. Landfills and dump areas can often be the source of nonpoint pollution if improper liners and collection devices were installed at the time of construction. Waste materials could leach and affect groundwater and surface water systems if the leachate hydrologically connects to these resources. As part of the Walsh

investigations, several trenches were excavated using a backhoe in order to determine the depth and type of waste disposed in the landfill. Results indicate that the trash appeared to have been placed in long trenches and then covered with about 1.5 to 2 feet of fill. The trash extends up to 13 feet deep in some places. The landfill dimensions are about 160 feet (north/south) by 140 feet (east/west).

A total of 11 trenches were excavated during the Walsh investigations. Six did not contain waste materials. Four of the trenches contained little waste, and one trench in the southwest corner of the dump contained large amounts of waste. Two soil samples were taken at the site, one from a trench containing a small amount of trash on the west/central portion of the dump at a depth of 6 feet (just above bedrock). Debris in this trench consisted primarily of soil and cobbles but included glass, cans, plastic, black-stained soil, wood, and paper. The second sample was taken from the trench in the southwest corner of the site that contained pipes, wire, cans, a hot water heater, pails, pans, glass, plastic, rugs, lumber, rubber, and clothes. The sample was taken at a depth of about 14 feet, which was 2 feet below the disposed wastes.

Each of the samples was analyzed for VOCs, SVOCs and total metals. No detectable concentrations of target compounds were found in the VOC and SVOC analysis. The metals results are included in **Table 6.1.** Results indicate that the Historic Town Dump is of little concern in regards to being a potential nonpoint source.

Septic Systems

It is unknown if the existing septic systems within the *Project area* are having an impact to the water quality of the basin. Very little information is available regarding these systems. A summary of obtained information is as follows;

- Alvin Marsh – Dolores County septic system inspector, knew only of features associated with systems in the SunDial development (personal communication, 2006). He was not aware if any of the systems within the Town of Rico were engineered or not. Further research by the Dolores County staff could yield no distinct information about the systems themselves.
- Of particular interest (as identified by area residents and the previous systems inspector: Mickey Perlman) is the septic system associated with an RV parks located South of Town, just down-gradient of the *Project area*. Direct communication with the park owners indicates that these systems are adequate, well maintained and a part of the CDPHE permitting program. It is unlikely that there is any concern related to these systems.
- It is more likely that the out-dated septic systems within the Town are of potential concern to the *Project area* and require further evaluation.

There are an estimated 220 septic systems within the Town of Rico. This number was based upon the fact that there are 247 water taps, 27 of which are not being used (no structures on the associated property). It is also estimated that approximately 25% of these septic systems are not working property, or have cesspool type systems, which are

currently illegal in regards to meeting standard building codes (Town of Rico, 2006). In addition to the 220 systems associated with the Town of Rico, there are others outside Town limits that fall within the Dolores County permitting guidelines. **Table 6.2** provides a summary of septic systems that occur outside the Town limits, but within the *Project area*, that are reviewed as part of the Dolores County permitting system. These are the only septic systems for which any inventory was available.

A conventional on-site sewage disposal system consists of a septic tank and filter field. Sewage from the house enters the tank where its organic compounds are partially broken down by bacterial action. The effluent from the tank still contains many solid and soluble organic compounds, inorganic solutes and bacteria. This effluent is conveyed slowly through the pipes in the filter field and allowed to drain into the soil over a large area. Bacterial action within the soil further breaks down the solid and soluble organic compounds, some of the inorganic solutes become bound to soil particles, and the remaining solids, including bacteria, are filtered back into the soil (Dunne, T. and L.B. Leopold, 1998). The effluent then drains to groundwaters and streams. Certain pollutants, particularly nitrates remain in the effluent and can become a water quality concern down-gradient. In addition, biological indicators and pathogens of septic systems (Coliforms, E. Coli) can also present a human health concern.

Engineering specifications for septic systems recommend that for efficient operation, the filter field should be located in a large volume of soil (SCS, 1967; 1972). The drain pipe should be buried below the top soil at a depth of at least 60 cm. There should be at least 1.5 m of soil above the bedrock so that the effluent will be adequately filtered before reaching the bedrock. The water table (depth to groundwater) should be at least 60 cm below the base of the drain field, and filter fields ideally should not be located on hill-slopes with gradients greater than about 10 percent (HHFA, 1954: SCS, 1967 and 1972). These optimal requirements are not always available in a given setting, especially for a high-altitude, valley-confined community setting such as the Town of Rico. Another point of consideration is the seasonal temperatures which can limit the amount of viable activity time for the bacteria in the system as a whole.

Given the historic condition of the septic systems associated with Town of Rico, it is likely that the combined effluent from these systems is a potential concern to the groundwater quality within the *Project area*. Fortunately, the Town has taken significant strides towards the completion of a wastewater treatment plan which will address many of the existing systems. Future development will also be largely addressed with the use of this plant. If, for whatever reason, the WWTP project were not to be completed, it is likely that engineered septic systems would have to replace the existing systems and serve as the construction template for future development. The Town of Rico is anticipating significant growth in forthcoming years, and any new septic units will add to the existing burden. If however, the WWTP were to be successful this concern would no longer apply.

Storage Tanks

Storage tanks are often used to contain fuels, oils, solvents, water or other materials. If these tanks are not properly constructed they can act as a source of nonpoint pollution. As per review of the USEPA and CDPHE above-ground, underground and leaking underground storage tank (AST, UST, LUST) inventory system that is managed by the Colorado State Oil Inspection Program (CSOI), there are 11 registered tanks within the Rico area zip code. A summary of features associated with these tanks are provided in **Table 6.3.** Available information was also reviewed to determine if any spills have occurred and were reported. Two events were recorded under the CSOI database and are summarized as follows;

- CDOT Rico (211 N Hwy 145 – 11/16/1994) Release identified; no further action required (as of 11/16/1994 and 11/28/1995) (COSTIS, 2006).

- Silver Creek Mercantile (225 S. Glascoe – 10/19/1998). Release was confirmed (9/28/1998), no further action required (2/18/1999) (COSTIS, 2006).

There were no further details regarding these 'events' available for public review. However given the fact that these events were reviewed by CSOI personnel and deemed appropriate for 'no further action', it can be assumed that there is no cause for concern in regards to residual contamination etc. In regards to the tanks currently within the *Project area* (**Table 6.3**), all of these tanks are regulated and reviewed by the CSOI. Most are out of commission and no longer being used. The remaining are regulated under the Resource Conservation and Recovery Act (RCRA) UST program which is managed by the CDPHE Hazardous Materials Division. There are no records of any of these tanks as having issues. Since they are property managed, it can be assumed that minimal to no nonpoint concern would be associated with these facilities.

Spills and Chemical Applications

Spill related information was obtained by accessing the CDPHE Environmental Release and Incident Reporting (ERIR) database (ERIR, 2006), in combination with the National Response Center (NRC, 2006). Results of the queries revealed little information of concern. The CDPHE database had record of five spill reports in 'Dolores County' since 1992. A summary of the public records related to these spills is provided in **Table 6.4**. There were no results from the National Response Center indicating there have been no severe spill incidences in the County (NRC, 2006). The records obtained from both database sources are kept current on their web sites (refer to ERIR and NRC reference citations)**.**

The USDA tracks fertilizer and chemical applications as part of their local extension efforts. Estimates are projected if 'real time' information is not obtained from local farmers and ranches. Research from the USDA Census of Agriculture (www.nass.usda/gov/research/Cropland/SARSIa.htm) indicated that there are no

recorded or projected chemical uses. This may be due to the low percentage of agricultural lands within the *Project area*. In addition, there were no pesticide treatment permits listed for the County. It is likely that any fertilizer, or pesticide use is on an individual case basis and not large scale. Given this slight amount of use, it is unlikely that intentional chemical releases are a significant nonpoint concern within the *Project area*.

Stormwater

In natural settings, rainfall is converted to runoff (stormwater) or is infiltrated into the underlying soils and groundwater table. In areas with impervious cover (paved roads, compacted bare ground, buildings etc.), less and less rainfall is infiltrated and more volume is converted to stormwater. As a result, less water is available to the groundwater table which in turn lends less water to the stream during dry periods (and more flow occurs during storms). The effects of the hydrodynamic adjustment are as follows;

- Floods increase in magnitude and frequency
- Dimensions of the stream channel are no longer in equilibrium and the stream banks are compromised
- Channels enlarge and scour stream banks
- Bank erosion contributes sediment load to the stream bed
- In-stream habitat degrades due to sedimentation and cut banks
- Water quality declines
- Aquatic life diversity decreases

The *Project area* would be defined as being comprised of 'sensitive streams' since they have a watershed impervious cover of zero to 10%.(CWP, 2001). As development occurs, the amount of impervious cover will increase, thereby increasing the amount of stormwater that will reach the sensitive streams. It is imperative that best management practices are put into place during construction and post-development in order to control these new hydrologic inputs.

Stormwater carriage of sediment, salts and metals is of utmost concern when a road or impervious barrier is very closely located to a surface water body. Then, the sheet flow will have an un-impeded pathway by which to transport sand, salt and metals. Roads and impervious surfaces act as a conduit for stormwater. As such, 'municipalities' are managed under the CDPHE stormwater permitting process. Municipal infrastructure stormwater permits are required for sites with a population of 10,000 or greater, or if they occur within close proximity to a populated center. Neither of these conditions apply for the Town of Rico. Therefore, the Town does not currently need to be concerned about the control of stormwater flows from their residential and industrial settings from a permitting standpoint. However, in the absence of having to comply with regulations, there are no stormwater controls, or best management practices, stormwater is largely uncontrolled and can act as a nonpoint source of pollution. The types of stormwater

sources, or problem areas associated with the *Project area* are described below (roads, recreator activity, construction, road sanding/salting, elevated metals in soils).

Stormwater - Roads

Highway 145 fortunately has a footprint that occurs with a 'buffer' distance between the actual road and the Dolores River. For the most part, there is a riparian fringe, or vegetation habitat that buffers stormwater and allows for the solids, salts and metals to settle out. This in-turn can create a 'phytotoxic' (poisonous to plants) response to the plants from the salts. If enough salts accumulate over time, the plants can be affected, and ultimately die. CDOT tries to balance the needs of the road de-icing with the potential overburden to adjacent areas. There are other roads (forest service roads) that run immediately adjacent to surface water bodies. These roads are bare earth and can create sheet-flow surfaces for Stormwater to travel and pick up sand from the road itself. Of potential concern are the following roads;

- ✓ FR 550 which is immediately adjacent to Scotch Creek for approximately 5 miles of distance
- ✓ FR 578 is immediately adjacent to Barlow Creek for the entire length of Barlow creek up to Bolam Pass
- ✓ FR 204 is immediately adjacent to the headwaters reach of the Dolores River for an approximate distance of three miles, and
- ✓ There are a myriad of roads that access residential and mine features within the Silver Creek sub-basin that can impact Silver Creek itself, and

Stormwater - Recreator Activity

Dispersed Camping and Recreator impacts along the River corridor may create a source of litter and human impacted areas. There are several types of recreator activities within the *Project area*: incidental camping and boat launch points along the length of the corridor (dispersed throughout the area), camping within designated campgrounds, hiking and mountain biking on established and un-established trails, and hunting or fishing along the corridor.

There are two campgrounds within the *Project area*.

1. Clayton Campground, with camper and tent sites;
2. Emerson Campground, located about 16 miles north of the Town of Dolores with family and group picnic sites adjacent to the upper Dolores River.

The above listed areas are identifiable impacted areas where there are known recreator impacts. There is also 'dispersed' recreator activity in the form of river-side campsites, launch points and recreator activity. Camping sites and launch points can create impervious surfaces thereby enhancing Stormwater sheet flow and particle carriage to the receiving system. It is unknown if this pressure is creating an impact to the drainage. Communication with the USFS recreation staff (Rick Ryan – River Patrol, Tom Kelly and Penny Wu – recreation specialists [USFS, 2006]) indicate that recreator pressure is present, but has not been extensively studied. The type of activity within the *Project area* is defined as 'dispersed' meaning the typical type of activity is characterized as single family, overnight stays (USFS, 2006).

The USFS has some outfitter/guide permits for fly fishing instruction for the *Project area* (comprised of five permit holders for a total of 132 user days (USFS, 2006), and there may also be some kayak/rafter use but it would be limited. There are five commercial fly fishing permit holders for the Upper Dolores. These outfitters provide instruction and guiding for fly-fishing recreators. The following is a list of outfitters and the number of 'user days' permitted by the US FS for use along the Dolores River Corridor (source: USFS, 2006);

- Animas Angler – 12 user days
- Circle K Ranch – 30 user days
- Duranglers – 20 user days
- Telluride flyfishers – 30 user days, and
- Telluride Outside – 42 user days.

There are other boating outfitters and educational-based permit holders (approximately 16 current permit holders) for the Dolores River as a whole BLM, 2006). The BLM Dolores Field Office manages 97 miles of the Dolores River from Bradfield Bridge to Bedrock, Colorado. The boating outfitters are managed by an allocation of number of launches which may have up to 25 people per launch. There is no limit on user days for this type of recreator activity (R. Ryan [BLM, 2006]). The Dolores River has a recorded number of user days by year as follows;

- For 1999 – 439 user days,
- 2000 – 921 user days,
- 2001 – 0 user days,
- 2002 – 0 user days,
- 2003 – 214 user days,
- 2004 – 174 user days, and 2005 936 user days (CROA, 2005 and 2006).

The number of user days is a reflection of the in-stream flows. During 2001 and 2002, a severe drought condition prohibited the use of the River by rafting industry. Very few water/boat-use recreators frequent the *Project area* with the

exception of kayakers. For the most part, only the fly-fishing outfitters frequent the *Project area*.

All the areas visited by recreator activities can demonstrate stormwater impacts since the ground has been compacted and is lacking vegetation. During rain events, the exposed ground can create a path for soil to erode into receiving drainages when rain or snow melt events occur. It is known that impact to the riparian and wetlands along the shoreline have occurred since vegetation has been trampled and damaged. Camp sites/launch points have created impervious surfaces at areas along the Dolores River. The extent is not wide-spread or considered significant at this point, however this type of impact may become an issue in the future and recreator activity increases. There is the need for pro-active planning to accommodate recreator use and minimize riparian/wetland area damage.

Stormwater - Construction

Construction activities are often found to be significant sources of stormwater erosion. Construction activities are managed under the CDPHE stormwater permit system. Review of the current stormwater permit status for Dolores County indicates that there is only one construction activity with a stormwater permit within the *Project area* (Permit: COR 038415; for Atlantic Richfield, within the Rico Townsite, along North St. Louis (tunnel) from 6/16/2005 for a long term use) (M. Czahor, pers. Comm.. 2006; CDPHE, 2006). Given the very low number of permits held within the *Project area*, it does not appear that construction activities are a current concern. However, given the anticipated future amount of construction activity associated with proposed residential and light-industrial development, it is likely that this source of stormwater can become significant in the near future.

Stormwater impacts will become more of a concern as the Rico area is developed. The increased amount of impervious surface created by build-out will compound the issues associated with stormwater by decreasing the infiltration capacity to zero, creating immediate runoff of precipitation from these impervious surfaces (Leopold, 1968; Seaburn, 1969 and Anderson, 1970). Areas of land that produce stormwater runoff also yield sediment, plant nutrients, bacteria and other pollutants (Anderson, 1970). Area residents have described the current conditions of pattern of sheet flow (stormwater and snow melt) as having the following patterns of travel : Flows along the South side of the highway travel down the corridor and ultimately cut across to the wetlands behind the Conoco gas station where they are routed down on to the Columbia tailings area, and don’t seem to be having an impact to the wetland area. Flows along the North side above Town are captured within the Silver Creek drainage system

Stormwater - Road Sanding/Salting

Road sand and salt operations as part of routine CDOT maintenance is a widespread concern throughout the State of Colorado given the need for the use and application of road sand and salt. As per communication with CDOT personnel, CDOT applies ½ the average concentration of magnesium chloride within the Town of Rico Town limits as a result of request from concerned citizens. The actual rate of sand and salt release varies depending upon storm event (CDOT, 2006). The rates of application supplied by Greg Roth/Maintenance Dept./Durango-DCOT were summarized as follows;

- A typical rate of material application is 750 pounds per 12 foot lane mile.

- From the top of Lizard Head pass down to the Montezuma County line, CDOT used + 1,577 tons of Sand/Ice slicer mix. The Ice slicer is 10% of the total amount.

The effects of 'over burdening' of road sand and salt can be very visual. Roadside vegetation often demonstrates a brown or yellow discoloration, or mortality. Little to no sign of phytotoxicity was noted within the *Project area*. There are definite areas along the highway with significant sand deposition that could ultimately transport to the Dolores River. CDOT attempts to minimize this amount but has to balance the application with the season activities. At this time, there does not appear to be a significant concern associated with this nonpoint source. It appears that stormwater controls are keeping most of the materials confined to the immediate roadside, and these materials are having minimal damage to the environment.

Stormwater - Elevated Metals in Soils

The Town of Rico has a unique stormwater issue potentially related to the enriched metals associated with Town soils. The soils have a natural elevation of metals, but there are also other mine-related wastes throughout the area that have elevated metals and occur throughout the town. Precipitation that comes in contact with these materials (and the native enriched soil) could lead to stormwater with elevated metals concentrations. Review of soils by Walsh (1995) indicated that 'risk' associated with the soil could be characterized by type. The risk ranking was due to the presence of elevated metals. The types of soils present were mapped and highlighted in order to understand the relative risk associated with these materials. The soil units with a high ranking included;

- Alluvium mixed with mine waste materials
- Alluvium mixed with mill tailings
- Clinker/fill/alluvium
- Clinker with mine waste

- Dump debris
- Disturbed soil
- Fill material
- Fill material mixed with mine waste
- Fill material mixed with mill tailings
- Mine waste spoils
- Mine waste and borrow areas
- Slag mixed with mine waste
- Tailings impounds

There were a number of types of soils present within the river corridor that could be described as 'high risk'. Since the time of this report, several VCUP activities have taken place to abate contaminated soil conditions. This Walsh mapping effort likely represents historic worst case' conditions. None-the-less, it provides an indication that site soils within the corridor likely have elevated lead which should be brought into consideration when addressing stormwater impacts for the *Project area*.

"Recent detailed mapping of surficial geology and mine waste materials is presented on Figure II-2 in Rico Townsite Soils VCUP Project Final Data Report and Data Evaluation, Volume I (Atlantic Richfield Company, 2006). This mapping was conducted specifically to identify and locate visible mine waste materials within the Rico Townsite. The mapping documents that mine waste materials occupy only local areas, mostly associated with the historic mine and mill sites in town and some larger road fills in the vicinity of those historic sites. These areas are estimated to comprise only about 11 percent of the surface area within the Townsite. Some of the surface gravel on unpaved roads (mostly in the northeast corner of town) also contains some amount of waste rock. To the degree that metals may be dissolved from soils and mine wastes in town and carried in Stormwater runoff, the very substantial majority of any such metals load would be generated from natural soils (alluvium and colluvium) and not mine waste materials. Also, nearly all of the mine waste materials in the Townsite are comprised of coarse-grained (gravel to boulder size) waste rock that is much less susceptible to metals dissolution by Stormwater runoff than fine-grained (silt to sand size) tailings would be. In regard to lead in surficial soils in the river corridor, AR has performed extensive sampling and analysis to identify areas with elevated lead concentrations and will remediate those areas (if any) that exceed the applicable health-risk based actions levels for this area that are currently being developed in cooperation with CDPHE under the soil lead VCUP (Atlantic Richfield Comment information – as provided in Appendix H to this report).".

6.2.2 Inactive Mines

The exposure of mining related waste materials (tailings and waste rock) to oxygen and water can lead to the release of acid mine drainage. A reaction takes place between the water, oxygen and metal-sulfide minerals such as pyrite. Essentially, sulfuric acid is produced which dissolves metals and carries them in solution to groundwater and streams (CGS, 2000). A summary of the chemistry of acid rock drainage is as follows;

Reaction 1. $FeS_{2(s)} + H_2O + 7/2O_2 \rightarrow Fe^{2+} + 2SO_4 + 2H^+$

(Pyrite + water + oxygen) yields (iron + sulfate + acid)

Reaction 2.* $Fe^{2+} + 1/4O + H^+ \rightarrow Fe^{3+} + 1/2H_2O$

Reaction 3. $FeS_{2(s)} + 8H_2O + 14Fe^{3+} \rightarrow 15Fe^{2+} + 2SO_4 + 16H^+$

Reaction 4. $Fe^{3+} + 3H_2O \rightarrow Fe(OH)_{3(s)} + 3H^+$ (catalyzed by bacteria)

(s) = solid

> ***Reaction 1)*** *A metal sulfide (pyrite) mineral reacts with water and oxygen producing acid.* ***Reaction 2)*** *Ferrous iron released from pyrite is oxidized to ferric iron, consuming some acid.* ***Reaction 3)*** *Ferric iron reacts with pyrite and water producing large amounts of acid.* ***Reaction 4)*** *Ferric iron reacts with water to produce a red precipitate and more acid (CGS, 2000).*

Geochemical investigations show that contamination from historic mines is generally less than what is predicted by geochemical or aquatic chemistry models. Most of the studied mining districts have at least a few sources of contaminants, but, in the majority of cases, the metals and acidity of concern are naturally mitigated to acceptable levels within a few miles of the sources (Nash, 2002). As studied by Nash (2002) and others, mine sites within Central Western Slope, Colorado; most sites that have 'self mitigating' circumstances have cadmium and zinc as their major metals of concern which typically occur at concentrations 1x to 2x greater than chronic exposure standards protective of aquatic life. Such is the case for the *Project area* which grapples with these and other metals loading issues within Silver Creek and the Dolores River.

A variety of wastes and contaminant release types can be associated with a mine site. These include released water, tailings and waste rock. Of principle concern are the direct adit releases where an underground portal is serving as a drain to an underground mining area when then releases this water to receiving surface water drainage. The treatment of these point source discharges can be costly and prolonged over time. The type of chemistry and contaminants associated with these direct discharges are reflected in the series of chemical equations above.

A second principle type of waste with a contaminant concern is mine tailings. Tailings are created from milling processes which pulverize ore rock into finely ground rock. This material is typically finer 'than beach sand' and is then subject to physical and chemical methods to concentrate the minerals. This can involve the use of jigs, tables, amalgamation and floatation. After going through several stages, the waste sand is typically disposed of in tailings piles which are often closely associated, if not directly released to an adjacent stream (Nash, 2002). The fine grain size of the tailings tends to make the constituents more reactive than in coarse mine waste or in un-mined rock. These tailings are easily eroded during storm events. Therefore, if these wastes remain in place adjacent to streams, flood events are likely to erode these materials and cause deposition within the receiving drainage these new 'tailings sediments' can be a toxic material to bottom-dwelling aquatic life within this system. In addition, the soluble or mobile portion of metals in the waste materials can become available through a series of chemical reactions, and pose an additional degradation issue to the water quality (Nash, 2002).

Waste rock can at times pose a contamination issue if it contains significant metals content and acidic character. Waste rock was given its name since this rock did not meet ore grade standards and was not milled. It is typically fairly large in size and associated with the bottom of piles or removed from the working mine by considerable distance (as compared to the processed tailings and ore rock). It is difficult to generalize the acid-mine-waste generation capabilities of waste rock as a whole. Each mine and geographic setting has its own unique set of variables that affect the contaminant release potential. Samples from adjacent receiving drainages, or from 'toe seeps' provide indicators of the contaminant producing potential of this material.

Section 4 provided an analysis of water quality conditions within segments of the Dolores River and Silver Creek based upon available information gathered in recent years. The studies which yielded the most relevant and usable information were developed in order to characterize point and nonpoint pollution attributable to inactive mines within the *Project area*. Thus, the conclusions and findings presented in **Section 4,** pertain here. In addition, others (CGS, 1989) have characterized inactive mines throughout the *Project area*, and were not captured by the SEH data gathering efforts which served as the focus of the **Section 4** discussion. Results from both this document (**Section 4**) and the CGS efforts (CGS, 1989) were combined to draw the following conclusions regarding inactive mine contributions to nonpoint pollution within the *Project area*;

- There are significant nonpoint sources of metals loading attributable to inactive mines within both the Dolores River corridor and Silver Creek that require further characterization and possible remedy efforts

- As per results from the **Section 4** water quality analysis, it appears that there are several mine-related nonpoint (and point) sources within the Silver Creek and Dolores River basins. Of significance to water quality concerns are the Argentine

mine, an unnamed adit within Silver Creek, St. Louis tunnel and ponds, Columbia tailings, Rico Boy/Santa Cruz mines, and the Silver Swan Mine. Results do indicate that these features require further evaluation and possible remedy development. **Figures 6.1 and 6.2** depict conceptual models of the Rico Boy/Santa Cruz mine sites, and the Silver Swan mine site. As shown within these figures, these sites encompass both nonpoint and point sources of water contaminant releases. There has been a considerable amount of remedy development as part of the voluntary clean-up program (**Figure 6.3**), yet these sources of water quality concern still remain. The recommendations provided within this document (this Section and **Section 8**) describe that these particular features (in addition to the Argentine, unnamed adit, the St. Louis system, Columbia tailings etc.). Require further evaluation and effort in order to control these sources.

- As per results from the CGS evaluation of abandoned mine lands associated with federal lands (mixed with some private land ownership) there are several mine sites which pose a significant environmental risk, and can possibly be contributing to the overall metals load observed within Dolores River and Silver Creek. The particular mine sites of interest (as shown in **Table 4.10 and Figure 4.2** in **Section 4**) include;

  - ✓ The **Mountain Spring Mine** has both private and federal land ownership. The degraded water from this spring likely connects with the Dolores River. There is a large, sulfide-rich mine dump that has phytotoxic characteristics associated with the spring. There is a flooded shaft that has been measured to release 30 gpm of water during Spring melt conditions. The water from the shaft flows adjacent to waste dumps and has degraded water quality with low pH (3.6 and 3.9 as measured by Walsh Inc., 1995) and moderate conductivity (2,500 uS). The dumps associated with this site have acid generating character and contain significant amounts of material (upwards of 85,000 yd3). Seeps associated with the dumps yield very acidic leachate (pH of 2.7 – 3.5). The Middle CHC mine is located immediately above the Mountain Spring Mine and is thought to hydrologically communicate with the Mountain spring Mine (CGS, 1989). Any activities taken to control the Mountain Spring concerns should likely look at the potential contributions from the Middle CHC site as well.

  - ✓ The **Nola Lily Mine** is located below the St. Louis adit and settling ponds, on the east side of the Dolores River. Water drains from one adit, and three dumps have significant volumes of sulfide materials. It is unknown as to how much degraded water quality influence these features may have, and likely contribute to the settling ponds. Further evaluation of the hydrologic conditions associated with this site need reviewed.

- ✓ The **Revenue Mine** is located on the south side of Silver Creek and contains several mine waste dumps with seeps that may contribute to the degraded water quality within Silver Creek. Since there is no discernable point discharge associated with this Site, it will be difficult to delineate the site's contribution to Silver Creek's water quality. A strategic sampling effort could be designed in order to capture the potential load contribution contributed by this site.

- ✓ **Other mines (ABG, Aztec, Sambo, Horse Creek Sites)** were reviewed by CGS but found to have a lower overall risk ranking. These mines should be evaluated from the context of understanding their potential contribution to the total metals load within the *Project area*. For instance, the ABG is located immediately adjacent to the Dolores River and has been found to flow at a rate of 28 gpm. The water quality is not significantly degraded, but may still contribute metals load. The seasonal contribution associated with this site should be further evaluated.

6.2.3 Hydrologic Modifications and In-Basin Changes in Water Usage

Hydrologic modifications can affect nonpoint sources by adjusting water levels and nonpoint communication with a water body. For instance, if a surface water resource is drawn down, the groundwater recharge may be drawn in at an accelerated rate. Another type of effect is associated with drawn down surface water bodies where shoreline is exposed thereby affecting viable riparian areas and exposing sediment as soil to erosion. It is important to understand the *Project area* hydrologic modifications to put into perspective any compounding variables that may be affecting nonpoint sources.

There are minimal hydrologic modifications to the in-stream flows associated with the *Project area*. The following provides a summary of existing modifications, followed by a description of proposed modifications.

Existing hydrologic modifications:

- Much of the Dolores River channel through the Town of Rico is confined within a narrow valley form due to confinement from the highway footprint, historic mining features and development. As a result, scouring and high-energy flows have eroded banks and caused concern for flooding conditions. While no flows have been displaced from the valley form, the true channel path has been affected and is no longer available through portions of the *Project area*.

- The current potable supply for the Town of Rico exists within the upper reach of Silver Creek. There is likely an immediate depletion to the Silver Creek catchment as a result of this use, but given the fact that the Town of Rico relies upon individual septic systems, a large portion of the consumed water will

eventually be returned to the watershed as a whole via groundwater recharge. Therefore, the actual amount of irrecoverable loss is at a minimum.

- There are irrigation ditches associated with the *Project area* that exercise their water rights during the irrigation season. A summary of those amounts by ditch, location and seniority are described in **Appendix C**.

- There are seeps and distinct flows associated with inactive mine features that may be creating a different hydrologic regime than what was historically present within the *Project area* before the mining era. For instance, the portal for the Argentine was plugged in order to route flows through to the St. Louis tunnel. This re-routing of subsurface mine-collected groundwater exemplifies the dynamic equilibrium of groundwater balance within the *Project area*. It is unknown as to how the presence of the underground mine workings may have altered the groundwater to surface water hydrologic pathway.

- There were several Voluntary Cleanup Projects (VCUPs) undertaken by AR to control mine tailings issues within the *Project area*. There have been other mine-related activities that have likely affected the hydrology since materials were moved, recycled etc. The Colorado Division of Minerals and Geology has conducted only one mine closure-type activity within the *Project area* and it entailed the closure of a hazardous adit within Horse Creek. The hazards were related to potential human injury and not related to environmental concerns (Krebaucher, P. pers. Comm.., 2006). .

Proposed hydrologic modifications:

- The Town of Rico is on the cusp of constructing a WWTP which will have a point of discharge on the Dolores River. The water balance associated with this facility will likely have a minimal impact to the *Project area*, given that the point of diversion for the potable supply will be up-gradient within the Dolores River basin, and the point of release for the WWTP is down-gradient.

- Rico has a 3.0 cfs water right on Silver Creek that is senior to CWCB's in-stream flow right (2.78 cfs conditional, with 0.28 cfs absolute). CWCB has a 20 cfs in-stream flow right on the Dolores River that is more than natural winter baseline flows (16 – 17 cfs on average in winter months). The Town of Rico is pursuing a watershed planning and river restoration program in cooperation with the USEPA and CWCB. The CWCB could be satisfied by either pumping lower alluvium for augmentation, or 'injuring with mitigation' (Heil, E., No date). The point of diversion change is unlikely to affect the overall hydrology of the *Project area*. The potable supply needs are minimal and will have less of an effect when drawn from the Dolores River as compared to Silver Creek. By moving the potable supply point of diversion, Silver Creek will have restored flows which will be particularly beneficial within this catchment during low flow periods.

- The Town of Rico is anticipating a significant amount of growth and development. Much of the residential population is comprised of seasonal occupants. None-the-less, it is anticipated that industrial development will accompany the anticipated growth, and the residential community will likely expand slightly (in regards to year-round residents). As a result, a loss due to potable supply will occur. It is unknown as to how much this loss will equate to, but will be managed given the need for continuous mitigation of injury attributable to this additional use.

6.3 Groundwater Issues

Little is known in regards to groundwater issues, other than the fact that inactive mines have created a unique underground setting that has likely affected groundwater quantity and quality. What few studies have been completed (Harris Engineering, USEPA, Ecology and the Environment) indicate that groundwater quality in general is of good quality. However, the points from which samples were taken for these studies broadly characterize area conditions. It is known that seeps associated with inactive mine features represent groundwater that has daylighted via an artificial opening. The water quality with many of these mine-site seeps is often degraded with low pH, high conductivity and elevated metals concentrations. These seeps become a concern when they make contact with a surface water body with a designated use such as the potable supply or variety of uses designated to the Dolores River. Results from this plan indicate the need to further evaluate several seep sources and their contributions of degraded water quality to the receiving systems of Silver Creek and the Dolores River. It may also be required to study additional tributaries such as Horse Creek and Aztec Gulch (and others) where little information is available, but there are known mine sites within the area.

6.4 Nonpoint Source Recommendations

The Town of Rico has several nonpoint pollution source issues that require different types of activity. The most significant current nonpoint pollution concern is associated with mine-related features. There are several mine-related sites that are loading metals into Silver Creek and the Dolores River that require further study and possible remedy development. The specific recommendations associated with these Sites can not be formulated until additional information is gathered in order to characterize these sources.

There are other potential current nonpoint sources related to septic systems. This source however, may be controlled if the Town were to achieve its goal with the construction of a WWTP. If in the event this WWTP were not to succeed, the Town would need to address potential impacts with the construction of engineered septic systems to eventually replace the non-engineered systems which exist today.

There are other nonpoint sources in the *Project area*, but none are significant enough to warrant action in the form of remedy of BMPs, but rather would benefit from active planning to control these sources in the future. The most significant future potential nonpoint pollution concern is in the form of stormwater impacts. A variety of future activities may enhance the amount of sheet flow from rain fall to travel across bare earth surfaces and roadways thereby causing potential sediment, salt and metals deposition to receiving drainages. This stormwater concern comes from a variety of sources. These sources include; increased recreator activity within the river corridor which can trample the vegetative buffer zone and create bare earth surfaces, increased construction throughout the Town of Rico for residences, commercial and light industrial activity (a large portion of which is closely located to the Dolores River corridor). The Town of Rico does not have a stormwater management system, which may post as its most significant concern in the future as growth continues and the amount of stormwater flows will increase.

It is recommended that the Town of Rico take an active role in the planning and management of the mine-related and stormwater related nonpoint source pollution control development, as they move forward with their various economic development activities. As a first step; it is recommended that the Town administration become aware and knowledgeable of nonpoint source control measures and options. There are a variety of mechanisms (professional societies, Council of Government training sessions, and other types of training sessions) that can provide an overview of these topics. Specific recommendations for nonpoint source control strategies are described below and within **Section 8** (specific strategies are more thoroughly described within Section 8 since stormwater BMPs are proposed to be co-located with other nonpoint source controls related to mine sites).

Once best management strategies are put in place, it is imperative that monitoring of the success (or failure) of these controls begin. It is preferable that monitoring take place prior to nonpoint source control, during and after. The information gained would clearly demonstrate the effectiveness or the needs of the source control practice. General recommendations for source control strategies and monitoring are described in the following subsections. These recommendations are laced into the overall suite of Watershed Planning Recommendations provided in **Section 8**.

6.4.1 General Nonpoint Source Recommendations

There are several types of pollutants that could be introduced into the *Project area* watershed as a result of nonpoint sources. These include soil/sediment, nutrients and metals (including salts). The soil/sediment is a result of stormwater transport of soils to the receiving system. These soils become sediment once they are introduced into the stream channel. When sediments settle to the streambed in large quantities, the sediment clogs the spaces in between the rocks and gravel in the streambed. Excessive sediment in streams smothers aquatic habitat and may reduce the numbers and diversity of aquatic organisms that form the base of the food chain. (Waters, T.F., 1995).

Nutrients (primarily nitrogen and phosphorous) can come from the septic systems and from organic material adhered to soil particles that are transported via stormwater. They are essential for healthy aquatic systems; however an overload of nutrients in a stream often leads to excessive algal growth and productivity. This in turn, may reduce the availability of dissolved oxygen to aquatic organisms, alter stream habitats, lead to unfavorable aesthetics and odors and lead to the release of heavy metals from streambed sediments (Waters, T.F., 1995).

Metals can come from a variety of nonpoint sources including combustion of leaded fuels, natural geologic features and mine-related features. Certain metals are essential elements, while others are toxic to aquatic life. Aquatic systems can assimilate metals to an extent, but can 'over load' and end up exhibiting toxic effects. The methods for capturing and treating these various types of pollutants vary. The following describes some general best management strategies to capture and prevent the transport of these contaminants to the *Project area* watershed.

The Town of Rico has the added concern of having lead present at sometimes elevated concentrations within the industrial and residential settings. Therefore, stormwater flows of Town soils may have additional lead concerns due to these mining related historic levels. There are a number of 'soils' data sets that have useful information from which to characterize the potential effect these soils may have (Wash Env [1995], AR and CDPHE [years]). This information could be used to estimate the potential soils overland flow impacts to receiving systems. Soils transported to receiving drainages, in turn could become a source of sediment and sediment contamination, if the soils have contaminant issues. Simplistic models could be applied to determine if this pathway is of potential concern, but is beyond the scope of this document. The analysis of this potential pathway is a 'recommendation for next steps' as identified in **Section 8**.

For the <u>control of stormwater related concerns</u>, there are a standard set of pre-emptive measures described by others (Lorch, B. and L. Wyatt, 2000; USEPA, 2005) These strategies are useful for the control of soil, salt, nutrients and metals that can transport to receiving drainages. These general strategies include;

1. Retain and protect natural vegetation: Natural vegetation is the most efficient form of erosion control. In the harsh mountain climate it is difficult to re-establish vegetation. Vegetation reduces erosion by:

   - ✓ Absorbing raindrop impacts
   - ✓ Reducing runoff velocity
   - ✓ Reducing runoff volume by increasing infiltration into the soil
   - ✓ Acting as an anchor to improve soil and slope stability

Therefore, when construction begins, it is prudent to strip only the area required for construction, and stage grading so that only the portion of the site that will be constructed within the next 14-21 days is cleared of vegetation.

2. Time grading to minimize soil exposure during snowmelt and rainy periods: In the Rocky Mountains, spring snowmelt results in saturated soil conditions and the highest volume of natural runoff. Late summer thunderstorms result in high intensity runoff. Both of these hydrologic events cause erosion of unstable or disturbed soils. Therefore it is best to schedule major grading work during early summer or late fall.

3. Protect disturbed and cleared areas: After grading is completed, seed and mulch the bare areas as soon as possible. The mulch will protect the soil until the vegetation is established. Grasses provide the best short-term protection. Blankets and matting will reduce erosion on slopes. After construction is complete, grasses can be replaced with desired long-term vegetation.

4. Infiltrate runoff from impervious surfaces: On undisturbed land much of the rainwater and snowmelt seeps into the ground. Runoff from impervious surfaces such as roofs, paved walkways and driveways, and packed soil surfaces greatly increases erosion potential. Locate infiltration trenches below roof eaves and along driveways and parking areas. If a roof drip line or driveway is on a steep slope, install a lined ditch to route the runoff to a dry well or an infiltration trench located along a slope contour.

5. Minimize the length and steepness of slopes: Long or steep exposed slopes have high erosion potential due to the concentration of runoff. To shorten runoff pathways, construct barriers to divert runoff before it can reach erosive velocities.

6. Keep runoff velocities low: The energy of slowing water dramatically increases as velocity or volume increases. If velocity doubles, the erosive energy quadruples, and the water can move particles 64 times as large. Velocities can be kept low by:

   - ✓ Keeping flow volumes low (through measures such as preserving site vegetation, infiltrating runoff or dividing runoff into several channels).
   - ✓ Constructing flow barriers at frequent intervals, or
   - ✓ Lining channels with rough materials such as vegetation or rocks.

7. Protect drainage-ways and outlets from increased flows: Grading may cause runoff to concentrate in a single channel instead of being dispersed over a broad area. These changes can cause channel erosion unless protection measure are installed.

8. Keep clean water clean: Divert runoff from off-site and on-site undisturbed areas away from cleared or disturbed areas (entails the use of 'run-on' channels.

9. Trap sediment on site: Some erosion during construction is unavoidable. Sediment-laden runoff must be detained on-site so that the soil particles can settle out before the runoff reaches a stream, or someone's property.

The above are 'general' guidelines for the control of stormwater related issues. There are numerous specific approaches for each of the numbered guidelines. These efforts will help control several types of nonpoint pollutants including soil/sediment, metals/salts and nutrients. Addition types of general BMPs for nutrients and metals would include;

- The enhancement of a 'riparian buffer' or vegetative fringe that would take up the nutrients and metals, and remove them from being transported to adjacent streams.
- The enhancement of a travel distance, and decreasing of water energy for flows to drop heavy solids out of solution which typically contain nutrient load.

6.4.2 Monitoring Recommendations

Monitoring of the nonpoint sources is recommended. The Town of Rico should implement a *Project area*-wide monitoring program that could be designed to gather information pertinent to a number of goals. The monitoring program could be designed to capture the nonpoint pollution impacts, in addition to point source impacts etc. The recommended monitoring program design is described in detail in subsection 7.4**.** Prior to its implementation however, it is recommended that a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) plan be written for the monitoring program. These two documents would provide the overriding goals, structure and distinct steps to be taken throughout the monitoring program, and would be formatted to follow standard FSP/QAPP requirements (USEPA, CDPHE and others). These documents should be reviewed by the watershed stakeholders in order to obtain a cohesive and comprehensive plan for monitoring. The monitoring plan will not displace others' activities within the watershed, but will build upon the existing programs and will ultimately share the obtained information with other interested parties if deemed appropriate.

6.4.3 Best Management Practice Recommendations

As identified within this Section, a potentially significant nonpoint source of pollution associated with current and future development within the area of the Town, includes stormwater and the substances carried by it. Given that the Town is on the cusp of significant growth, it is recommended that a stormwater management plan be implemented so that future growth does not add undue burden to this nonpoint source. The Town should also remain aware and active in regards to proposed development Stormwater regulatory compliance. All proposed development activities will be required to obtain a Stormwater Construction Permit through CDPHE. Information regarding the

permit requirements etc. can be found on the USEPA National Pollutant Discharge Elimination System web page concerning Stormwater and Construction programs (http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm) and the CDPHE Construction Permit Unit web page (http://www/cdphe.state.co.us/ap/conperm.asp.

It is also recommended that the current Stormwater flows be managed in a uniquely integrative manner with certain proposed development projects. It has been mentioned, that a riverwalk/river corridor greenbelt may be designed to allow for recreational use. There has been significant, long-term demonstrated success with riparian area construction that allows for this use and also is engineered to address Stormwater concerns (case study – Cherry Creek Reservoir/Denver, CO). There is an abundance of guidance and potential ideas for engineered Stormwater features that could enhance the riverwalk setting. These projects lend themselves to grant funding (i.e. low-impact development funds: USEPA, 2006) and demonstrate the Town's investment towards improvement of water quality. Example sources of information that the Town could use to scope such a project include;

- International Stormwater Best Management Practices (BMP) Database. Constructed by a consortium of regulatory agencies and private enterprises. The database provides a review of BMPs available for numerous settings and goals (http://www.bmpdatabase.org/).

- There are also numerous training and assistance programs associated with the USEPA and the Center for Watershed Protection, in order for interested parties to become educated and enabled to secure grant sources. A source of USEPA can be found on the USEPA Stormwater web site (http://yosemite/epa.gov/R10/WATER.NSF/).

6.4.4 Inactive Mine Recommendations

The first and foremost recommendation in regards to addressing the nonpoint concerns related to the inactive mines, is to conduct further monitoring of key features that have shown demonstrated issues (Argentine, unnamed adit, Rico Boy, Santa Cruz, Silver Swan etc.) as well as those that have little to no information available and may be of potential concern (Mountain Spring Mine, The Revenue Mine and others. Once a solid foundation of understanding the load contribution associated with each has been completed, it is possible for the Town to complete pro-active cleanup projects of the high priority sites.

Proactive cleanup efforts require regulatory compliance procedures, funding, engineering and economic analysis, follow-on operations, maintenance and monitoring. Embarking upon such a task can seem daunting but has been met with success throughout the Rocky Mountain Region. Regulations are often the most difficult hurdle for proactive groups to cross. The treatment, transportation, removal and eventual repository of wastes (solid and liquid) are all regulate by a variety of authorities. Understanding these regulatory requirements and being compliant can be difficult. For instance, pro-active cleanups have

been very successful when 'solid' waste sites (such as mine waste) have been tackled (refer to the Colorado Watershed Assembly web site), however the treatment of water is a difficult task for stakeholder-lead groups to grapple with. The 'treatment of water' as defined within the CWA, creates a liability of ownership and continued operation and maintenance of the remedy that was put in place. This holds the proactive group liable for continued maintenance and monitoring of a remedy in-perpetuity. Since most pro-active-stakeholder groups are unable to deal with such a liability, water issues often go unaddressed. Recently however, legislation is being passed and reviewed in order to aid those who would like to take steps and deal with contaminated water. As per recent legislative information provided through the CWA,

> *"The Good Samaritan Clean Watershed Act, introduced May 10, 2006 in the U.S. Senate, seeks to remove some of the legal barriers that discourage non-liable parties from cleaning up abandoned mines. The proposed legislation was introduced on behalf of the Bush Administration. The Senate Committee on Environment and Public Works held a full committee hearing to discuss the legislation on June 14, 2006.*
>
> ***"The Good Samaritan legislation would help remove the threat of liability and encourage volunteers to restore watersheds."***
>
> *There are more than 500,000 abandoned hardrock mines in the U.S. Acid mine drainage from these mines pollutes watersheds and degrades water quality. In many cases, the mine owners who contributed to the contamination no longer exist, so the onus of cleanup falls to the federal government or voluntary parties. Under existing laws, third parties can be liable under the Clean Water Act (CWA) and/or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) even if they did not cause the pollution. The Good Samaritan legislation would help remove the threat of liability and encourage volunteers to restore the watersheds.*
>
> *Before initiating cleanup, parties would be required to submit a permit application to USEPA outlining their cleanup plan, financial resources, and other relevant information. USEPA would evaluate the application, and if acceptable, issue a permit. The parties conducting the cleanup would be granted CWA and CERCLA liability protection only for actions taken under the permit. USEPA would maintain enforcement authority which would allow the Agency to issue administrative orders for violations of the Act or pursue civil action in U.S. District Court. "*

This legislation may enable many proactive efforts. Regardless, there are other proactive remedy strategies not involving water management that the Town could embark upon. Once a thorough characterization of the mine source areas is complete, the beginning stages of remedy efforts can commence. These steps are further described in the nonpoint source control recommendations in the next Section (**Section 7**).

TABLES

Table 6.1 Results of Metals Analysis in Soils Collected from the Historic Town of Rico Dump. (source; Walsh, 1995).				
Parameter and Units	Detection Limit	Soils of the Western US (typical concentrations)	Location	
			T-01	T-02
Aluminum (mg/L)	100		19,000	10,000
Antimony (mg/L)	20	<1 – 2.6	ND	ND
Arsenic (mg/L)	20	<0.1 – 97	ND	36
Barium (mg/L)	50	70 – 500	110	140
Beryllium (mg/L)	2	<1 – 15	ND	ND
Cadmium (mg/L)	2	0.01 – 10	ND	4
Chromium (mg/L)	5	3 – 2000	24	16
Cobalt (mg/L)	5	0.05 – 65	10	8
Copper (mg/L)	5	2 – 300	9	74
Iron (mg/L)	5		26,000	24,000
Lead (mg/L)	20	<10 – 700	20	380
Manganese (mg/L)	5	30 – 5000	500	4,300
Mercury (mg/L)	0.2	<0.01 – 4	ND	ND
Molybdenum (mg/L)	20		ND	ND
Nickel (mg/L)	5	<5 – 700	24	13
Selenium (mg/L)	20	0.01 – 12*	ND	ND
Silver (mg/L)	10	0.01 – 8*	ND	11
Thallium (mg/L)	50	0.02 – 2	ND	ND
Vanadium (mg/L)	10	3 – 500*	29	24
Zinc (mg/L)	5	10 - 2100	65	640

Location Description

T-01 Trench No. 1 from the Rico town dump
T-02 Trench No. 2 from the Rico town dump

* = source: Bowen, 1979, all others from Schacklette & Boerngen, 1984.: as cited in Walsh, 1995.

ND – Not detected at stated Detection Limit

Table 6.2 Summary of Lots with Permitted Septic Systems. (as per Dolores County Assessor Records, 2006).		
Address	County Rd	Lot #
15050	Sundial Village	3
15050	Sundial Village	5
15050	Sundial Village	4
15050	Sundial Village	9
15050	Sundial Village	2
15050	Sundial Village	14
15050	Sundial Village	6
15050	Sundial Village	10
15050	Sundial Village	7
15050	Sundial Village	15
15050	Sundial Village	16
To be determined	S. Sundial Way	18
15050	Sundial Village	13
15050	Sundial Village	8
15050	Sundial Village	11
15050	Sundial Village	12
15050	Sundial Village	17
15050	Sundial Village	1
-	S. Sundial Way	-
15050	Sundial Village	-

Table 6.3 Summary of UST/ASTs within the Project Area. (source; COSTIS, 2006b).				
Facility / Owner	Capacity and Type	Product	Tank Material	Status
Rico Town Shop / Dolores County	500 gal UST	4-Diesel	Galvanized steel	Permanently Closed
Rico Town Shop / Dolores County	500 gal UST	Gasoline	Galvanized steel	Permanently Closed
Colorado Dept. of Transp.	6000 gal AST	4-Diesel	Unknown	Currently in use
Colorado Dept. of Transp.	10000 gal UST	4-Diesel	Bare steel	Permanently Closed
Colorado Dept. of Transp.	2000 gal UST	Gasoline	Bare steel	Permanently Closed
Rico Country Store	4000 gal UST	4-Diesel	Unknown	Permanently Closed
Rico Country Store	6000 gal UST	Gasoline	Unknown	Permanently Closed
Rico Country Store	6000 gal UST	Gasoline	Unknown	Permanently Closed
Whitewater RR/Qwest Safety and Env.	- UST	4-Diesel	Bare steel	Permanently Closed
Rico Country Store	10000 gal UST	Gasoline	Jacketed Steel Tank	Currently in use
Rico Country Store	10000 gal UST	Gasoline	Jacketed Steel Tank	Currently in use

Table 6.4 Summary of Spills within the Project Area for the past 10 Years. (source; ERIR, 2006).				
Date Reported	Potentially Responsible Party	Location of Spill	Description of Spill	Degree and Type of Impact
11/21/2004	Frank Edward Transportation Serv.	Hwy 491 mile marker 60	75 Gal Diesel fuel	Low impact, no water-body affected
03/16/2001	Questar Exploration and Product	Dove Cr. Facility S 5, TS40W, R19W	725 Gal Ethylene glycol	Storage tank leak, low impact, no water-body affected
06/22/1998	M. Avery	Rico	30 (unknown units) of mercury, found under carpeting	Low impact, no water-body affected
10/01/1996	Dick Simon Trucking Inc.	CO 666, 0.4 miles S of MP 58	100 Gal of Oil/Diesel	Low impact, no water-body affected
06/12/1995	Clover Club Foods Co.	CO 666 ½ mile N of MP 55	50 Gal of Oils/Fuel	Overturned truck, low impact, no water-body affected

FIGURES

Figure 6.1. Conceptual Model Depicting the Point and Nonpoint Source Discharge Areas Associated with the Rico Boy and Santa Cruz Mines.

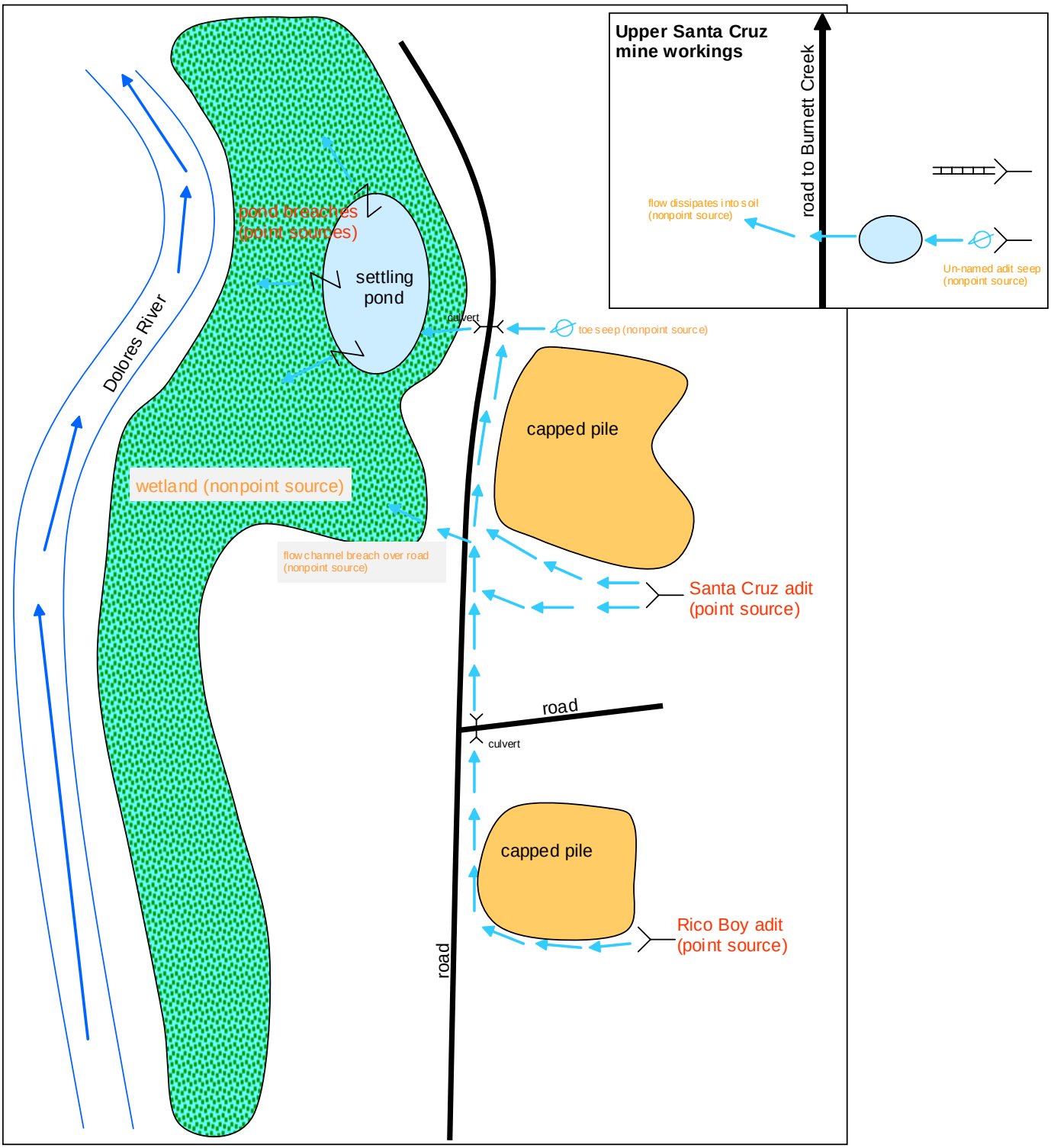


Figure 6.2. Conceptual Model Depicting the Point and Nonpoint Source Discharge Areas Associated with the Silver Swan.

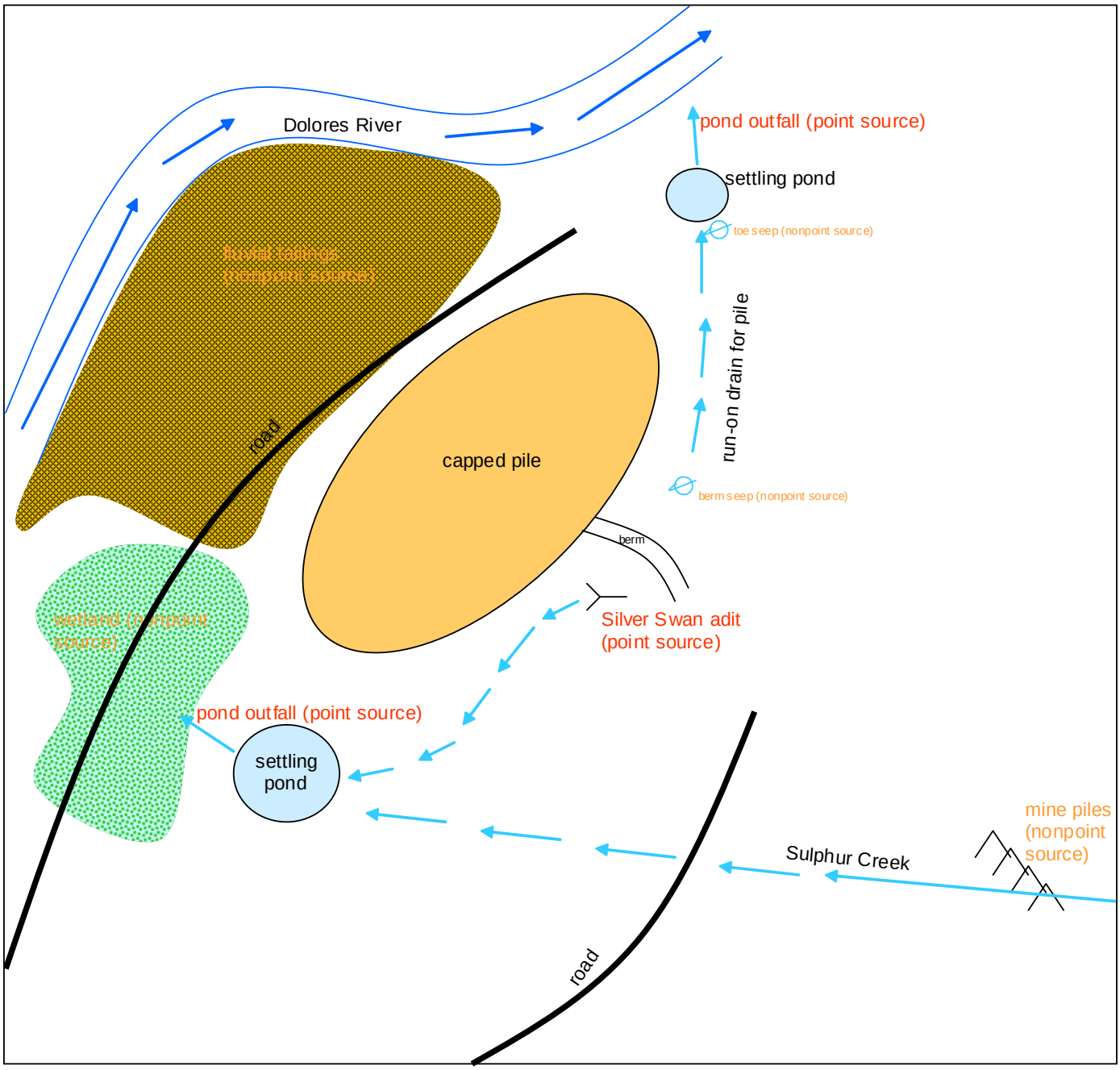
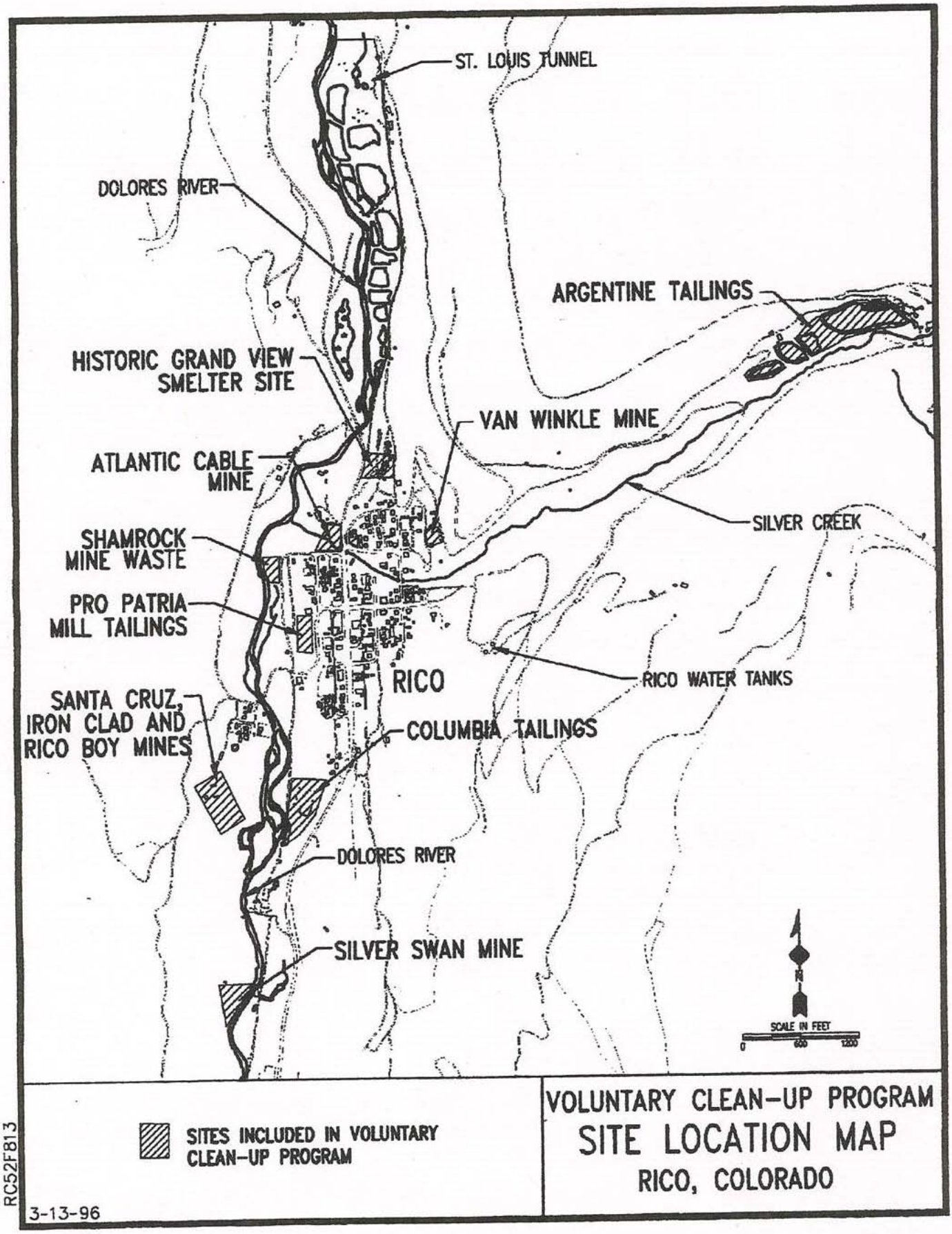


Figure 6.3. Voluntary Clean-up Program Site Location Map (source; CDPHE).



SECTION 7

7 WATER QUALITY MANAGEMENT GOALS AND RECOMMENDATIONS

7.1 Introduction

The Town of Rico has identified several planning goals in regards to water quality. They wish to maintain the water quality, and improve upon it where possible. The first step in achieving these goals involved the understanding of what the existing water quality is, and the determination of whether it is of 'good' quality. If there are compromised water quality conditions, then the Town would like to characterize these issues and determine if there is a way to correct them.

Figure 7.1 provides a summary of identified current nonpoint and point sources of pollution to the *Project area* that pose a concern. **Figure 7.2** identifies potential future point and nonpoint sources of pollution that require management. The identified features within these figures serve as the focus of many of the recommendations provided within this Section.

The following provides a summary of the recommended next steps for the Town of Rico in order to achieve their water quality goals. This plan documented the information which describes the water quality and quantity characteristics of the *Project area*. As a result of compiling and interpreting this information, recommended projects that would assist with addressing ongoing concerns were formulated. The primary areas requiring further attention are related to;

1. The continuation of watershed planning by maintaining an active, dedicated *Project area* watershed stakeholders group, by becoming an active stakeholder to other – overlapping watershed groups and land-management projects, and by integration of this plan into the Town of Rico Regional Master Plan (subsection 7.2),

2. The further characterization of the watershed water quality, sediment quality and aquatic life in order to more fully understand water quality concern sources and impacts (subsection 7.3),

3. Control of nonpoint sources of stormwater and mine-related water quality issues (subsection 7.4), and the

4. Control of potential future point sources associated with the Wastewater Treatment plant, St. Louis tunnel, other development-related sources etc (subsection 7.5).

The management and preservation of sensitive stream-side (and River-side) riparian areas is key and integral to the above recommendations. As such, the 'management of riparian/wetland areas' was retained as its own recommendation within this document,

even though it is a part of other recommendations. The recommendations provided within this document coincide with the Town of Rico Regional Master Plan goals set forth in 2004 (Town of Rico, 2004) as summarized below. They also coincide with recommendations provided by others from previous watershed studies (Matrix Design, Corey Sue Derfus) as well as with ongoing regulatory efforts (TMDL development by CDPHE). The following subsections (7.2, and 7.3) describe previous documented watershed recommendations by others. The remaining subsections review and interpret the findings from previous Sections (4 through 6) to formulate recommendations based upon the water quality analysis.

7.2 Recommendations by Others

Previous 'watershed related' studies have been completed by others, and have provided recommendations to achieve a diversity of objectives for the overall health of the system. There are two such reports that provide good guidance and ideas for water quality, flood protection, river restoration and aquatic life habitat improvements. These studies include:

- Matrix Design Group, 2004. Dolores River Watershed Evaluation and Recommendations Report: For the Town of Rico In Dolores County, Colorado. Prepared for the Town of Rico and the Colorado Water Conservation Board. (September 30, 2004).

- Corey Sue Derfus, Aqua-Hab Inc. 2001. "Report of Biological and Aquatic Surveys along the Dolores River Corridor at Rico' (January, 2001).

A summary of their findings and recommendations as they pertain to this Plan are described in the following subsections (7.2.1 and 7.2.2). This Plan took into consideration, these suggestions along with 'general guidance' recommendations regarding the goals to achieve in order to achieve general watershed goals and funding requirements. For instance, USEPA, 2005 strongly recommends that before a watershed stakeholder group begin the process of addressing water quality concerns, their efforts should be coordinated with any ongoing studies, cleanup efforts and regulatory activities (such as TMDL pursuits). These other 'ongoing activities' pertain to the *Project area*.

The *Project area* is on the cusp of having a TMDL being developed, and there are ongoing studies and efforts being completed by AR to address mine-related water quality concerns. Therefore, this plan tried to design recommendations that would meet the needs of the TMDL and coordinate with AR efforts. In summary, the suggestions by others (Matrix Design, C.S. Derfus) and the ongoing interests of the Town of Rico (as identified in the Town of Rico Regional Master Plan) and others (CDPHE – TMDL, AR; described in subsections 7.2.3 and 7.2.4) were folded into the recommendations presented within this document.

An additional subsection was devoted to the evaluation of the Town of Rico planning goals as defined within the Rico Regional Master Plan document (Town of Rico, 2004).

The goals, objectives and policies set forth within the Rico Regional Plan were reviewed in order to be sure that this plan addressed the watershed-related concerns within it, and to evaluate the goals to determine if this plan was cohesive with their direction, or if there were conflicts. Subsection 7.2.3 provides the analysis of the Rico Regional Master Plan goals etc. as compared to the findings and recommendations of this plan.

7.2.1 Matrix Design Group, 2004

Matrix Design Group (2004) completed a "Watershed Evaluation and Recommendations Project" as per the request of the Town of Rico and the CWCB in cooperation with the USEPA and CDPHE. The purpose of this document was to guide protection of the watershed. The document provides recommendations for next steps in studies, river restoration projects and flood protection strategies. For the purpose of this document, the recommendations provided by Matrix that describe next steps for studies as related to water quality improvement (with respect to the water quality program where it was determined that much remains to be done) are revisited herein and include;

- Perform a sediment analysis along the Dolores and Silver Creek stream corridors in and around Rico
- Perform an ecological risk assessment within the Dolores River and Silver Creek in and around Rico
- Propose additional engineering controls to address point source issues related to the engi9neered caps within the stream corridor
- Identify and remove residual tailings that remain within the stream bed or alluvial fan as part of the stream restoration
- Perform a new feasibility study to address technically effective technologies to treat the mine discharge from the St. Louis ponds
- Perform long term monitoring throughout the area once engineering controls and other remedies are established to document water quality/effectiveness

Specific water quality-related environmental concerns within the Dolores River corridor identified by Matrix included:

- ✓ The Silver Swan Adit (according to CDPHE studies) is considered a point source discharge to the Dolores River and is contributing to the zinc load in the stream
- ✓ The Santa Cruz and Rico Boy Adits, and the Columbia Tailings are considered a point source discharge to the Dolores River (according to CDPHE studies) and are contributing to the zinc load in the stream.

- ✓ The St. Louis Ponds and adit are considered a point source discharge to the Dolores River and is a major contributor to the zinc load in the stream

- ✓ There is a need to perform a new feasibility study to address technically effective technologies to treat the mine discharge from the St. Louis Ponds

In regards to Silver Creek, according to CDPHE, the Argentine Seep discharge and the Blaine Adit are considered point source discharges to Silver Creek and both contribute zinc load to the stream. However, further CDPHE correspondence indicates that the Blaine adit does not discharge into Silver Creek and that this flow is now entirely diverted to the St. Louis tunnel. In addition, there is the possibility of at least one other point source discharge in Silver Creek yet to be investigated. Since the contaminant source and loading issues within Silver Creek are yet unknown, or poorly understood; Matrix provided the following recommendations for Silver Creek;

- ✓ Perform a sediment analysis along Silver Creek stream corridor in and around Rico (to determine metals concentrations and load potential)
- ✓ Perform an ecological risk assessment within Silver Creek in and around Town of Rico
- ✓ Identify and remove residual tailings that remain within the stream bed or alluvial fan a part of the stream restoration
- ✓ Propose additional engineering controls to address point source issues related to the engineered caps within the stream corridor.

There were no environmental concerns associated with areas north of the St. Louis ponds, and those south of town. These 'data gaps' or study needs identified Matrix were formulated as a result of their watershed evaluation, as well as their findings of 'data gaps' from studies completed previously by others. Recommended next steps by these other sources include;

- From the USFWS (2003) – an evaluation of metals concentrations in surface water and sediment from 'depositional' areas may need to be completed in order to understand the risk potential to wetlands and aquatic life within the area.

- From the Brownfields work completed to-date; further analysis for the presence of PCBs at the maintenance garage site may be needed in order to determine if a 'constituent of concern' is present.

Matrix also provided a significant amount of information on river restoration recommendations that fall within the categories of floodplain protection, aquatic life habitat enhancement etc.. Matrix provided additional proposed improvements in a utopia map which describes all the possible improvements that could be implemented without constraints. The top two improvements included the elimination (or minimization of elevated metals loading with the implementation of engineered controls to address point sources, and the removal of contaminated sediments. The remaining goals address flood

plain protection and the building of in-stream, or channel-adjacent features to enhance river values to the community. This information was not revisited herein since they are thoroughly outlined within the Matrix document. As per Matrix' suggestion, any river improvements or changes should be layered into the information they have provided, so that the Town of Rico can plan for watershed change. For instance, the potential river-side development activities should be planned in such a manner so as to acknowledge the floodplain impacts and potential food issues, habitat issues etc., which they may create.

7.2.2 Corey Sue Derfus – Aqua-Hab, Inc

The reach of the Dolores River that goes through the Town of Rico was studied and subdivided into 5 sub-reaches by Corey Sue Derfus of Aqua-Hab, Inc (2001). The purpose of this report was to promote/protect wetlands, riparian habitat and aquatic habitat. The report did not address water quality, but rather focused on natural bank stabilization improvements. These improvements would include;

- Removing berms and levees,
- Adding boulder structures in the river for habitat
- Planting wetlands and installing a new stream gauge.

Matrix reviewed the information provided within the Aqua-Hab (2001) report and concluded that the 'implementation of the study improvements' may be premature without additional study. For example, if the effects attributable to contaminated stream sediments were still largely unknown, the proposed wetlands and boulder placements as described by Aqua-Hab may not improve the trout populations. Also the proposed 'planted bank vegetation' could be destroyed by floods or earthmoving equipment used for restoration activities.

7.2.3 Others

There are other entities that envision a variety of future watershed goals. A summary of some of the known activities are as follows;

- The CDPHE intends on completion of a TMDL analysis of the watershed which will affect allowable metals load releases. This will affect nonpoint and point release rates within the drainage.
- The USFS is in the process of completing their goals for their Forest Plan. A component will include watershed management to achieve the SJNF Forest Plan Goals.
- There are minimum instream flow requirements as put forth by the CWCB.
- Trout Unlimited envisions the Dolores River as a key aquatic habitat for salmonid fisheries.
- Boaters Associations; there is a continued interest to balance flow requirements associated with downstream water uses, flow requirements for instream fisheries with preferred boater flows for rafting and kayaking. These interest groups are

often active in regards to watershed stakeholders groups, forest planning efforts etc. and should be a part of this watershed stakeholder group as well.

- Lower Watershed Groups; there is a movement towards the formation of a basin- or region-wide watershed group that encompasses the Dolores River, the San Miguel to the Colorado River. The USGS in Grand Junction is forming a collective group of watershed trustees to begin procuring available information and beginning the first steps towards building an understanding of the water quality and quantity issues surrounding this large basin. The ultimate goal is to gain a thorough understanding of the Dolores River + San Miguel River influence to the Colorado. It is important that this *Project area* stakeholder group become an active participant with this lower-area group.
- SJCA, CFAR and other public interest groups view the Dolores as a critical watershed and a key component of the overall health of lower watershed areas of interest.

The list of 'others' who have interests in the watershed are numerous. This wide-spread interest emphasizes the need for the Town of Rico to remain intimately involved in 'others' and their processes. For instance, it is very important that Town of Rico keep involved in SJNF forest planning. There may be planned land uses (i.e. recreator activity) that could impact the *Project area*. It is important that the Town of Rico express an opinion during the Forest Planning process.

7.3 Watershed Coordination and Continued Planning

This document represents the first step towards watershed improvement and management activities. It gathers all available information that can characterize the watershed water quantity and quality. From here, there are various 'projects' which the Town of Rico can tackle in order to maintain or enhance their watershed *Project area* condition. This Section provides a ranked listing of recommended projects. The first category of recommended projects is referred to as 'Watershed Coordination and Continued Planning'. There are projects that fall within this category as follows;

1. Stakeholder Group Development, Meetings and Coordination,
    a) Presentation of this plan
    b) Assign a group coordinator
    c) Formalize the group structure and goals
    d) Develop a memorandum of understanding between stakeholder members
    e) Determine a strategy to accomplish monitoring
    f) Develop an electronic database
    g) Conduct meetings
    h) Use the stakeholder group as a resource to educate and reach the public
2. Integration into the Town of Rico Regional Master Plan

There are several specific components to each of the above recommendations and are described in the following subsections.

7.3.1 Stakeholder Group Development, Meetings and Coordination

Effective watershed management includes active participation from stakeholders, analysis and quantification of the specific causes and sources of water quality problems, identification of measurable water quality goals, and specific actions needed to solve those problems (USEPA, 2005). A watershed plan has the greatest chance of success when stakeholders are brought into the process at the very beginning of the watershed planning effort, therefore the first and foremost recommended project is the continued activity, and enhancement of the watershed stakeholders group with a designated watershed coordinator who will spearhead the project efforts, keep the projects on track, track the watershed group progress and keep the momentum of the group going for years to come. This is a necessary step towards the successful completion of any future watershed-based project efforts, and is a critical component to iterative watershed planning (CDPHE, 2005; USEPA, 2005).

Currently, there is a group of stakeholders concerned with watershed issues, that has been working together to reach a consensus in regards to ongoing concerns expressed by the Town. Stakeholder participants include;

- The Town of Rico (administration and citizens)
- Dolores County
- Montezuma County
- Residents and Public
- Dolores Water Conservancy District
- Dolores River Planning Group
- USEPA Region VIII
- San Juan National Forest
- Colorado Division of Wildlife
- Army Corps of Engineers
- Department of Local Affairs
- Colorado Water Quality Control Division
- Rico Alpine Society
- Nature Conservancy
- Trout Unlimited
- Colorado Department of Transportation
- Colorado Water Conservation Board
- Atlantic Richfield Corporation (AR)
- San Juan Citizens Alliance (SJCA)
- Trust for Public Land
- Citizens for Accountability and Responsibility (CFAR)
- And others

Other federal, state and local agencies have routinely been involved with the efforts to-date. In addition, private interest groups and others associated with down-stream concerns have also been involved (Trout Unlimited, Dolores Water Conservation District etc.). The stakeholder group has met several times over the past few years and was instrumental in getting this Watershed Planning effort completed. It is recommended that this document serve as a platform to begin the next steps of project completion. In regards to watershed coordination and continued planning, the following **specific recommendations** are provided;

1. This document should be presented to the widest base of possible stakeholders for the watershed, and be a working document that brings to life the watershed concerns to all those who have an interest, or stake in the watershed condition. Presentations to area agencies (USFS, US BLM, CDOW, CDPHE, Dolores County) and private interest groups (Trout Unlimited, SJCA, CFAR and others) should be made so that feedback and coordination of projects can be accomplished. Often, within a watershed, stakeholders share common concerns and may be embarking upon the same types of projects to accomplish similar goals. So as to stream-line efforts and accomplish these similar goals in a time and cost-effective manner, it is imperative to reach out to as many interested parties and share the watershed goals and next steps.

2. Assign a watershed coordinator who will spear-head the efforts including coordination of meetings, management of projects and management of overall watershed activities. This person will be responsible for keeping communication channels open to all who are interested, being the point of contact and 'common thread' from start to finish on the watershed projects, managing the projects in all their aspects (scoping, securing funds, reviewing contractors, managing the projects themselves, documentation and reporting) and being responsible for the routine stakeholders meetings.

3. Formalize the watershed group by clearly identifying all the possible stakeholders that will be involved with the continued progress of the watershed projects. This group will be responsible for procurement and management of funds for the completion of projects. The establishment of a stakeholder watershed group is a necessary step for the successful completion of any community-lead pro-active project. The watershed group can team with other interested downstream groups (i.e. San Juan Citizens Alliance – Dolores River Coalition; Citizens for Accountability and Responsibility (CFAR)) to assist with large scale Dolores watershed issues, and can act independently to achieve their area-focused projects. The watershed group should 'adopt the watershed' as per USEPA suggestion and support (described within USEPA, 2000), and become a member of the Colorado Watershed Assembly which also provides support. The stakeholder group will manage the database developed from the watershed studies. This group will meet quarterly and set a 5-10 year project strategy list and go about all the necessary efforts to accomplish the tasks. The list of proposed

tasks for this group to tackle represents the next set of recommended next steps is described in the following subsections.

4. Develop a partnership memorandum of understanding (MOU) which documents the stakeholders wishing to participate, their interests in the watershed planning process and a defined set of goals and projects to be accomplished within a set time-frame. The vision and mission of the stakeholder group is clearly outlined within this document (CDPHE, 2005). This MOU is a skeleton 'work plan' which identifies the sequence of projects to tackle and their associated time frame. The identified stakeholder partners describe within the MOU how best they are able to contribute to the process (i.e. financial contribution, technical assistance, permitting assistance, guidance and review, etc.).

5. Determine a method by which monitoring can begin immediately. As per subsection 7.4, monitoring of *Project area* water quality and quantity issues is of immediate concern. There are key parameters and locations that need to studied as soon as possible so as to obtain baseline information. The Town of Rico is on the cusp of completing significant development projects within the watershed. It is imperative that baseline conditions be understood, so that changes over time can be evaluated and perhaps corrected if need be. The amount of effort and associated cost for baseline monitoring can be held at a minimum. Suggestions for addressing costs are described in **Section 8**. It can not be emphasized enough however, the importance of gathering this information as soon as possible, and maintain the monitoring for years to come.

6. Construct an electronic database that contains reference citations, links, descriptions and electronic copies of all available documents describing the *Project area* water quantity and quality characteristics. This information should be made available to the public by perhaps being linked to the Town of Rico web page. The information supplied to the database should come from the watershed stakeholders group. Physical copies of the documents should be housed within a file system at the Town of Rico for referral. A physical-copy collection has been obtained as a part of this documentation effort and will be supplied to the Town upon completion of this effort.

7. Hold meetings with the Watershed Stakeholders on a frequency appropriate to the amount of activity being completed by the group. When the group begins the process of pro-active cleanups, it may be necessary to meet once a month. Until that time, it may be appropriate to meet on a quarterly basis. The purpose of the meetings is to keep a momentum of the activities and projects to be accomplished. The stakeholders could coordinate their meetings with the Town of Rico Board meetings, and Planning meetings so as to maintain communication in regards to watershed planning issues that need to be integrated into Town processes.

8. Use the Stakeholders as a means to provide education and public outreach to the community and others in regards to watershed issues. The stakeholders represent knowledgeable people who share a common interest in watershed concerns. These people are resources and can provide settings to educate the community in areas of their expertise. This will pass along information about watershed topics which will enable the community in watershed areas.

The above recommendations are project ideas that fall within the Watershed Planning and Coordination category of activities. The above blend into other categories of activities including monitoring, risk assessment, best management practices and other projects which are described in the following subsections. This document, in combination with the CDPHE (2005) guidance document [can be used to guide and direct the next steps of activity.

7.3.2 Integration into Rico Regional Master Plan

There is information, and recommendations within this Plan that should be reviewed and considered for adoption into the Town of Rico Regional Master Plan. **Figure.7.3** Horizons depicts a very conceptual planning recommendation for integration into the Rico Regional Master Plan. This figure depicts 'zones' or 'horizons' of areas that occur above the flood plain. The inner most zone represents the 100-year flood plain, and is excluded from development activities (with little exception). The Town's Land Use Code (article VIII) contains regulations pertaining to development in the floodplain. The Town has adopted amendments to the code (Ordinance 2003-1) that provides for floodplain management in accordance with Federal Emergency Management Agency (FEMA) guidelines. This area was considered 'excluded' and this plan endorses the need to prohibit development within this zone.

The next area moving up in altitude from the flood plain represents a horizon 100 feet above the flood plain. This horizon is referred to as the 'Protected Area' horizon. It is recommended that everything within this area that is proposed for development, or is currently present; needs to adhere to aggressive stormwater best management practices and planning in order to control ongoing and future nonpoint concerns. Specifically, vegetative zones created by riparian and wetlands need to be preserved and enhanced. There should be no destruction of these buffer zones which provide assimilative capacity for nonpoint pollution sources. This horizon captures the Town of Rico footprint and many of the inactive mine areas. This plan goes on to recommend that stormwater associated with the Town and certain mine features do require control through the placement of BMPs or remedy actions. These are further described in the following Sections.

The next, or upper-most horizons represent areas referred to as 'Requiring Active Planning'. This means that the Town of Rico should thoroughly scrutinize existing and proposed development activities from the perspective of Stormwater BMPS for nonpoint source control. Vegetative buffers should be planned and accommodated. Gentle slope

cuts along contours and other methods for minimizing erosion should also be integrated. These approaches are all cohesive with existing Town of Rico Regional Master Plan approaches and do not present anything new.

As part of the planning process, it is recommended that the Town begin an inventory of impervious surfaces within these planning zones. Estimating current and future impervious cover is a good indicator of potential watershed concerns related to stormwater. The conversion of forests, wetlands, and meadows to rooftops, roads, and lawns creates a layer of impervious surface in the urban landscape. Impervious cover is a very useful indicator with which to measure the impacts of land development on aquatic systems. The process of urban and economic development has a profound influence on the hydrology, morphology, water quality, and ecology of surface waters (Horner, et al., 1996). In many regions of the country, as little as ten percent watershed impervious cover has been linked to stream degradation, with the degradation becoming more severe as impervious cover increases (Schueler, 1994). Depending on the degree of impervious cover, the annual volume of stormwater runoff can increase by two to 16 times its predevelopment rate, with proportional reductions in groundwater recharge (CWP, 2001; Schueler, 1994). There are simple mapping models and techniques (as described by Horner et al., 1996; Schueler., 1994 etc.) that can be used to inventory and project potential issues. This tool can be integrated into the Town of Rico planning process.

There are goals written within the Rico Regional Master Plan that this Watershed Plan will help to achieve. The watershed plan in general, endorses such community goals such as 'preservation of historic character', building houses etc to minimize footprint areas of disturbance, focus development north and south of town while preserving the natural character to the east and west, etc. All of these Goals are cohesive with the watershed plan recommendations since they will minimize impact to susceptible areas and ultimately, the watershed itself. In this respect, the watershed plan supports the Regional Planning Goals set forth by the Town. As shown within **Figure 7.4**, there is a substantial amount of private land ownership associated with mine claims located throughout the valley. This presents a unique challenge in regards to controlling growth impacts, especially in regards to the watershed which lies within and below the potential environmental damage created by human activity.

There are goals and recommendations provided within this plan that support the Rico Regional Plan as summarized in **Table 7.1**. This Watershed Plan itself will help to achieve certain water-related goals set forth in the Rico Regional Master Plan as follows;

- <u>Water System</u> – as described within the Town Master Plan, the point of diversion for the potable supply is a pressing need for the Town. Negotiations for this effort are underway and will require a 'injury with mitigation' approach for the CWCB. This plan represents a tangible product documenting the Town's interest in their watershed and the possible activities they will undertake to improve water quality conditions.

- Water Rights – as stated in the Town Master Plan, the town's water rights are a point of concern for possible future water needs. This document serves to provide all available information regarding water rights within the *Project area*, the DWR points of contact for future referral and a summary of water balance conditions given the current setting.

- Waste Water Treatment – The Master Plan recognizes the need for a Town WWTP, but does not mention the possible 'complementary' uses of the WWTP in regards to the watershed condition. This plan has taken the opportunity to integrate the future WWTP as a condition to manage and use to the Town's benefit for other purposes. The Town is well along in the process of constructing a WWTP. As part of the NPDES requirements for the WWTP, this plan proposes a monitoring effort that can be implemented and maintained by the Town and can serve as supplemental compliance information for the WWTP. This plan also recommends the use of WWTP materials (biosolids) as a possible innovative technology for inactive mine site waste areas.

- Streets and Alleys – The Master Plan states that a goal for the streets and allies is to "systematically improve street drainage to reduce deterioration of street surfaces and avoid run-off damage to private properties. This watershed plan coincides with this goal, but adds to it by recommending that run-off be controlled so as to limit the amount of watershed impact that can occur. Stormwater can be uniquely managed and enhance 'greenbelt' areas along the proposed river walk, or river park. This plan recommends that the Master Plan fold in Stormwater management practices into their proposed river front activities

- Protection of Natural Resources – The Master Plan strongly emphasizes the need for natural resource protection. There are numerous goals throughout the plan that describe methods by which to minimize impacts. This watershed plan highly endorses these Master Plan goals since any natural resource preservation will ultimately benefit the watershed. If surrounding areas were to be denuded of top soil and vegetation, this will be a significant impact to the watershed (sheet flow, interrupted hydrologic cycle, possible stormwater impacts). As stated within the Master Plan, the Town has a goal to "work cooperatively with County, State and Federal agencies to prevent environmental degradation from activities such as mining, timber harvests and road development. Given the sensitive nature of the surrounding environment, it is very critical that the Town maintain an active participation with the SJNF Forest planning. Intense recreator impact will affect the natural resources and the watershed. This plan can be used as a tool to demonstrate the potential impacts and the need to control them if they occur. Therefore, this plan coincides directly with all of the Master Plan goals for resource protection.

An item within the Rico Regional Plan that is currently of potential concern in regards to this plan is the statement that "The Columbia Tailings site was reclaimed by AR in 1996.

This site is proposed for use as visitor parking, river trail access and picnic tables.". As per review of the water quality information, it appears that the Columbia may be associated with some metals release to the Dolores River. Until that amount is more thoroughly understood, it is recommended that any development be curtailed. It may be possible to achieve the Town's goals for this piece of property and also install water quality improvement features. The renovation of this site should be planned to achieve multiple goals, one of which is to improve the released water quality from the Columbia.

An addition planning item that requires further attention by this Watershed Plan, would be the development of a 'Municipal Hot Spring' with the use of the existing geothermal waters. The water quality associated with the geothermal springs is very unique. It contains a 'buffering capacity' associated with the common ions (calcium, magnesium and iron) but also contains enriched levels of other metals (i.e. arsenic). During the planning process for this municipal facility, a watershed water quality impact assessment should be completed. The springs currently do not appear to create a concern in regards to water quality impacts to the Dolores River. However, if the point of discharge were to be altered, they may be of concern. This needs to be further evaluated during the planning process.

In summary, this Watershed Plan should be an active source of information for future Town of Rico planning efforts. This document should continue to evolve as information becomes available. It is recommended that Town of Rico administration, staff, Board members, planners, interested public become involved by first becoming more familiar with Watershed subject material. There is an abundance of resources, training opportunities etc. that is available. These are mentioned in later recommendations, but certain relevant resources to the overall planning process are as follows;

- There is a variety of USEPA resources for watershed planning, management of a watershed group, integration of watershed concerns into community planning and regulation requirements, training etc. A brief list of some of the most relevant training resources are:

    - ✓ CWP, 2006. (Center for Watershed Protection). The Smart Watershed Benchmarking Tool. Produced for the Office of Wetlands, Oceans and Watersheds, USEPA. January, 2006.

    - ✓ USEPA, 2006. (US Environmental Protection Agency). Watershed Academy (provides information and training on implementing watershed approaches). Training is provided at http://www.epa.gov/owow/watershed/wacademy/ [For instance – an Introduction to the Clean Water Act can be found at http://www.epa.gov/watertrain/cwa/leftindex.htm)

- ✓ USEPA, 2006. (US Environmental Protection Agency). Benefits of Watershed-based NPDES Permitting. Training is provided at http://www.clu-in.org/conf/tio/ownpdes/

- ✓ USEPA, 2006. (US Environmental Protection Agency). Draft Handbook for Developing Watershed Plans to Restore and Protect our Waters. USEPA OWOW. [copies provided to the Town, and additional copies and training can be obtained from: http://www.clu-in/org/conf/tio/owhandbk_011806/

- ✓ USEPA, 2006. (US Environmental Protection Agency). Opportunities for Citizen Involvement in the Clean Water Act. Training is provided at http://www.clu-in.org/conf/tio/owopcitinv_041906/

- ✓ USEPA, 2006. (US Environmental Protection Agency). Integrating Wetlands into Watershed Protection Efforts. Training is provided at http://www.clu-in.org/conf/tio/owinwetpro_051706/

- ✓ USEPA, 2006. (US Environmental Protection Agency). An Introduction to Wetland Restoration, Creation, and Enhancement. Training is provided at http://www.epa.gov/owow/wetlands/restore/finalinfo.html

- ✓ USEPA, 2005 (US Environmental Protection Agency). Guidance for Characterization, Design Construction and Monitoring of Mitigation Wetlands. Training is provided at http://www.clu-in.org/conf/itrc/mitwet_101105/

- ✓ USEPA, 2005 (US Environmental Protection Agency). Low Impact Development Strategies, Tools and Techniques for Sustainable Watersheds. Training is provided at http://www.clu-in.org/conf/tio/owlid_101905/

- ✓ USEPA, 2005 (US Environmental Protection Agency). The ABCs of TMDLs for Stakeholders. Training is provided at http://www.clu-in.org/conf/tio/abctmdl_092805/

- ✓ USEPA, 2005 (US Environmental Protection Agency). Eight Tools of Watershed Protection in Developing Areas. Training is provided at http://www.clu-in.org/conf/tio/watershedtools_062205/

- The NRCS provides an wealth of resources dedicated towards successful watershed planning and eventual project completion. The 'economics' associated with watershed Planning to address water quality concerns have been modeled

and provide compelling evidence to support the management of water quality concerns (NRCS, 2006). There is also guidance for developing specific plans for specific water quality concerns (SCS, 1999). Other documents of potential interest to the Town of Rico may include;

- Conservation Corridors Planning at the Landscape Level: Managing for Wildlife Habitat (Johnson et al, 1999).
- GIS Applications for Census Data in Watershed Analysis (USDA, 2006)
- Stream Corridor Inventory and Assessment Techniques (NRCS, 2001) – A document describing methods for remedy of stream conditions using planning tools.

7.4 Monitoring to Address Data Gaps

Results of the water quality analysis (**Section 4**) revealed the need to obtain further information to characterize the *Project area*. As described in **Section 4**, there have been many, brief, and 'focused' studies conducted in the area. Each served a distinct purpose, and therefore had a limit in their use to characterize the *Project area* as a whole. As a result there are significant time periods from which little to no information was gathered, and significant gaps in the types of samples collected. **Figure 7.5** depicts the 'proposed next steps for studies' which are further described in the following subsections. This figure was developed based upon the findings from a data gaps analysis. **Figure 7.6** depicts a 'data gap' identification of areas within the *Project area* that have little to no information available. Most all of the investigations completed to-date have been centered around the mining-district. There are other mining-impacted areas and areas with natural sources of water quality character (geothermal, natural metals sources etc.) that require further evaluation.

Section 4 pulled the available information together to construct an overview of historic and existing water quality conditions. As a result, certain 'data gaps' were identified. These data gaps need to be addressed before any significant, definitive action can be taken towards actual water quality source control. It appears that there is good information for certain *Project area* features (i.e. the reach of the Dolores River from above the St. Louis to the point of the Silver Swan discharge) however, this information needs to be put in context to the entire *Project area*, and in relation to other possible point and nonpoint sources.

Research by others indicates that there are mine-related features in other drainages (Horse Creek, Aztec Gulch, above the St. Louis ponds along the Dolores River, the Mountain Spring Mine, and others). Only cursory information is known about these areas. Several (i.e. Mountain Spring Mine, Aztec Gulch) have been documented as having poor water quality and reaching a confluence to the Dolores River. There is virtually little to no information for certain tributaries (Scotch Creek, Horse Creek) that have mining districts.

These areas, and mine-sites require further analysis in order to determine if there are any associated water quality related issues.

The second category of recommendations formulated by this plan is Monitoring to Address Data Gaps. Very specific areas of informational gaps exist for the *Project area* and include;

1. Comprehensive *Project area* data
2. Aquatic life monitoring data
3. Metals loading and synoptic sampling
4. Sediment data

Prior to the implementation of any data collection effort, it is recommended that the proposed sampling strategy be thoroughly documented within a Field Sampling Plan (FSP). This FSP should be described, presented and provided for review and approval by the Town and the Watershed stakeholders.

The data obtained from these various monitoring efforts would be folded into various documents that describe the existing ecological risk condition (further described in subsection 7.5) and regulatory document requirements (such as for the TMDL, NPDES permitting requirements for the WWTP, the mitigation of injury requirements for the point of diversion change etc.). The following provides an overview of the monitoring efforts needed in order to address existing data gaps. These monitoring efforts should be coordinated with ongoing studies (such as those being conducted by AR/SEH, and CDPHE) with the information being made available to all interested parties including downstream user groups, watershed groups etc.. They should also follow standard guidance and techniques that ensure a high level of Quality Assurance and Quality Control. Examples of guidance describing general considerations for water quality sampling activities are provided within **Appendix B** and within **Section 10**.

7.4.1 Comprehensive *Project area* Monitoring

Currently, there are ongoing efforts to monitor the water quality within specific portions of the Dolores River, and the majority of Silver Creek. This information is extremely useful, but focused to a narrow portion of the *Project area* as a whole. **Figure 7.5** depicts a conceptual proposed plan for additional sampling (monitoring) that is needed in order to fill data gaps (as shown in **Figure 7.6**). The entire *Project area* needs to be studied in order to capture the potential effects attributable to other possible source areas (i.e. Horse Creek, Scotch Creek, Aztec Gulch, specific sites such as the Mountain Spring Mine etc.) The entire *Project area* needs to be sampled for water during both high and low flow conditions and needs to have flows measured above, within and below strategic locations throughout the watershed.. Portions of the *Project area* need to be sampled for sediment and benthic macroinvertebrates (BMI) which serve as a useful indicator of aquatic health. The combination of information gained from the water, sediment and aquatic life samples

will be used for the completion of an ecological risk assessment and the regulatory processes that will be underway (TMDL, NPDES permitting etc.).

Specific details regarding the comprehensive area monitoring of water quality should be first documented into a **Field Sampling Plan** (FSP) for review and approval by the watershed stakeholders. The FSP will provide the details regarding the methods for sample collection and analysis, as well as the overlying quality assurance/quality control procedures (QA/QC) which dictate the accuracy and precision of the methods and findings. This process of FSP review will hopefully bring about the coordination of this proposed effort with other ongoing or planned monitoring efforts. Some of the specific considerations to fold into a designed watershed water quality study are as follows (while specifics for the aquatic life monitoring, sediment sampling are in subsections 7.4.2 and 7.4.3);

- Samples of water should be taken at distinct points above, within and below the inactive mine site areas (as shown in **Figure 7.5**).

- Samples should be taken from distinct point and nonpoint source releases such as the Argentine seep, the Mountain Spring Mine and others, as identified from others who have identified these potential additional source areas (as shown in **Figure 7.5**)

- Samples should be collected during high and low flow conditions within a given year. Sampling activity at each location should include the collection of water quality parameter measures (pH, temperature, conductivity, hardness and alkalinity), flow or discharge (cfs) and collection of samples (surface water and sediment for the analysis of metals content, benthic macroinvertebrates for the analysis of species identification).

- Sample collection should be coordinated so that the down-gradient samples are collected first, and then progressing up-gradient to the final location. All samples should be collected within as brief of a time period as possible so as to eliminate confounding variables introduced by time. Parameters of pH, temperature, hardness, alkalinity and conductivity should also be taken at the time of sampling using standardized techniques.

- Samples of water should be co-located with samples of sediment and benthic macroinvertebrates and flow measurements in order to be able to draw conclusions about cause and effect, and contaminant transport. Surface water samples will be collected first, followed by sediment, and finally benthic macroinvertebrates.

- Samples should be collected for the analysis of both total and dissolved metals. The suite of metals to be analyzed for should include arsenic, cadmium, chromium, copper, iron, lead, manganese, selenium, silver, zinc.

- Samples will be filtered (for dissolved), preserved and sent to appropriate laboratories for analysis. Copies of critical documentation (field notes, chains of custody, analytical results) will be copied, scanned and electronically tracked.

- Results will be interpreted to determine the potential effects to exposed aquatic life by comparison to appropriate toxicological thresholds, and will also be used to determine metals load.

- Sampling will be repeated in a similar manner each season and each year so that results are comparable and will yield information describing change over time.

- The results of the surface water sample analysis and the flow measurements should be used to calculate 'load' at each location (further described in subsection 7.2.3). Surface water sample results should also be compared to criteria protective of aquatic life (i.e. AWQC values) to determine if the measured concentrations are of potential concern.

The overall design should be *Project area* in scale, and take into consideration the requirements of needing to characterize metals load at key point and nonpoint sources (further described in subsection 7.2.3). Unique strategies, such as the use of synoptic sampling are also very useful and should be considered (also described in subsection 7.2.3). Agencies such as the USGS, USEPA and CDPHE often assist in such programs and would be significant contributors to the process, funding requirements and data interpretation. At the time of the FSP submittal, proposed strategies such as synoptic sampling should be described so that potential significant partnerships can be formed.

The sampling effort for the collection of comprehensive watershed water quality should be lead by a qualified individual with sampling experience. This effort should be designed to capture and quantify metals load which is key to the understanding of nonpoint sources and potential effects. These efforts can be completed with the assistance of community members. Under the guidance of the sampling leader, community members can assist with sample collection, record keeping, sample shipment, and ultimately results interpretation. It is highly recommended that these efforts be described and 'offered' during Town meetings in order to gather support and interest. It is imperative that the results be presented on a timely basis during several community forum events so that the public is educated and kept aware of the results and findings. The assigned field team leader should also take the lead in this regard and be able to present and document the study methods and findings each sampling season. These results should also be folded into this plan so that this plan evolves and adopts the findings into the recommended projects.

7.4.2 Aquatic Life Monitoring

There are many species of aquatic life that serve as useful indicators of ecosystem health. It is recommended that the sessile bottom-dwelling organism group of benthic macroinvertebrates serve as the focus for the evaluation of aquatic ecosystem health throughout the *Project area*. These organisms serve as the functional food group for higher trophic organisms such as fish, and are highly susceptible to contaminant exposure and effects. As such, they represent the key and most susceptible aquatic organism group within an aquatic ecosystem. These organisms are also easy to identify (to family level) within the field, and are simple to collect.

Often, the direct measure of aquatic organism health is a better indicator of ongoing water quality conditions rather than the results of water sample analysis. Sample analysis does not provide a measure of the ongoing assimilative capacity and water chemistry balance that so often abates a contaminant effect. The direct measure of the resident aquatic life provides a direct indication of possible contaminant effects. Effects are often elicited in the form of decreased abundance and diversity. These effects are very apparent and simple to measure and provide a strong line of evidence in regards to the system as a whole.

It is recommended that samples of benthic macroinvertebrates be collected as part of the watershed monitoring program (refer to **Figure 7.5**). The collection of interpretation of findings should be completed by a qualified individual well versed in the processes of aquatic sampling. Community members can become involved once initial guidance has been provided, and can eventually take ownership of the monitoring program is they so choose. There are useful tools available to the public to learn how to monitor streams and aquatic habitats using qualitative and/or simple quantitative methods. A condensed list of useful, pertinent methods applicable to the stream settings in the Town of Rico area are as follows;

- STREAM*A*SYST – A tool to help land-owners examine stream conditions (NRCS, 2001).
- Stream Visual Assessment Protocol (NRCS, 1998),
- Guide to Effective Monitoring of Aquatic and Riparian Resources (USDA, 2004)
- Biotic Condition Indicators for Water Resources (WSI, no date$_a$)
- Index of Biotic Integrity (IBI) (WSI, no date$_b$)
- The EPT index (WSI, no date$_c$)
- Rapid bioassessment protocols for use in streams and rivers: periphyton, benthic macroinvertebrates and fish (USEPA, 1999)

- And others as described by: Fore et al., 1996; Hilsenhoff, 1981 and Lenat, 1988; Rosenberk and Resh, 1993)

Similar to the recommended guidelines for the comprehensive watershed monitoring effort, it is recommended that the sampling of benthic macroinvertebrates be first documented within an FSP. The effort should be coordinated with the proposed watershed monitoring of water quality and sediment. Specific sample collection guidelines are as follows;

- The use of a bottom-sampling device such as a Hess sampler, or dredge should be used. These apparatus sample a distinct unit of area and should be used at targeted substrate types of cobbles and gravels where benthic macroinvertebrates reside.

- Samples of invertebrates should be cleaned of significant debris and placed within preservative solution (such as ethanol or isopropyl alcohol). Each sample should be properly documented and labeled, and shipped to a laboratory for taxonomic identification.

- Cursory identification of families and numbers of species should be gathered in the field if possible.

- Habitat conditions (bottom substrate composition, temperature, water clarity) should be recorded and may be best documented by following the USEPA RBP protocol for habitat characterization.

- The results can be used with the use of a variety of biometrics (i.e. EPT Taxa etc as described within the USEPA RBP protocol) which helps to determine if there are impacts to the aquatic life.

As with the other types of biomonitoring being proposed within this plan, it is recommended that the results be documented and presented to the community. The lead field team member should be held responsible for disseminating the information and entering it into the proposed database to be constructed by the watershed stakeholder group.

7.4.3 Metals Loading and Synoptic Sampling

An analysis of metals loading within the *Project area* watershed would serve to help identify the sources of nonpoint metals pollution. There are a variety of techniques used routinely in mining district watersheds that help isolate source areas (Kimball, B.A. et al., 1999; Church, S.E., 1996 and others). The development of cost-effective remediation of mine waste sources is dependent upon being able to definitively determine the mine-waste related contaminant contribution. The significance of a given source depends on the toxicity of a particular metal, how much the metal enters the stream, and whether or not the metal remains in the stream in a toxic form. The amount of metal entering the

stream is called the mass loading and is calculated as the product of metal concentration and stream discharge. Discharge (or flow) is measured at cross-sectional areas from locations above and below source areas. At these same locations, samples of water are taken and analyzed for metals content. The combination of the discharge and metal concentration is required in order to calculate load as follows;

Eqn. 2.2 $\text{Load} = (C_{metal} \times Q_{site}) \times M$

Where;

Load – is the mass of metal in pounds per day
C_{metal} – is the concentration of metal, in micrograms per liter,
Q_{site} – is the streamflow, in cubic feet per second, and
M – is the conversion factor of 0.0864 (to convert mg/s to kg/day)

Loading (as calculated above) is a critical step within watershed planning. It is a recognized tool for the determination of source release rates and is a required data type for USEPA and CDPHE watershed planning (CDPHE, 2005; USEPA, 2005). It is recommended that the comprehensive watershed data collection effort (described in subsection 7.4.1 and shown within **Figure 7.5**) be designed in order to capture load contributions. This is a simple matter of measuring flow at each sample location where water samples are taken. The combination of water quality analytical results and flow measurements will provide direct measures of metals load at each location. These results can then be used to determine change in metals load over distance, and differences between seasons (high and low flow).

An additional recommended sampling strategy that would yield extremely useful watershed water quality and water quantity information would be with the use of a ***synoptic sampling*** strategy. Synoptic sampling is a method of sampling surface water in a drainage as it travels down-gradient over time. A single slug or parcel of water is collected at locations starting at the top of a watershed and traveling down-gradient at the rate of flow. Therefore, the single slug will be sampled as it travels and as it may change in chemical composition over time and distance. The analysis of the sample results helps to identify source areas within a particular drainage.

For instance, using **Figure 7.7** as **an example** of a synoptic event for a slug of water sampled along Silver Creek. The results indicate the following;

- A substantial increase in zinc between locations B and C that may be associated with the adit. The flow increased substantially between these two locations as well which provides dilution, yet the concentration of zinc still increased dramatically indicating that this adit is a potentially significant source

- Further review of **Figure 7.7** shows a gradual decrease in zinc from locations C to D, with a significant increase in flow which is likely providing dilution of the zinc load.

- Comparison of results from D to E show a slight, perhaps insignificant increase in flow, with a significant increase in zinc concentrations. This indicates the presence of a potentially unknown source such as an adit, or groundwater. This highlights the need for further evaluation.

Synoptic sampling, when combined with a metals loading approach can provide valuable information to determine source areas and the amount of metals contribution. It is recommended that as a part of the Ecological Risk Assessment and routine monitoring programs, a synoptic sampling regime be implemented, and that the design incorporate a metals loading component.

7.4.4 Sediment Sampling

To-date, there has been very little characterization of the sediment quality within the *Project area*. Sediment represents an important exposure medium to aquatic organisms and can often act as a source of contaminants to a system. Sediment occurs as a result of overland flows of surface water carrying soils into a receiving system. The sediments therefore can be comprised of mine waste materials, road sand/salt and other potentially contaminated materials.

Suites of aquatic organisms (such as benthic macroinvertebrates) are often directly exposed to these materials and can become adversely affected. In the absence of a viable benthic macroinvertebrate base, populations of higher trophic level organisms can become affected by indirect exposure (consumption of contaminated benthic macroinvertebrate prey species) or directly (with the loss of an entire food base). Since the *Project area* encompasses several sources of potentially contaminated sediment, it is recommended that a sampling effort be completed in order to characterize this exposure medium.

The sediment samples should be co-located with surface water and benthic macroinvertebrates (as shown in **Figure 7.5**). Similar to water, they should be collected during both high and low flow periods. Samples should be taken from depositional areas where 'fines' sizes collect and would represent 'worst case' contaminant conditions (small particle sizes contain more surface area, lending to potentially higher concentrations of an absorbed contaminant). Similar to the other monitoring programs, the methods should be documented within an FSP and subjected to review and approval. Preliminary guidelines for the collection of sediment are as follows;

- The use of a bottom-sampling device such as a dredge or a direct-push core should be used.

- Depositional areas where fines materials have collected should be targeted. The samples should be co-located in time and space with the surface water and benthic macroinvertebrates samples.

- Samples should be analyzed for the same suite of metals proposed for the surface water analysis.

- Samples should be submitted to the same analytical laboratory as the surface water samples, and be subjected to the same suite of QA/QC procedures. If possible, and if funding permits, samples should be analyzed for both 'solids' total metals content, and pore water, dissolved metals content.

Similar to the other proposed monitoring programs, this effort should be completed (lead by) a qualified individual capable of teaching the skills to others. Results should be interpreted by the field team leader and presented in a timely fashion to the Town community.

7.5 Aquatic Ecological Risk Assessment and Regulatory Documentation

The **third category** of recommendations formulated by this plan is for the completion of an Aquatic Ecological Risk Assessment and Regulatory Documentation that can be completed from the data collected from the second category of recommendations (Monitoring to Address Data Gaps).
The information gained from the previously described sampling efforts can serve a number of purposes. First and foremost, it will help to answer any questions regarding water quality characteristics and the potential sources of any contaminant load. If the sampling efforts are appropriately designed, reviewed and approved of by regulatory agencies (i.e. USEPA, CDPHE) then the information can also support an 'Ecological Risk Assessment' and regulatory documents such as the TMDL, the WWTP NPDES and for the CWQB mitigation of injury reports. The information can also be documented as part of grand-funding requirements etc.. The following subsections describe the potential documentation efforts that can be completed once the information was collected from the various sampling efforts previously described.

7.5.1 Aquatic Ecological Risk Assessment

Ecological Risk Assessment (ERA) is a process to collect, organizes, analyze and present scientific information to improve decision making. When applied in a watershed context, risk assessment methods can help bring scientific data into environmental decisions. An ecological risk assessment evaluates the potential adverse effects that human activities have on the plants and animals that make up ecosystems. The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions. When conducted for a particular place such as a watershed, the ecological risk assessment process can be used to identify vulnerable and valued resources, prioritize data collection activity, and link human activities with their potential effects. It is a regulatory tool that serves to demonstrate the relationship between a contaminant and the possible effects to exposed/valued resources. This is accomplished

by evaluating the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors.

An ERA is a standard process and is outlined in two USEPA guidance documents (USEPA 1992, USEPA 1998). The process also brings together scientists and decision-makers so that scientists can better focus on needs of the decision-makers while helping them better understand the ecological implications of their actions. Risk assessment provides a basis for comparing, ranking and prioritizing risks, and estimating ecological effects as a function of exposure to stress in the watershed.

For the purposes of the Town of Rico, an ERA would be of benefit because it would;

- Design and collect relevant data (water quality, water quantity and biological resource inventory) that would measure contaminant releases, concentrations and effects to the *Project area*.
- Address the goals and concerns the Town of Rico has in regards to their watershed, and keep those goals in mind as possible remedy efforts draw near.
- It would be focused upon only those areas in question (needing data) and would target only those contaminants that would be 'risk drivers' to the aquatic ecosystem health that may require remedy efforts.
- Be designed to address several data gaps and issues identified within this document such as the need to evaluate the risk associated with sediment, and the potential risk associated with stormwater flows and deposition of soils that may have lead associated with it.
- Would be coordinated with CDPHE, USEPA, AR and others to assist in data gaps or issues of concern and could be used as part of the continued evaluation for NPDES requirements, TMDL development etc..

As defined in subsection 4.4.3 of this report, there are metals in solution that are affecting the water quality. The elevated concentrations indicate'impairment' to the designated use of certain segments of stream within the *Project area*. These exceedences of criteria are indicators of potential concern, but are not true or definitive expressions of risk. Additional information gathered through the ERA process would assist in the evaluation of the risk condition. This information could then be used to open discussions regarding appropriate standards and criteria for the *Project area*.

It is recommended that an ERA utilize the data obtained from the previously described monitoring events (subsection 7.4, and shown in **Figure 7.5**). It would serve to characterize the risk associated with surface water, sediment and surface soils (as deposited sediment) contaminants. A standard CERCLA approach as defined by standard guidance (USEPA, 1989; 1992;1994; and 2001) will be followed. A 'Tiered' approach will be implemented by initially completing a Screening Level ERA (SLERA) with the use of screening benchmarks (i.e. such as those described in Long, E.E. and L.G. Morgan, 1991; USEPA, 2000; D.D. MacDonald, 1994; E.R. Long et al., 1995) which serves to identify contaminants of concern. Contaminants identified from the initial

screen, will be carried forward into a 'Baseline' ERA (BERA) which relies upon refined estimates of risk obtained from field-gathered and modeled ERA steps.

The entire program will be designed and implemented in order to achieve several data gap goals identified in this document. The first step to the ERA process will be with the documentation of a formal Field Sampling Plan and associated Quality Assurance/Quality Control Plan. This effort will be coordinated with all interested parties. The document will be provided as a DRAFT for review to the watershed trustees. Upon completion of the field effort, a DRAFT Screening Level (and Baseline if the data collection effort proceeds to the Baseline level) ERA will be presented and provided for Review. The results can be used to identify suitable water quality and biological endpoints for the *Project area*. The Town of Rico will be an active part of the process so that the goals and results will be strongly tied to their goals of the *Project area*.

7.5.2 Regulatory Documentation

As previously described, the obtained water quality data from the various monitoring strategies described within subsection 7.4 can serve multiple purposes. The TMDL process relies upon strategic data collection efforts that characterize the load associated with point and nonpoint sources. The studies described within subsection 7.4 would achieve the necessary data quality objectives required for the TMDL development. Similarly, the proposed WWTP will be subject to NPDES compliance reporting. The proposed sampling in subsection 7.4 can overlap with this requirement and provide a robust data set from which to be able to determine if the WWTP is meeting its permissible effluent goals. In addition, the monitoring can be used to assist with the definition of mitigated injury as part of the CWCB requirements for the potable supply point of diversion process. If any of the water quality improvement projects (as described in the following subsections of 7.6 and 7.7) were to be implemented, the monitoring of water quality pre- and post- project would provide a quantitative measure of improvement (or; referred to as mitigated injury). In summary, there is a number of other regulatory processes that would benefit from the proposed monitoring strategies. It is strongly recommended that these other uses be folded into the monitoring efforts in order to develop a cohesive, collaborative and cost-effective monitoring and documentation effort for the *Project area*.

7.6 Nonpoint Source Control

The **fourth category** of recommendations formulated by this plan is for the completion of various Nonpoint Source Controls.The results of the water quality analysis, and review of hydro-dynamic conditions within the *Project area*, it was determined that there are both nonpoint and point sources of water quality concern. The interpretation of available water quality data indicate the presence of metals-releasing nonpoint sources predominantly associated with mine-related features. Hydro-dynamic conditions within the watershed indicate the presence of stormwater issues related to existing development and recreator activity. These two categories of nonpoint sources require controls.

The specific recommendations associated with nonpoint source controls include the monitoring of potential and known nonpoint source areas (as previously described in **Section 6**), and additional recommendations of;

1. Pro-active planning of riverwalk/river corridor features in order to blend potential nonpoint source control best management practices into the design. There are BMPs suitable for the control of Stormwater and for the control of mine waste that may add unique features to the proposed design.

Specifically for Stormwater,

2. To document and implement a Stormwater management plan as part of the Town of Rico Regional Master Plan, and

3. To become pro-actively involved with Stormwater management as development occurs (especially in regards to the riverwalk/river corridor development), and to control existing Stormwater issues related to recreator activity and existing development.

Specifically for <u>mine-site related nonpoint sources</u>,

4. Become actively involved in all mine-site related closures/cleanups and integrate concepts of watershed issues into the design,

5. Re-evaluate existing remedy efforts for the Columbia and Argentine to determine if existing remedies are suitable for the contaminant releases once additional monitoring data become available

6. Upon completion of the monitoring data obtained from the proposed monitoring efforts (in subsection 7.4), identify suitable mine-sites that can be pro-actively remedied in order to control nonpoint sources of metals load. Current information indicates the need to evaluate sites within Horse Creek, Aztec Gulch, the Mountain Spring Mine and others.

As previously mentioned, there are numerous established BMPs for stormwater concerns. There are also, numerous remedy measures for the control of mine-waste issues. The following Sections describe recommendations to control both stormwater and mine-related nonpoint sources. Both could benefit from the pro-active planning of the proposed riverwalk/river corridor. With the proposed development efforts that could occur within the River Corridor (Maintenance garage area, the proposed River Lodge, Ice Rink, and WWTP) it should be recognized that there are both benefits and risks to be gained from these efforts. There are obvious benefits of increased economic and infrastructure development that are not the emphasis of this document. There are additional benefits to the watershed which include the ‘stabilization’ of potential mine-

wastes that would be buried as a result of the development activities. This stabilization will prohibit solids material movement into the actual corridor and eliminate that particular fate and transport pathway of a potential contaminant source. However, with the burial of these wastes there is the concern that groundwater intrusion, infiltration and contamination can still occur. Groundwater following the topography of the valley bottom will potential percolate through the waste materials and become degraded. This degraded water can then co-mingle with Dolores River surface water and present a water quality issue.

With the placement of structures upon the waste material, the potential for 'removal' as a remedy strategy, or in-situ treatment is no longer viable. The only remaining remedy strategy to capture the potentially degraded groundwater would be treatments of the water after its release from the mine-waste. Strategies such as wetlands fringe habitats may be suitable. These plant-barriers can afford some contaminant mitigation but only function during certain seasons. At low flow (winter setting) conditions, the wetlands do not function since the season prohibits natural cycles. There would still remain the potential for contaminant seepage during these times of the year.

Another watershed concern related to the proposed River corridor development is associated with the encroachment of man-made structures etc., into the actual river corridor. These physical disturbances will limit the flood plain width of the corridor and create a potential for flooding issues (as described within the Matrix Design Group, 2004 document). By tightening the river corridor width, there will be a loss of area for which the energy of water can be dampened, and the ability of scouring cobbles to fall out. This is a consideration that should be accommodated with flood engineering controls as development progresses.

7.6.1 Controlling Stormwater

Stormwater as a nonpoint source is going to become an increasing concern as the *Project area* receives more and more human pressure from development of the area, and from recreator use activity (**Photo 7.1**). Given that the Town is on the cusp of significant growth, it is recommended that a stormwater management plan be documented within the Town of Rico Regional Master Plan, and be implemented so that future growth does not add undue burden to this nonpoint source. The Town should also remain aware and active in regards to proposed development stormwater regulatory compliance. All proposed development activities will be required to obtain a Stormwater Construction Permit through CDPHE. Information regarding the **permit requirements** etc. can be found on;

- the USEPA National Pollutant Discharge Elimination System web page concerning Stormwater and Construction programs (http://cfpub.epa.gov/npdes/stormwater/authorizationstatus.cfm), and

- the CDPHE Construction Permit Unit web page (http://www/cdphe.state.co.us/ap/conperm.asp).

It is also recommended that the current stormwater flows be managed in a uniquely integrative manner with certain proposed development projects. It has been mentioned, that a 'river front' greenbelt or walkway may be designed to allow for recreational use. There has been significant, long-term demonstrated success with riparian area construction that allows for this use and also is engineered to address stormwater concerns (case study – Cherry Creek Reservoir/Denver, CO). There is an abundance of guidance and potential ideas for engineered Stormwater features that could enhance the riverwalk setting. These projects lend themselves to grant funding (ie. low-impact development funds: USEPA, 2006) and demonstrate the Town's investment towards improvement of water quality.

To summarize; there are two overlying recommendations in regards to Stormwater nonpoint source controls;

1. To document and implement a Stormwater management plan as part of the Town of Rico Regional Master Plan, and
2. To become pro-actively involved with Stormwater management as development occurs (especially in regards to the riverwalk/river corridor development), and to control existing Stormwater issues related to recreator activity and existing development.

Example stormwater management plans are available on the USEPA Stormwater web site. There are numerous resources regarding management plan formats, BMPs, permit requirements etc. For additional information regarding specific BMPs by type of source etc., the Town of Rico is referred to the USEPA Stormwater Site (http://cfub/epa.gov/npdes/stormwater/menuofbmps/menu.cfm) and various literature sources (i.e. Lorch, B. and L. Wyatt, 2000). In addition, there are 'short courses' that interested public and Town administrators can attend (at nominal charge) in order to become more educated in the realm of stormwater management and BMPs (refer to the Summit Water Quality Committee and the Denver Regional Council of Governments).

In regards to proposed Town of Rico strategies for the control of nonpoint sources, the following recommendations are being made;

For control of stormwater as related to development changes:

- Enhance, stabilize and protect existing riparian buffer zones. These biological buffer zones represent the best mechanism to control stormwater water quality impacts to a receiving system. These areas need to be maintained, and preserved.

- Endorse infrastructure planning for Stormwater control and BMPs. There is an abundance of 'engineered' approaches and relatively simple BMPs that assist with

the control of stormwater issues. CDOT and others have standard practices, and guides available Lorch, B. and L. Wyatt, 2000). CDPHE has a stormwater permitting system that requires the use of BMPs before, during and after construction efforts of 0.1 acre of greater. However, the active regulation and monitoring of BMP efforts during construction phases can be problematic for CDPHE given their limited personnel and resources. The Town of Rico needs to take an active role (perhaps identify a citizen interest group) to make sure construction efforts are managed closely.

For control of stormwater (and other subtle nonpoint sources) related to recreator activity:

- Plan for river access and use by identifying 'hardy' access points that are clearly identifiable and usable for the recreators.

- Preserve the habitat of the riparian and stream-side settings by creating sturdy, and obvious access areas, thereby limiting wayward travel and disturbance.

- Educate and provide interpretation at recreator areas so that users are aware of the fragility of the system and that the Town of Rico has an active interest for habitat preservation

The Town of Rico has the added concern of having lead present at sometimes elevated concentrations within the industrial and residential settings. Therefore, stormwater flows of Town soils may have additional lead concerns due to these mining related historic levels. There are a number of 'soils' data sets that have useful information from which to characterize the potential effect these soils may have (Wash Env (1995), AR and CDPHE). This information could be used to estimate the potential soils overland flow impacts to receiving systems. Soils transported to receiving drainages, in turn could become a source of sediment and sediment contamination, if the soils have contaminant issues. Simplistic models could be applied to determine if this pathway is of potential concern by comparison of the soil concentrations to derived sediment concentrations. This approach should be folded into the Ecological Risk Assessment proposed in subsection 7.5. The modeled sediment concentrations can then be compared to 'benchmark' values protective of aquatic life (sources: USEPA, 2001; Long, E.R. and L.G., 1991; MacDonald, D. 1994 and Long, E.R. et al., 1995). The results will provide an indication of whether overland flow of Town soils is of potential concern to the aquatic ecosystems within Silver Creek and the Dolores River.

In regards to recommendations for specific Stormwater BMPs, it is recommended that the Town refer to standard guidance and web pages which provide an abundance of information. Some unique guidance which contain innovative technologies that could be used as part of the riverwalk/river corridor planning are as follows;

- International Stormwater Best Management Practices (BMP) Database. Constructed by a consortium of regulatory agencies and private enterprises. The

database provides a review of BMPs available for numerous settings and goals (http://www.bmpdatabase.org/)

- McFero Grace III, J. 2002. Overview of Best Management Practices related to Forest Roads. USDA Forest Service, Southern Research Station. Paper Number: 025013, The Society for Engineering in Agricultural, Food and Biological Systems.

- USEPA, (US Environmental Protection Agency), 1995. Ecological Restoration: A Tool to Manage Stream Water Quality. EPA-841-F-95-007. November, 1995.

- USEPA, (US Environmental Protection Agency), 1995. Wetlands Fact Sheet Number 16, Wetlands Mitigation Banking, EPA 843-F-95-001p.[*Wetlands mitigation banking, which allows for the restoration, creation, or enhancement of wetlands to compensate for future development activities is described*]

- USEPA, (US Environmental Protection Agency), 1999. Stormwater Technology Fact Sheet: Vegetative Covers. EPA 832-F-99-027.

- USEPA, (US Environmental Protection Agency), 1999. Stormwater Technology Fact Sheet: Wet Detention Ponds. EPA 832-F-99-048.

- USEPA, (US Environmental Protection Agency), 1999. Stormwater Technology Fact Sheet: Minimizing Effects from Highway Deicing. EPA 832-F-99-016.

- USEPA, (US Environmental Protection Agency), 1999. Stormwater Technology Fact Sheet: Stormwater Wetlands. EPA 832-F-99-025.

- USEPA, (US Environmental Protection Agency), 2000. Field Evaluation of Permeable Pavements for Stormwater Management. EPA-841-B-00-005B.

- Interstate Technology and Regulatory Council (ITRC) Training Guidance: Technological and Regulatory Guidance Document for Constructed Treatment Wetlands. December, 2003. [ITRC provides both web-based and technical training sessions, as well as web-available guidance documents (http://www.ITRCweb.org).

- Interstate Technology and Regulatory Council (ITRC) Phytotechnology Technological and Regulatory Guidance Document. April, 2001.

- USEPA Workshop – Introduction to Ecological Restoration Web Page: provides links to technical guidance as follows (http://www.epa.gov/reg3hwmd/risk/eco/restoration/workshops/intro_eco_rest.htm)

- ✓ Restoration/Creation of Freshwater Wetlands: Primary Considerations and Lessons Learned.
- ✓ Essentials of Stream Restoration.
- ✓ Riparian Restoration and Buffers and Planting Woody Species for Upland Restoration.
- ✓ Effectiveness of Biosolids Application for Remediating Metals Mining sites.
- ✓ Stormwater Wetlands and Other Stormwater Best management Practices

There are also numerous training and assistance programs associated with the USEPA and the Center for Watershed Protection, in order for interested parties to become educated and enabled to secure grant sources. A source of USEPA can be found on the USEPA Stormwater web site (http://yosemite/epa.gov/R10/WATER.NSF/).

7.6.2 Controlling Mine-related Nonpoint Sources

Results of the water quality analysis indicate that there are ongoing mine-site related nonpoint releases of potential concern. There is considerable uncertainty associated with the data interpretation presented within this document, given the data gaps identified in this existing information.

Cursory water quality results do indicate that the Columbia tailings, and Argentine tailings have nonpoint sources of metals to the Dolores River and Silver Creek. There is also the indication of other possible nonpoint sources from mine related wastes such as fluvial tailings (**Photo 7.2**) located adjacent to the Rico Boy/Santa Cruz Mine areas. These potential source areas are the subject of intense study and ongoing activity. The nonpoint release of metals associated with the Columbia may be able to be addressed with unique remedy design features that could be integrated into the riverwalk/river corridor development. The Argentine has a significant seep (**Photo 7.3**) that begins as a nonpoint source that is channelized forming a point source with significant load contributions that will require a thorough engineered analysis. This potential source area needs further evaluation prior to remedy development. In addition, to these two potential contaminant sources, there may be other mine-site related nonpoint source areas as yet unidentified (thus, emphasizing the need for completion of a comprehensive monitoring study). In general, the recommendations to the Town of Rico in regards to the mine-related nonpoint releases are as follows;

1. become actively involved in all mine-site related closures/cleanups and integrate concepts of watershed issues into the design,

2. re-evaluate existing remedy efforts for the Columbia and Argentine to determine if existing remedies are suitable for the contaminant releases once additional monitoring data become available, and

3. upon completion of the monitoring data obtained from the proposed monitoring efforts, identify suitable mine-sites that can be pro-actively remedied in order to control nonpoint sources of metals load. Current information indicates the need to evaluate sites within Horse Creek, Aztec Gulch, the Mountain Spring Mine and others.

Under current law, public or private entities that undertake remedial activities at abandoned or inactive mine sites risk being held liable for any ongoing discharges from such sites that may occur following remediation, even where the entity had no legal responsibility for a site prior to beginning the remediation work (Colorado Mining Water Quality Task Force, 1997; CDPHE WQCD, 1997). There is currently no provision in the Clean Water Act which protects from legal responsibility a remediating agency, or 'Good Samaritan' who does not otherwise have liability for abandoned or inactive mined lands, who attempts to improve the conditions at these sites. Specifically, a 'Good Samaritan' may become legally responsible, under Section 301(a) and Section 402 of the CWA for any continuing discharges from the mined land after completion f a clean-up project (CDPHE WQCD, 1997). However, there is ongoing efforts within the legislature to lift liability from those Good Samaritan's who pursue abandoned mine land clean-up activities. Until such time, as the legislation acknowledges there efforts it is recommended that all pro-active efforts be coordinated with responsible parties and regulatory authorities. These entities are to be key in the Watershed Stakeholder group and can help guide efforts, as well as direct any proposed actions (refer to BLM AML success stories for current examples of pro-active efforts., i.e. Lake Fork Watershed, Lake County, CO).

The watershed stakeholders group represents an entity that can embark upon pro-active cleanup efforts. The stakeholders include key land-owners, regulators, and concerned citizens etc.; all of whom are empowered to conduct studies and implement construction efforts once an agreed-upon plan with funding is in place. Under Section 303(d) of the CWA, states are required to identify waters not meeting water quality standards, and then prioritize the list and develop TMDLs for high priority waters. The *Project area* occurs within a high priority water and CDPHE has taken active strides to develop the TMDL. Watershed restoration and planning guidance emphasize the need to develop watershed efforts in a cohesive manner with TMDLE needs. The *Project area* is perfectly situated to address mine-related water quality concerns in a cooperative manner with the TMDL effort. It is highly recommended that the Watershed Stakeholders group concentrate their mine-related nonpoint source control efforts with the TMDL process by having the CDPHE representatives be an integral part of the stakeholder team, develop the proposed monitoring plan with TMDL needs in mind, and eventually embark upon pro-active cleanup of mine-related nonpoint sources so as to diminish the metals load that is of concern (and was key to identifying the *Project area* as a TMDL priority).

In regards to recommendations for specific mine-related nonpoint source controls, it is recommended that the Town refer to standard guidance and web pages which provide an abundance of information. Some unique guidance which contain innovative technologies

that could be used as part of the riverwalk/river corridor planning are integrated into the following list of resources;

- Costello, C. 2003. Acid Mine Drainage: Innovative Treatment Technologies. National Network of Environmental Management Studies Fellow for the USEPA OSWER Innovation Office.

- USEPA, (US Environmental Protection Agency), 1995. Ecological Restoration: A Tool to Manage Stream Water Quality. EPA-841-F-95-007. November, 1995.

- Guidance and Training provided through the USEPA River Corridor and Wetland Restoration program: http://yosemite.epa.gov/water/restorat.nsf.

- USEPA, (US Environmental Protection Agency), 1993. Bioremediation Resource Guide and Matrix. EPA 542-B-93-004; NTIS PB94-112307

The control of mine-related nonpoint sources will be an integral part of the *Project area* TMDL process. There are specific guidance/case study documents which describe how to approach stream restoration activities in order to achieve TMDL goals;

- USEPA, (US Environmental Protection Agency), 1993. Application of restoration techniques (TMDL Program) within the framework of the TMDL process. TMDL Case Study #8, Boulder Creek, CO. EPA 841-F-93-006. June, 1993

The Town of Rico is in a unique position to pro-actively plan for mine-related remediation efforts in coordination with other ongoing activities. The Town is on the cusp of building a Wastewater Treatment Plant to service the residential and industrial settings within the town limits. The 'products' of the WWTP could be of beneficial use to the mine-related nonpoint source control process. The organic enriched effluent may afford some water quality protection to uncontrolled mine-related releases such as the Rico Boy, Santa Cruz, Silver Swan, Mountain spring Mine and others. The biosolids sludge could also be used as 'cap' or mine-waste treatment material for tailings left in place and creating a water quality issue (Mountain Spring Mine and others as yet unidentified).

Biosolids are treated municipal sewage sludge, and have a growing number of useful applications such as the reclamation of mine lands (Murray et al., 1981; Sopper, 1993, and Toffey, 2003, Costello, 2003). There are federal standards (Section 103Cof the CWA) and state standards that have to be met in order to apply biosolids to land. When biosolids are used to reclaim mine land, they afe almost always applied with lime (USEPA, 2005) which serves to increase the pH of the soil and assist with decreasing the availability of the metals (Sopper, 1993). Biosolids also have useful application as fertilizer which may serve Town purposes in other areas (proposed community green house, reclamation of developed lands etc.).

There is also the potential for using passive wetlands for the treatment of mine drainage (and Stormwater issues as previously discussed). There is an abundance of available literature, guidance and case studies that indicate the use has mixed results. The possibility of using constructed wetlands to assist with the mine-related nonpoint sources should also be evaluated as a viable remedy alternative since this alternative is conducive with Town goals and possible Riverwalk/River corridor enhancement.

There are very strategic steps that need to be taken, and engineered analysis needed to determine the potential of these remedy strategies. There are environmental concerns, permitting issues and regulatory constraints that surround these proposed ideas. Consultation with professional water permitting and engineering personnel is required for these efforts. There is guidance, relevant case studies and general information about these strategies as follows;

- Brown, R., M.C. Amacher, W.F. Mueggler, and J. Kotuby-Amacher, 2003. Reestablishing natural succession on acidic mine spoils at high elevations: long-term ecological restoration. http://www.fs.fed.us/rm/pubs/rmrs_rp041.pdf, available at http://www.srs.fs.usda.gov/kns/pubs_be/viewpub.jsp?index=5590

- Costello, C. 2003. Acid Mine Drainage: Innovative Treatment Technologies. National Network of Environmental Management Studies Fellow for the USEPA OSWER Innovation Office.

- Murry, D.T., S.A. Townsend and W.E. Sopper, 1981. Using Sludge to Reclaim Mineland. BioCycle, 22(3), 48-55.

- Sopper, W.E. 1993. Municipal Sludge Use in Land Reclamation. Lewis Publishers: Boca Raton.

- Toffey, W. 2003. Twenty-five Years of Mine Reclamation with Biosolids in Pennsylvania. From: Conference Proceedings – Rev/Tech: Cleaning up Contaminated Properties for Reuse and Revitalization: Effective Technical Approaches and Rools, USEPA Technology Innovation Office. July 22-24, 2003.

- Upper Arkansas River Alluvium Remediation: Biosolids Demonstration, Leadville, CO. 2000. Available at: http://faculty.washington.edu/clh/leadville.html

- USDOI (US Department of Interior), 2002. Office of Surface Mining. Acid Mine Drainage Treatment Techniques and Costs. Available at: http://www.osmre.gov/amdtcst.htm.

- USEPA, (US Environmental Protection Agency), 1993. Emerging Technology Summary: Handbook for Constructed Wetlands Receiving Acid Mine Drainage. EPA 540-SR-93-523.

- USEPA, (US Environmental Protection Agency), 1993. Preparing Sewage Sludge for Land Application or Surface Disposal: A Guide for Preparers of Sewage Sludge on the Monitoring, Record Keeping, and Reporting Requirements f the Federal Standards for the Use of Sewage Sludge, 40 CFR Part 503. EPA 831-B-93-002a. September, 1993.

- USEPA, (US Environmental Protection Agency), 1993. Technical Support Document for Land Application of Sewage Sludge, Volumes 1 and 2. NTIS PB93-110575 and PB93-110583.

- USEPA, (US Environmental Protection Agency), 1994. Biosolids: Beneficial technology for a Better Environment. EPA 832-R-94-009. June, 1994.

- USEPA, (US Environmental Protection Agency), 2000. Introduction to phytoremediation. EPA 600-R-99-107. February, 2000.

- USEPA, (US Environmental Protection Agency), 2001. Abandoned Mine Site Characterization and Cleanup Handbook. EPA 530-R-01-002.

- USEPA, (US Environmental Protection Agency), 2005. Biosolids Remediation and Lime Addition at the California Gulch Site in Leadville, Colorado. http://www.clu-in.org/products/demos/search/vendor_details.cfm?Project_ID=70

- CLU-IN – Technology Innovation Program. "Biosolids Recycling: Restore, Reclaim, Remediate". http://www.clu-in.org/search/t.focus/id/179/

7.7 Point Source Control

The **fifth category** of recommended projects is referred to as Point Source Control. There are currently four point source releases associated with the *Project area*;

1. the St. Louis tunnel and associated outfall,
2. the combined flows from the Santa Cruz and Rico Boy Adits,
3. the discharge from the Silver Swan Tunnel, and
4. the seep from the Argentine tailings.

There is also, the potential of a point source from an unnamed adit located below the overhead tramway along Silver Creek, and the Mountain Spring Mine seep. Both of these point sources have been documented by others, but were not verified during the production of this document. There are other potential point sources mentioned by CGS during their AML inventory that need review (CGS, 1989). The lack of specific information pertaining to these potential point sources represents a significant data gap in the understanding of water quality conditions within the *Project area*. This data gap was addressed with the proposed comprehensive watershed monitoring strategy presented in

subsection 7.4.1 above. For the remaining point sources with 'known' information, the Town is in a unique position in regards to being able to address these concerns. The point sources have all been addressed from a remediation perspective during VCUP actions by AR. These VCUP efforts have addressed a significant amount of contamination associated with the mine-site, yet point sources of water discharge remain. These point sources are to be a component of the proposed TMDL for the Upper Dolores and may capture the attention of the regulatory entities if they are found to be of significant concern and load.

Currently, review of the existing data identifies significant uncertainties in the data itself. The first and foremost recommendation in regards to these point sources is to capture a comprehensive watershed-scale monitoring program. There is historic data available (as reviewed within this plan), however there are significant uncertainties associated with it. A very well planned sampling effort needs to be completed before conclusions can be drawn about these point sources, and the potential for any further remedy development if needed. When the comprehensive data comes available, is evaluated and supports the decisions to pursue further actions, it is recommended that the watershed stakeholders group lead the effort for the process. The watershed stakeholder actions should then be coordinated with the North Rico non-profit which is managing other mine-related projects (Rico Bugle, 2006). The following specific recommendations were formulated for each point source;

1. **For the St. Louis Tunnel and discharge outfall:** The Town should continue their relationship with AR and assist with any strides that will move towards a treatment strategy for the tunnel. The data interpretation results from this study indicate the significant loss of flow from the tunnel to the outfall indicating that there is communication between tunnel flows to the Dolores River and possibly to groundwater. This indicates that the ponds do not capture and control all the flows released by the tunnel which presents a concern, and pending risk to the Dolores River. There is also a significant data gap in the understanding of the geothermal spring influences to the water quality. It is unknown as to how much metals these sources contribute to this system. There have been numerous ideas posed in regards to treatment of the tunnel water. It is apparent, that any treatment of the water will benefit the overall metals load within the *Project area*. Currently, the North Rico non-profit organization may take over the operation and maintenance of a treatment facility with AR guidance. This is a very positive mechanism to achieve the treatment of the tunnel water that will also enable to Town to be an active part of the St. Louis tunnel etc.. It is also recommended that the precipitate solids associated with the settling ponds be actively managed. It was unknown at the time of this document production, as to whether the ponds have a management schedule that addresses the disposal of these potentially hazardous materials. Given the history for the ponds to breach the berms, there is a definite concern associated with overtopping and release of materials to the Dolores River. Over time, the capacity of the ponds will diminish and the potential for overtopping of berms may become a concern. It is recommended that the Town take active part

in understanding the maintenance schedule associated with the ponds in order to be aware, and perhaps assist with the ponds so as to avoid a breach in the future.

2. **For the Santa Cruz/Rico Boy Adits**: Review of the current conditions of this point source indicates the need for control of the water and possible treatment. The flows from these two adits are combined into a single channel which then routes the water to a settling pond (**Photos 7.4 and 7.5**). The pond historically had a singular outfall into a wetlands area that is linked directly to the Dolores River. However, erosion and the collapse of the settling pond berm (created by a fallen tree – **Photo 7.6**) have lead to additional point discharges over time. The adits associated with these mines were viewed during high flow conditions. It appears that the BMPs in place, are functional during low flow conditions. However during high flows, certain features of the passive treatment areas are being circumvented, and mine-related water leaves the area uncontrolled to reach a confluence with wetlands associated with the Dolores River. For instance, the bulk-head/mine-doors for the Santa Cruz blockade are coated with fer-crete (precipitate formed from oxidized iron) and water is backing up into the tunnel. When released from the tunnel, much of the flow falls into the excavated channel for flow, but a portion flows uncontrolled down the slope. When both adit flows combine into a constructed pond, a significant amount of precipitate formation is apparent. This receiving pond had several berm breaches created by erosion and one fallen tree. It appears that this pond requires maintenance and perhaps additional footprint area to assist with the passive treatment of the water. In summary however, it appears that the existing passive treatment procedures for these combined flows are not sufficient to address the water quality concerns. Significant amounts of metals are still being released to the Dolores River as a result of these flows. It is recommended that these flows be extensively studied to identify a more aggressive, suitable remedy. It is possible to construct a series of settling ponds, wetlands areas or rip/rap channels (with limestone components) to assist with the treatment of these waters. The alternatives for remedy development need to be reviewed by a qualified engineer.

3. **For the Silver Swan Adit**: Review of the current conditions of this point source indicates the need for control of the water and possible treatment. There are two flowing features associated with the Silver Swan Site (**Photo7.7**). There are flows from the adit which were routinely sampled, and indicate significant metals load associated with the adit water quality. There is also, flow associated with the captured nonpoint tailings seep and stormwater collection system. These flows are routed to a settling pond and released at a distinct point to the Dolores River. The water quality associated with this point release does not appear to have been studied. The amount of metals contribution associated with the Silver Swan site needs further evaluation. Cursory information gained from the water quality analysis does indicate that there is a concern and the need for additional remedy efforts. It is recommended that the Town further study this site, become involved

with decision process in regards to its fate and endorse further action once additional information becomes available.

- **Other Point Sources –as yet to be Identified:** as previously mentioned, there are other potential point sources including the unnamed adit associated with the overhead tramway along Silver Creek, the Mountain Spring Mine and others. These point sources were not visually verified during the course of this plan's production. In addition, there is little information available to characterize the Mountain Spring Mine (and other CGS identified mine sites [CGS, 1989]) in order to determine if a flow pathway is complete. SEH has studied the unnamed adit and results indicate that it is a significant contributor of metals load to Silver creek. Given the uncertainties associated with the data sets however, it is recommended that further study be completed before any definitive action were to be taken in regards to these sites.

The Town's recently formulated nonprofit entity; 'North Rico nonprofit' provides a unique ability to become actively involved with the above mentioned projects. AR is in the midst of evaluating many of these point sources and their efforts rely on Town involvement. The nonprofit entity provides a potential mechanism by which the Town can assist with these efforts. *This plan recommends that there is a need for further studies to be conducted. However it should be noted that there are ongoing studies being completed by AR for the Water Quality Assessment of the St. Louis Ponds (SEH, 2005). Therefore, any future studies should be performed in coordination with these efforts. It should also be recognized that AR (as a member of the NorthRico Non-profit) intends to address the St. Louis Tunnel discharge with appropriate treatment upgrades to meet discharge permit standards ultimately established by CDPHE. AR believes that the the analysis performed as part of the CDPHE's ongoing WQA support the position that appropriate and protective permit limits can be established for the St. Louis Tunnel discharge without specifically accounting for, or requiring mitigation of, the other point sources noted within this plan.*

The 'un-identified' point sources need characterization before any action towards water quality improvement can be done. The characterization of these sources was folded into the Monitoring to Address Data Gaps strategy as described in subsection 7.4.

It is reiterated within this Section, that there exists the potential for using WWTP products as a part of the mine-related control strategies. The use of biosolids has been a successful effort at other mine sites with similar issues. Where possible, it is recommended that the WWTP be used as a remedy tool towards the water quality improvement goals. There are a number of training resources, guidance documents and points of contact that can assist with these approaches. A summary of some of the most relevant available resources is as follows;

- USEPA Workshop – Introduction to Ecological Restoration Web Page: provides links to technical guidance for Effectiveness of Biosolids Application for Remediating Metals Mining sites. (http://www.epa.gov/reg3hwmd/risk/eco/restoration/workshops/intro_eco_rest.htm)

- Bergholm, J. and E. Steen. 1989. Vegetation establishment on a deposit of zinc mine wastes. Environmental Pollution 56: 127-144.

- Brooks, R.R., A. Chiarucci and T. Jaffre. 1998. Revegetation and stabilization of mine dumps and other degraded terrain. Pages 227-247 in Plants that hyperaccumulate heavy metals: their role in phytoremediation, microbiology, archaeology, mineral exploration, and phytomining. CAB International, New York.

- Hossner, L.R. and R.M. Hons. 1992. Reclamation of mine tailings. Advances in Soil Science 17: 311-350.

- Lindemann, W.C., D.L. Lindsey and P.R. Fresquez. 1984. Amendment of mine spoil to increase the number and activity of microorganisms. Soil Science Society of America Journal 48: 574-578..

- USGS (United States Geological Survey), 1989. Riparian Ecosystem Creation and Restoration: A Literature Summary. byManci, K.M. and K.A. Schneller-McDonald. 1989. http://www.npwrc.usgs.gov/resource/literatr/ripareco/ripareco.htm)

- USEPA, (United States Environmental Protection Agency), 1995. Ecological Restoration: A tool to manage water quality.. EPA 841-F-95-007. November, 1995.

7.8 Riparian and Wetland Habitat Management

The **sixth and final recommendation** that was formulated from this Plan, is a one that has already been folded into the previous recommendations yet has tremendous value and merit as its own strategy. The preservation and possible enhancement of riparian/wetlands is key to the strategies presented within the Nonpoint and Point Source Control recommendations. Riparian zones play an integral role in the ecology and morphology of headwater streams. Conserving or restoring an intact riparian zone along streams has shown to help control nonpoint pollutant source load. Steedman (1988), Horner et al (1996) and others have found evidence that maintained riparian stream zones had higher quality habitat and aquatic life diversity as compared to similar urbanized streams that lacked intact riparian. An overlying recommendation that affects both the control of nonpoint and point sources, is to manage and protect existing riparian/wetland habitats, and enhance these vegetative buffer zones where possible.

Many of the recommendations previously discussed, present the opportunity to develop the Riverwalk/river corridor so as to accommodate BMPs for both stormwater and mine-site related sources. This would entail the protection and possible enhancement of riparian/wetland settings. The Town of Rico already has enacted wetland protection regulations that incorporate a 25-foot development setback. This is a tremendous stride forward towards the protection of these resources. This is endorsed strongly by the findings of this plan. The protection of wetlands in order to achieve watershed goals is a current trend and strongly endorsed by watershed protection entities (ie. CWP, 2006). It is suggested that wetland/riparian areas be enhanced in order to address nonpoint pollution concerns.

There are numerous guidance available for Stormwater BMPs utilizing vegetative buffer zones. There are also, numerous guidance for the control of mine-site contaminant releases with the use of vegetative barriers. There are operations and maintenance considerations with each of these strategies. None-the-less, the use of vegetative zones is a viable alternative that will serve multiple goals for the river corridor. When the Town begins the process of planning the river corridor features, it is recommended that qualified engineering firms knowledgeable in Stormwater and mine-site BMPs be enlisted to help design the area. The control of nonpoint sources should be a listed goal for these development efforts.

Once an established protected riparian/wetland setting has been completed, it is recommended that monitoring of riparian habitat functional condition be a part of the habitat management process. There are documented methods in place that can be utilized to establish ‘baseline’ and follow-on riparian condition using a simplistic functional index. The recommended methods for riparian monitoring are cited within NRCS, 1999; USDA, 2000 and 2004, BLM, 1998; and BLM 1999). The Town can take ownership of these monitoring efforts with some initial guidance. It is recommended that prior to actual riverwalk/river corridor development, a baseline study be completed (much of which has already been documented in current Wetlands Inventory documents [Drew, 2005] and others). Simple biometrics should be measured and routinely collected each year as development progresses. Once the system has stabilized and recovered, the vegetation should show trends of enhancement and stabilization.

TABLES

Table 7.1 Comparison of the Rico Regional Master Plan to the Recommendations Provided within this Watershed Plan.	
Town of Rico Master Plan Goal	Comparable Watershed Plan Recommendation
New development beyond the historic town plat will complement the existing town site by focusing development adjacent to town on the north and south sides while preserving natural forest areas to the east and west of town.	An evaluation of 'zones' suitable for various types of development was developed from this Watershed Plan. The development strategies provided within the Rico Regional Plan are cohesive with the Watershed Plan strategies.
Community Design Policy – Strive to inform, involve and empower the Rico community of all issues that affect and influence change of the community.	Education of the community is an integral component of each recommendation provided by this watershed plan. An informed community is a key asset to any type of planning and watershed improvement efforts.
Community Design Policy – Promote the viability of public community spaces, including but not limited to: the Main Street commercial area, the River Corridor, Town Park and public oriented businesses.	Public access spaces will serve to only assist to achieve the goals for watershed improvement. The proposed River Corridor can be used for a multitude of purposes to control stormwater, mine site releases and erosion, as well as enhance wetlands areas.
Community Design – Policy; Protect the natural appearance of mountain slopes from impacts by new development by promoting open space preservation for highly visible slopes and avoiding road cuts across such slopes (plus – all other objectives listed within this Regional Plan Goal).	This goal is very important and cohesive with the watershed plan goals. By maintaining natural areas, open space etc., there will be natural buffers to help control development impacts to the watershed. Proactive planning of roads will also serve to help control stormwater issues related to the watershed.
Establish and maintain a regional trail system for a broad range of outdoor recreational activities. Policy – Coordinate trail planning and development with the U.S. Forest Service.	This goal coincides with this Watershed plan goals by proactively addressing possible erosion/stormwater issues related to the watershed. By planning trails to occur 'along contours' and not cross cut buffering areas, possible issues can be abated.
Planning of the Rico River Park	Combine Park planning efforts with concepts of Stormwater controls, mine site restoration, and wetlands enhancement.
Preserve and expand access to the Dolores River	Planning access is a needed step in order to help control recreator impacts within sensitive habitat areas. This watershed plan recommends that recreator access points be planned, and serve a multitude of purposes (education, control of nonpoint sources, mitigation of impacted natural areas).

FIGURES

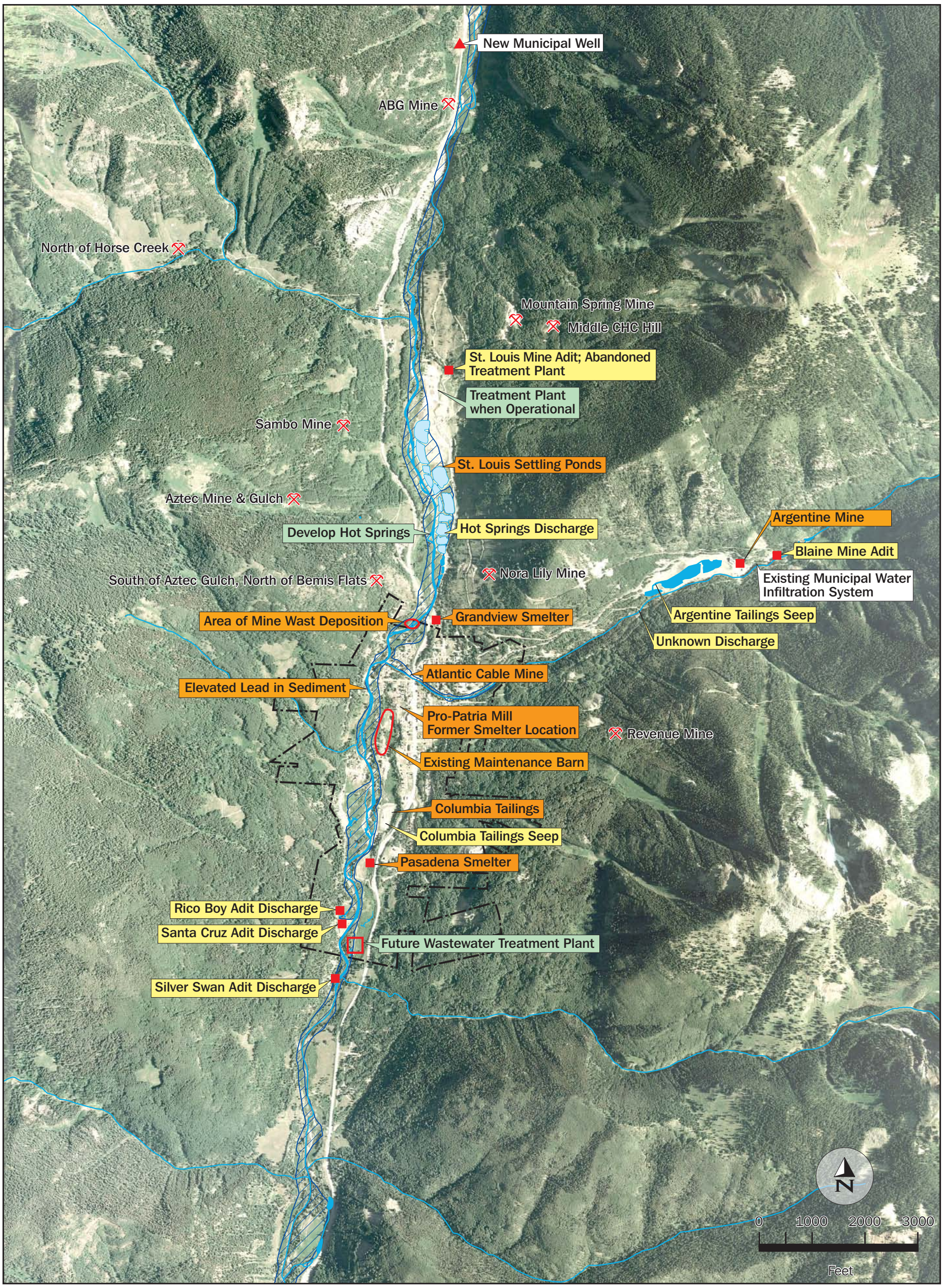


Figure 7.1

Summary of Known Point and Nonpoint Pollutant Sources as Related to the 100 year Flood Plain

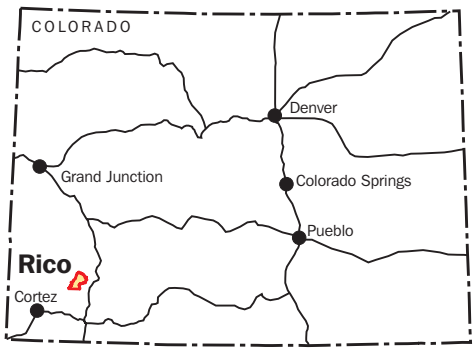
July 27, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- 100 Year Flood Plain
- USFS AML Site
- Municipal Water Supply Features
- Known Point Source
- Proposed Point Source
- Nonpoint Source

Prepared By:

K. King
Aquatic Toxicologist



Future Water Supply Pipeline

Brownfield Redevelopment

Light Industrial Development

Improved Settling Ponds (Dredging)

Future Trail Connection to the Galloping Goose Trail on Lizard Head Pass

Future Trail Head & Parking

Possible Forest Service Interpretive Site & Pedestrian Bridge across Silver Creek

Future Pedestrian Bridge across the Dolores River

Future Redevelopment Site: Potential River Lodge, Hot Springs Pool, Ice Rink

Ice Rink

"Garden of Eden" River Corridor Regional Trails / Wetlands

Current Town Park Facilities to be Renovated and Connected by Pedestrian Footpath to New Recreational Complex to the West

Proposed New Trail Segment

Water Park for Kayak & Rafting

Proposed Trail Head & Parking Lot

Potential Trail Head & Interpretive Site at Historic Rico Cemetery

Future Softball Field

Future Trail Expansion

N

0 1000 2000 3000

Feet

Figure 7.2

Potential Future Nonpoint Pollutant Source Areas by Type of Pollutant

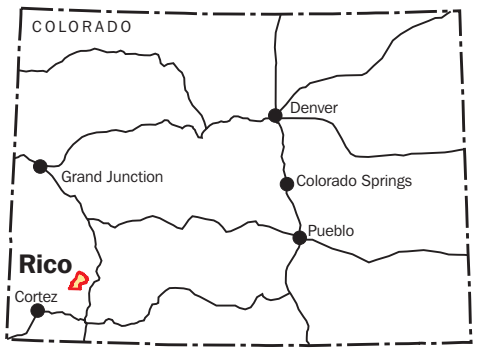
August 8, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- 100 Year Flood Plain
- Pipeline
- Storm Water (sediment, metals, salts, nutrients)
- Human Activity (coliform, sediment, nutrients)
- Metals, pH & Resuspension of Solids

Prepared By:

K. King
Aquatic Toxicologist



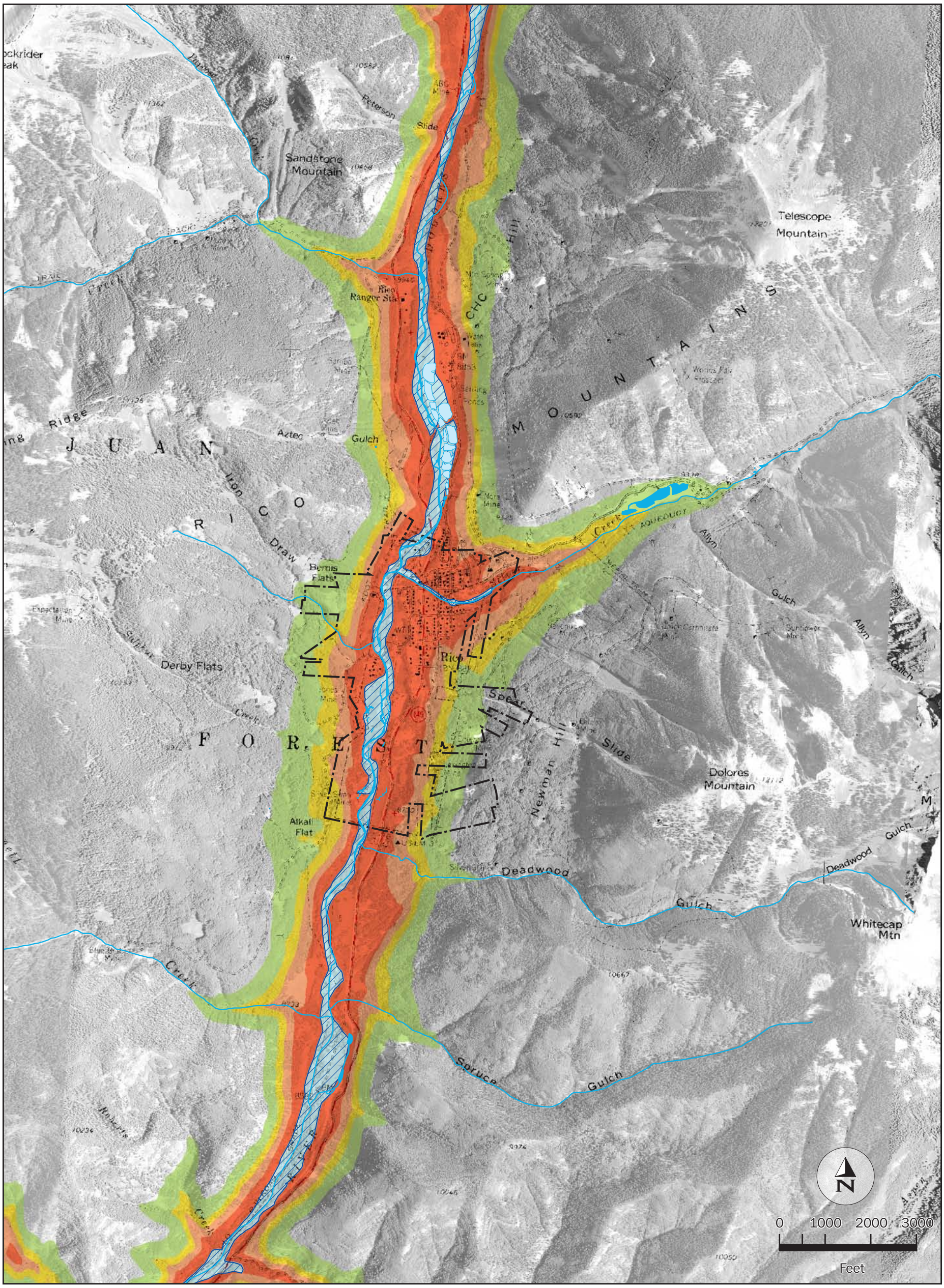


Figure 7.3

Horizons of Planning Activities

July 26, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- 100 Year Flood Plain
- 100 feet above Flood Plain = Protected Area
- 100 - 200 feet above Flood Plain = Active Planning Area
- 200 - 300 feet above Flood Plain = Active Planning Area
- 300 - 500 feet above Flood Plain = Active Planning Area

Prepared By:

K. King
Aquatic Toxicologist

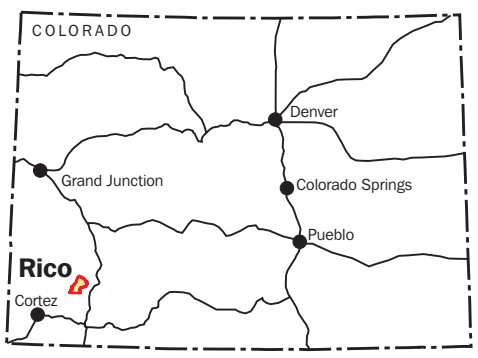
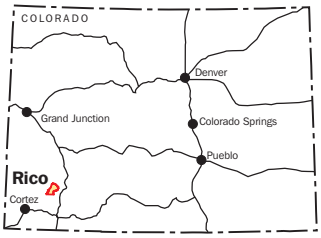


Figure 7.4

Historical Mining Claims within the Rico Area

July 27, 2006

- Rico Renaissance
- Matzick
- Hearnsberger
- Truelson
- Kendrick
- Holley
- Taylor
- Leighton
- Webster
- Ownership not assigned
- Town Parcels
- Claims



ABG Mine
North of Horse Creek
Mountain Spring Mine
Middle CHC Hill
Sambo Mine
Aztec Mine & Gulch
WQ, BMI, ERA
South of Aztec Gulch,
North of Bemis Flats
Nora Lily Mine
WQ, BMI, ERA
Sediment Assessment
Revenue Mine
Sediment Assessment
N
0 1000 2000 3000
Feet

Figure 7.5

Proposed Next Steps for Studies by Area

July 27, 2006

LEGEND

- Rico Municipal Boundary
- Rivers & Streams
- Water Impoundment
- 100 Year Flood Plain
- USFS AML Site
- Sediment Assessment
- Water Quality (WQ), Biological Monitoring and Inventory (BMI) & Ecological Risk Assessment (ERA)
- Metals Loading Analysis Sites & WQ, BMI, ERA Analysis Sites

Prepared By:

K. King
Aquatic Toxicologist

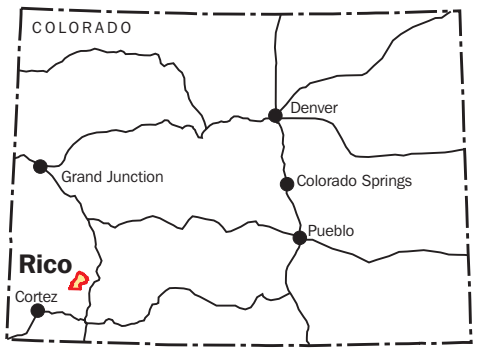


Figure 7.6. Conceptual Model Depicting Segments with Data Gaps.

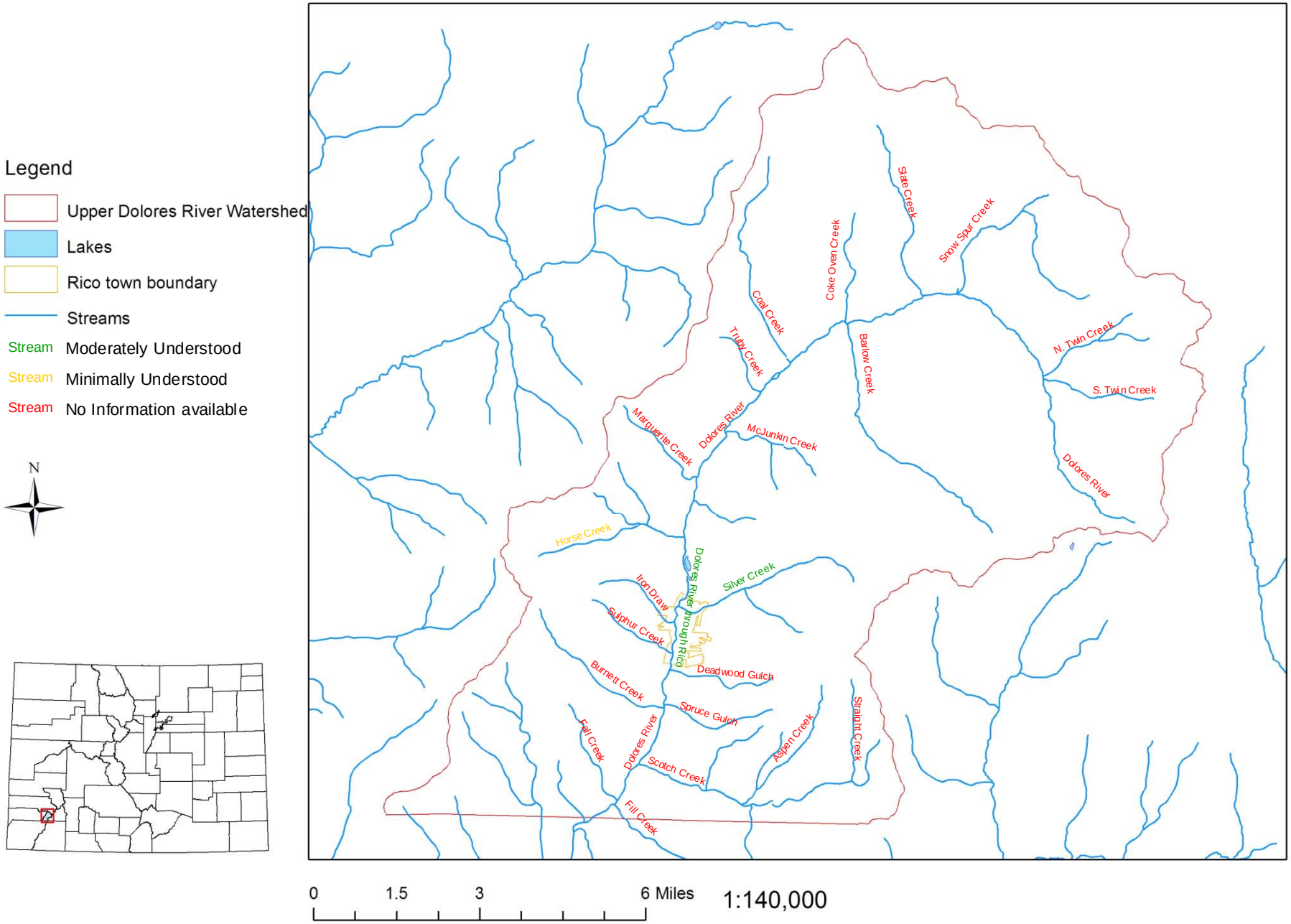


Figure 7.7. Hypothetical Example of a Synoptic Sampling Effort.

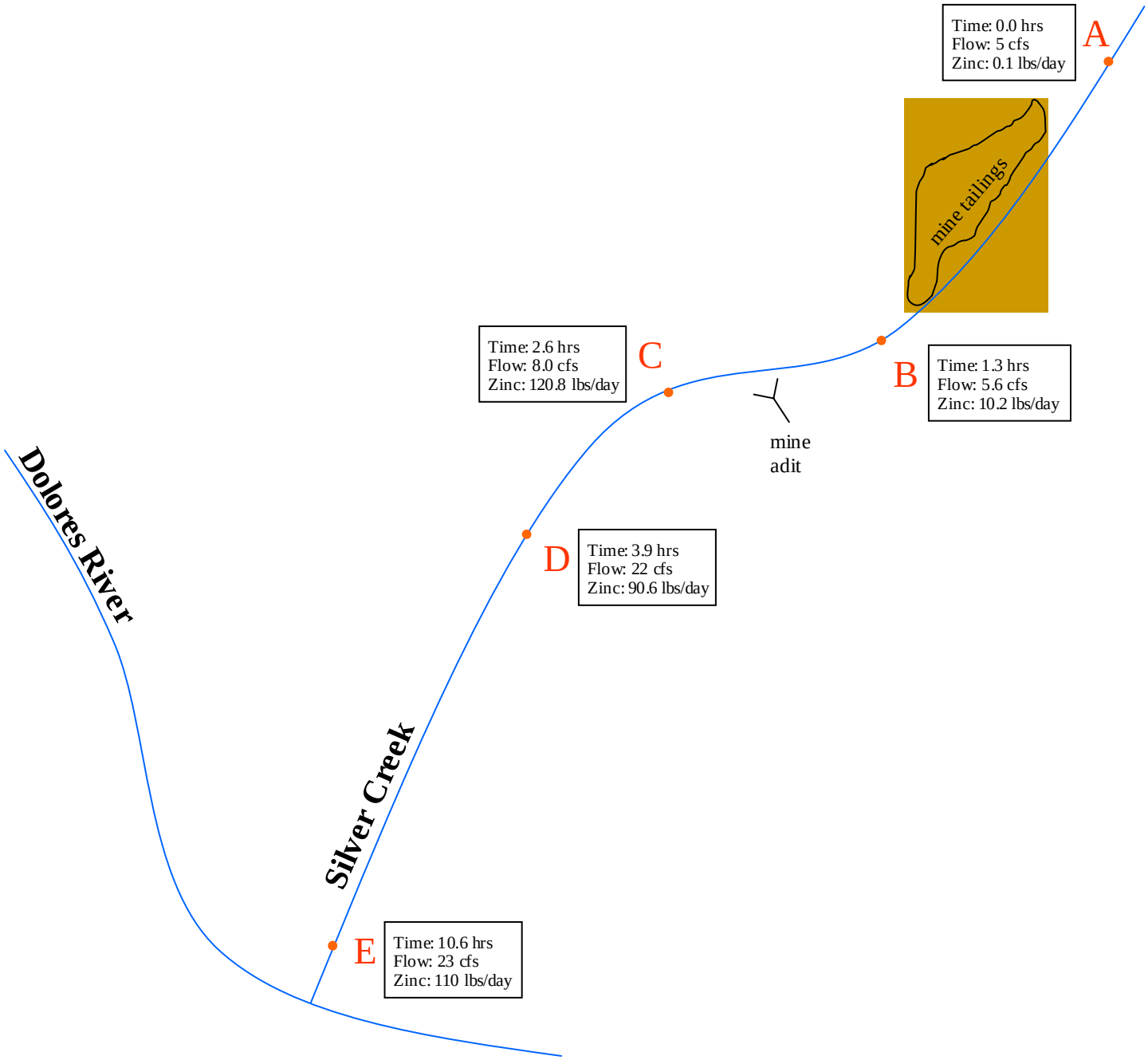


Photo 7.1. Example of Stormwater Impacts created by Recreator Activity. (storm drain located on top of a dirt road accessing an unrestricted campground adjacent to the Dolores River).

Photo 7.2. A Potential Nonpoint Source Requiring Further Evaluation : Fluvial Tailings Located Adjacent to the Santa Cruz and Rico Boy Mine Sites.

Photo 7.3. Ironoxide Deposits Associated with the Argentine Tailings Seep. This Photo Captures the SVS 12 Sampling Location.

Photo 7.4. The Santa Cruz Mine Adit. This Photo shows the Controlled Flow Channel (left) and the Uncontrolled Flow that is Circumventing the Remedy.

Photo 7.5. The Settling Pond for the Combined Flows from the Rico Boy and Santa Cruz Adits.

Photo 7.6. The Breach along the Rico Boy/Santa Cruz Settling Pond Created by a Fallen Tree.

Photo 7.7. Ironoxide Deposits from the Silver Swan Point of Discharge into the Receiving Wetlands Area.

SECTION 8

8 DRAFT FEASIBILITY ANALYSIS AND FUNDING ASSESSMENT OF RECOMMENDATIONS

8.1 Introduction

The purpose of this Section is to provide an overview of possible funding resources available for the recommendations presented within this plan. As previously mentioned, many of the recommendations 'fold into' the Rico Regional Master Plan and can be addressed by a variety of means. Certain recommended projects may be pieces of a larger project (i.e. Stormwater controls integrated into the Riverfront property development), or they can be entirely independent efforts (i.e. proactive cleanup of an inactive mine site). Securing funds for these projects will definitely vary by type. A considerable amount of effort can be accomplished by the contributed efforts of stakeholders. It is strongly recommended that each project be thoroughly presented and reviewed to the community so that as many interested parties can become involved. Community involvement and education is laced throughout all of the recommendations of this plan, and is key to the success of the proposed projects.

There are a number of funding mechanisms available that would support the recommended projects within this plan. Securing funds is a timely process and needs to be accommodated within the time-line for the completion of these efforts. The watershed stakeholders group can become responsible for tracking funding opportunities and being held responsible for process of identifying funding sources, their requirements, seeking community review and approval, submission of funding requirements etc.. The following provides a list of available, relevant grant funding sources that qualify for the recommended projects. This list represents only grant funds, and is subject to change in response to funding directives. The web page links or points of contact associated with each are provided below and within the Funding Source Information (**Appendix G**), as well as additional resources within the Points of Contact and Additional Resources for Information (**Appendix B**).

During the research efforts for this document, an abundance of information and resources was located. There are a number of training opportunities available that are recommended for the Town of Rico administration that would help with understanding watershed stakeholder group coordination and funding, and watershed project coordination and funding. Some of these training opportunities that target funding include;

- USEPA, 2006. (US Environmental Protection Agency). 2006. Sustainable Funding for Watershed Groups. Training is provided at http://www.clu-in.org/conf/tio/owsusfund_032206/

- USEPA, 2006. (US Environmental Protection Agency). 2006. Plan2Fund: A tool to organize your watershed funding. Training is provided at http://www.clu-in.org/conf/tio/owplan2fund_021506/

8.2 Cost Analysis and Recommendations

The potential costs associated with a portion of the recommended projects are summarized in **Table 8.1**. Some of the projects recommended are short-term while others would continue for years. Therefore, there is a 'cost per unit' provided for these various types of projects. There is a large uncertainty with being able to project costs with later projects due to needing expert opinion and review of site conditions in order to formulate project costs. Therefore, the costs associated with these later projects (association with point and nonpoint source controls) were not estimated within this Plan.

The following provide a summary of the specific grants that may apply to the recommended projects within this Watershed Plan. As with any grant submittal, it is highly recommended that a project idea be presented to the granting entity prior to significant grant work. Often, the 'mission' of a granting entity and the associated grant requirements can change. Language within grant requirements is often generic and subject to change. The USEPA Region 8 web page provides an 'interactive grants writing tutorial', points of contact and a link for Technical Outreach Services to Communities impacted by hazardous waste sites which the Town of Rico would be entitled to (http://www.epa.gov/region8/community_resources/grants/grants.html). It is also highly recommended that Town of Rico personnel attend an USEPA Grant Workshop to gain insight into grant opportunity changes (http://www.epa.gov/region8/topstories). Much of the information obtained and presented herein was gathered from an USEPA workshop attended by Grayling in June, 2006. Other resources were typically located through internet retrieval, or from points of contact that manage grant resources..

There are some 'general' or 'central' sources for researching funding opportunities. The ones reviewed for this plan included;

- Catalogue of Federal Domestic Assistance
- Catalogue of Federal Funding Sources for Watershed Protection (http://www.epa.gov/water/funding.html)
- Environmental Finance Program – A guidebook of financial tools (http://www.epa.gov/water/funding.html)
- USEPA: Grants and Debarment: Find Current Funding Opportunities (http://www.epa.gov/ogd/grants/funding_opportunities.htm)
- USEPA: Funding and Grants: Water (http://www.epa.gov/water/funding.html)
- USEPA: Watershed Funding: (http://www.epa.gov/owow/funding.html) (Fact sheet provided in **Appendix G**)

- USEPA: Region 8 – Grants: (http://www.epa.gov/region8/community_resources/grants/grants.html) (Fact sheet provided in **Appendix G**)
- Grants.gov (http://www.grants.gov/search/ an electronic application process is folded into this grant repository site)
- US Geological Survey: Contracts and Grants Information: Current Opportunities (http://www.usgs.gov/contracts/)

Table 8.2 provides a summary of the specific grant resources that could be tapped into for the recommended projects from this plan. The following provides specific descriptions for each grant. Summary information sheets (fact sheets) for some of the specific grants were located, and copies are provided in **Appendix.G**.

AWPPGs – Assessment and Watershed Protection Program Grants - Section 104(b)(3) Water Quality Cooperative Agreements (Fact sheet provided in Appendix G)
(http://www.epa.gov/owow/funding.rfp.html)
Timeline: June → August
Key aspects:

- Funds provided to projects that develop effective and comprehensive programs for watershed protection, restoration and management.

BRNFLD – USEPA Brownfields Program (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/region8/brownfields)
Key aspects:

- Helps communities clean up and redevelop properties
- Can be used for job training so that community members are actively addressing the clean up projects
- Helps mitigate potential health risks and assists in restoring economic vitality to contaminant-affected areas

CARE – Community Action for a Renewed Environment (Fact sheet provided in **Appendix G**)
(http://cfpub.epa.gov/care/index.cfm)
Timeline: Unknown
Key Aspects

- Requires community collaborative involvement to approach and reduce toxics.
- Pollution prevention (i.e. source water protection) a key variable.

CIG - Conservation Innovation Grants (Fact sheet provided in Appendix G)
(http://www.nrcs.usda.gov/programs/cig and Grants.gov)
Timeline: Open period – January → March
Key aspects:

- Watershed Protection and Flood Prevention Act (Public Law 83-566, Stat. 666) authorizes the Secretary of Agriculture to cooperate with State and local agencies in planning and carrying out works of improvement for soil conservation and for other purposes. It provides for technical, financial and credit assistance by the USDA to local organizations representing the people living in small watersheds (SCS, 2006).
- Awards competitive grants to non-federal governmental or non-governmental organizations for the development and adoption of innovative conservation approaches and technologies (soils emphasis).
- Need a letter of review from the local NRCS representative to endorse the project

CFP – Consolidated Funding Process Grants (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/cgi-bin/epa)
Timeline: Unknown
Key Aspects

- Five areas of funding potential, 1) regional geographic initiative (described below), 20 wetlands program development, 3) TMDL program funding, 4) NPDES Cooperative agreements, and 5) source water protection funding.

CWPF – Colorado Watershed Protection Fund (Fact sheet provided in **Appendix G**)
(http://cwcb.funding)
Timeline: unknown
Key aspects:

- Two categories: 1) project grants and 2) planning grants
- Project grants support projects that promote the improvement and/or protection of the condition of the watershed (TMDL development, watershed restoration etc.)
- Planning grants support development and implementation of successful watershed restoration plans.

EEGP – Environmental Education Grants Program (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/enviroed/grants.html)
Timeline:
Key aspects:

- Supports environmental education projects that enhance the public's awareness, knowledge, and skills to help people make informed decisions that affect environmental quality.

EJSGP – Environmental Justice Small Grants Program. (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/compliance/environmentaljustice/grants/ej_smgrants.html).
Timeline: Open period – January → March.
Key aspects:

- Promote the use of collaborative partnerships in addressing local environmental and/or public health issues.
- Can only apply for either EJSGP or EJCPS
- This opportunity serves to support building a foundation in identifying the issues, educating the community, forming a stakeholder group and envisioning solutions to the issues.
- Watershed protection organizations are NOT eligible, but local governments are.

EJCPS – Environmental Justice Collaborative Problem-Solving Cooperative Program. (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/compliance/environmentaljustice/grants/ej-cps-grants.html)
Timeline: Open period – January → March.
Key aspects:

- Promote the use of collaborative partnerships in addressing local environmental and/or public health issues.
- Can only apply for either EJSGP or EJCPS
- Required to have substantially built a foundation in identifying the issue, educating the community, forming a stakeholder group and envisioning solutions to the issues.
- Substantial USEPA involvement required
- Watershed protection organizations are NOT eligible, but local governments are.

FSRP – Five-Star Restoration Program
(http://cfpub.epa.gov/fedfund/search1.cfm)
Timeline: unknown
Key Aspects:

- The USEPA supports the Five-Star Restoration program by providing funds to the NFWF to support community-based wetland and riparian restoration projects.

NFP AMD – Not-for-Profit Acid Mine Drainage Reclamation (Fact sheet provided in **Appendix G**)
(http://cfpub.epa.gov/fedfund/search1.cfm;
http://www.grants.gov/search/search.do?oppId=2544&mode=VIEW)
Timeline: unknown
Key aspects:

- DOI's Acid Mine Drainage Reclamation program is designed to support the efforts of local not-for-profit organizations, especially watershed

groups to complete construction projects designed to clean streams impacted by AMD.

NRCS PL-566 SWP – Natural Resource Conservation Service Public Law 86-566 Small Watershed Program (Fact sheet provided in **Appendix G**)
(http://www.co.nrcs.usda.gov/programs/small-watershed-program.htm)
Timeline: unknown
Key Aspects:

- Provides technical and financial assistance to local sponsors for planning and carrying out watershed projects for flood protection of agricultural lands, rural infrastructure, watershed land treatment, water quality, and agricultural water management.
- The protection of soils resources is integral to these efforts.

OSM WIP – Office of Surface Mining, Watershed Intern Program (Fact sheet provided in **Appendix G**)
(http://www.osmre.gov/)
Timeline: unknown
Key Aspects:

- To provide funding support for a watershed intern for the completion of watershed studies including abandoned mine land site investigations, water quality studies etc.

P2 - Pollution Prevention Grant Program (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/oppt/p2home/grants/ppis/ppis.htm)
Timeline: March → May
Key Aspects:

- The USEPA created this program to provide matching funds to state and tribal programs to support P2 activities across all environmental media and to develop state programs.

RCF – Resource Conservation Funding(Fact sheet provided in **Appendix G**)
(http://www.epa.gov/region8/land_waste/rcra/grants.html)
Timeline: February → March
Key Aspects:

- This program addresses solid waste reduction and the innovative technologies that may lead to waste reduction.

RGI – Regional Geographic Initiative (Fact sheet provided in **Appendix G**)
(http://
Timeline:
Key Aspects:

- Provides funding to grass-roots initiatives to address regional contaminant-related issues.

TWGP – Targeted Watershed Grants Program (Fact sheet provided in **Appendix G**)
(http://www.epa.gov/owow/watershed/initiative
Timeline:
Key Aspects:

- Targeted watersheds (i.e. the Colorado River) are funded in order to implement watershed-based, on-the-ground, implementation projects to help build capacity of the many grass roots watershed organizations.

319 NP - Section 319 Nonpoint Source Implementation Grants
(http://www.epa.gov/cgi-bin/epa)
Timeline: February → March
Key aspects:

- USEPA provides funds for states and tribes to implement nonpoint source projects and programs in accordance with Section 319 of the CWA.
- Funds can be used for restoration projects that protect source area waters.
- BMPs are funded, as are watershed plans and planning efforts.

Wetland Program Development Grants (Fact sheet provided in **Appendix G**)
Timeline: Unknown)
Key aspects:

- The goal of the program includes increasing the quantity and quality of wetlands within the US by conserving and restoring wetland acreage.

WHPRP – Wildlife Habitat Policy Research Program
(http://ncseonline.org/WHPRP)
Timeline: Open period – May → July
Key aspects:

- Supports research projects that assist with the valuation of ecosystem services and estimations of the costs and benefits of habitat conservation, synthesis of what is known about the impacts of climate change on habitat and wildlife, review of State Wildlife action plans to determine the conservation priorities indicated by them.

The above provided possible funding resources for proposed projects that would take place in the near future. There are also, anticipated 'future' projects such as restoration of the stream corridor, protection of the potable supply and restoration of other habitats that may occur once the immediate project needs have been addressed. Some preliminary research was conducted in order to identify possible funding sources for these anticipated future projects as well and are summarized as follows;

- Protection of the Potable Supply:

  ✓ Drinking Water State Revolving Fund: This program funds projects for publicly- or privately-owned public water systems needed to protect

public health and ensure compliance with drinking water regulations. The program also provides funds for a variety of activities that support source water protection and enhanced water system management. (http://www.epa.gov/water/funding.html)

- Habitat Restoration (within the River/Stream corridors)

  ✓ Bring Back the Natives Grant Program: The National Fish and Wildlife Foundation program provides funds to restore damaged or degraded riverine habitats and their native aquatic species through watershed restoration and improved land management. (http://cfpub.epa.gov/fedfund/search1.cfm)

- Habitat Restoration (within the riparian/wetlands) and Special Studies

  - Cooperative Endangered Species Conservation Fund: The USFWS program provides financial assistance to areas entered into cooperative agreements for the development of programs for the conservation of endangered and threatened species. (http://cfpub.epa.gov/fedfund/search1.cfm)

  - Native Plant Conservation Initiative: The NWF supports on-the-ground conservation projects that protect, enhance, and/or restore native plant communities on public and private land. (http://cfpub.epa.gov/fedfund/search1.cfm)

  - Partners for Fish and Wildlife Program: The program provides funds to provide technical assistance to private landowners to restore fish and wildlife habitats on their lands.

  - Pulling Together Initiative: The National Fish and Wildlife foundation provides funds for private landowners and other entities interested in the long-term management of noxious weeds.

8.3 Benefit Analysis

A comprehensive quantitative benefit analysis can not be completed at this time since significant data gaps were identified and need to be addressed before further steps can be taken. There were four areas of recommendations provided within this document; 1) Watershed Coordination and Continued Planning, 2) Monitoring, 3) Nonpoint Source Controls, 5) Point Source Controls and 6) Riparian/Wetland Management. There are non-quantifiable benefits associated with the Watershed Coordination and Continued Planning, and Monitoring recommendations, but the benefits to be gained from completing any Nonpoint and Point Source Controls, and Riparian/Wetland Management

can not be quantified until a thorough water quality analysis is completed, as well as baseline monitoring of the riparian/wetland areas.

Based upon the existing information, it does appear that the water quality of the *Project area* would benefit from the proposed activities provided within this document. The actual amount of benefit (i.e. in terms of quantified metals load, or decreased sedimentation rates or enhanced wetlands/riparian areas) can not be determined until the source areas are characterized.

The benefits associated with the recommended goals associated with the Watershed Coordination and Continued Planning, and Monitoring recommendations are as follows;

For the Watershed Coordination and Continued Planning:

- Completion of the recommended projects within this category will enable and empower the Town in future planning activities within and surrounding their community. By incorporating this watershed plan into their future planning, future water quality and quantity concerns will be managed for. This will help control or abate any future condition of water quality and quantity concern.

- Endorsement of the proposed Watershed Stakeholder group activities will enable and empower the Town to tackle watershed concerns pro-actively. The Town will be knowledgeable in areas of water quality and quantity issues and be able to decide what projects are most suited to the overall Town needs and initiate the projects themselves. This will give ownership of the activities to the Town and lend to their success.

For the Monitoring:

- The proposed monitoring efforts will provide the Town a suite of very comprehensive data sets from which they can understand their watershed setting. This will enable and empower the Town to make their own educated decisions about next steps to achieve water quality goals, appropriate strategies for nonpoint and point source controls that are cohesive with other Town goals and be a key team member to regulatory processes that will ultimately affect the Town (TMDL, NPDES permitting).

- The proposed monitoring can be Town-integrated effort and an educational tool for the community. Much of the proposed efforts within the various monitoring strategies can be completed by interested community members. By having active participation, the Town will become more knowledgeable and ultimately more comfortable in the water quality/quantity setting, potential issues and potential activities to address the issues.

8.4 Projected Time-line and Goals

The proposed time-line for the recommendations provided within this document was summarized in **Table 8.2**. The reality of the time-line is dependent upon several key items as follows;

1) Review and approval of this Plan by the Town of Rico and the watershed stakeholder reviewers, and

1) Establishing the watershed stakeholder team which needs to be comprised of dedicated individuals willing to move forward with the proposed steps, and funding pursuits.

This document provides PROPOSED recommendations for projects to accomplish the Town's overlying goals of water quality improvement. The recommendations provided within this document were sequential in that the Watershed Coordination and Continued Planning needs to be begun before Monitoring can be initiated etc.. Regardless, these recommendations are DRAFT and subject to the review and approval of the Town of Rico and the watershed stakeholders who are reviewing this document. This document is subject to change and may ultimately provide a revised set of recommendations based upon review comments. Until this document is Final, the next steps and associated time-line can not be described.

A key step to this process is the identification of a dedicated watershed stakeholder group. To-date, several meetings have been held yet attendance and interest has been tenuous. A group of dedicated individuals representing key interest groups that can remain active and motivated towards meeting the goals of the recommendations within the Final Watershed Plan is essential to the success of the watershed process. Identification of these key individuals, inclusive of a watershed coordinator needs to happen before any remaining recommendations can be addressed.

TABLES

Table 8.1 Estimated Costs for Recommended Projects and the Level of Uncertainty Associated with the Cost Projection. Pg 1 of 3.			
Recommendation Category	Specific Recommendation	Potential Cost	Level of Uncertainty Associated with Estimated Cost
Watershed Coordination and Continued Planning	1. Stakeholder Group – formulation and coordination, integration to federal, state and regional watershed efforts ✓ Database Development, Information Repository ✓ Meetings, Coordination with other ongoing Watershed activities ✓ Regulatory coordination, steering of future studies and cleanup activities (TMDL, monitoring) etc. ✓ Education – Public outreach	15,000/year	Low
	2. Integration of Watershed Plan into Rico Regional Master Plan, and Rico Planning efforts	2,000/year[1]	Medium
Monitoring	1. Documentation – Field Sampling Plan : for Stakeholder review and Approval.	3,500/total	Low
	2. Comprehensive Project Area Monitoring (for the sampling of water quality, aquatic life, metals load, and sediment)	20,000/year	Low
	3. Ecological Risk Assessment and TMDL, updating the Watershed plan etc.	8,000/total	Low

Table 8.1 Estimated Costs for Recommended Projects and the level of Uncertainty associated with the Cost Projection. Pg 2 of 3.			
Recommendation Category	Specific Recommendation	Potential Cost	Level of Uncertainty Associated with Estimated Cost
Nonpoint Source Controls	1. Stormwater Management – Pro-active planning with Riverwalk/river corridor.	5,000[1]/total	Medium
	2. Stormwater Management – Documentation and Implementation of a Stormwater Plan	8,000[2]/total	Medium
	3. Stormwater Management – Control existing Recreator and Development-related Stormwater issues to the Dolores River	10,000[2]/total	Medium
	4. Mine-related Management – Retain Involvement with ongoing efforts and coordinate Watershed Issues	3,000[1]/total	Medium
	5. Mine-related Management – Re-evaluate Existing Remedies (i.e. using tMDL process) and determine Next Steps.	3,000[1]/total	Medium
	6. Mine-related Management – Identify Suitable Sites for Pro-active Remedy Efforts.	3,500[1]/total	Medium

Table 8.1 Estimated Costs for Recommended Projects and the level of Uncertainty associated with the Cost Projection. Pg 3 of 3.			
Recommendation Category	Specific Recommendation	Potential Cost	Level of Uncertainty Associated with Estimated Cost
Point Source Controls	1. WWTP Innovative technologies – use of biosolids for mine waste remedies – control of released materials	3,000[1]/total	Medium
	2. St. Louis Adit, Rico Boy/Santa Cruz, Silver Swam and other Point Sources – control of metals releases	-	High[3]
Riparian/Wetland Management	1. Protect, maintain and enhance existing riparian/wetland areas along the Dolores River and Silver Creek corridors by integration of a 'protected corridor' zone for development proposals, by construction of vegetation buffer areas during significant development efforts within the river corridor, by integration of vegetative buffer zone construction for nonpoint and point pollution source controls (refer to previous Recommendation Categories of Nonpoint Source and Point Source Controls)	-	High[3]

1 – The level of effort for these projects involves Town of Rico administration and staff. An approximate budget based upon anticipated hours with average hourly rates was presented for these categories.

2- These projects would require input from professional design engineers. Therefore the estimated costs have a 'medium' level of uncertainty since the cost estimate would have to be reviewed by others.

3- These projects have a high uncertainty associated with any cost projection since the technology used, scope of project, footprint of area are all largely unknown. Since there is such a high uncertainty, there was no prepared cost estimate provided.

Table 8.2 Possible Grant-Funding Sources Available for Recommended Projects. Pg 1 of 3.			
Recommendation Category	Specific Recommendation	Time-line for Completion	Possible Funding Sources
Watershed Coordination and Continued Planning	1. Stakeholder Group – formulation and coordination, integration to federal, state and regional watershed efforts ✓ Database Development, Information Repository ✓ Meetings, Coordination with other ongoing Watershed activities ✓ Regulatory coordination, steering of future studies and cleanup activities (TMDL, monitoring) etc. ✓ Education – Public outreach	Ongoing → future	EJSGP, CWPF, 319 NP, TWGP, RGI, AWPPG, CARE
		2007 → Future	EJSGP, CWPF, 319 NP, RGI, AWPPG
		Ongoing → Future	EJSGP, CWPF, 319 NP, AWPPG, CARE
		Ongoing → Future	EJSGP, CWPF, 319 NP, AWPPG, CARE
		ASAP → Future	EJSGP, BRNFLD, 319 NP, EEGP, RGI, AWPPG, CARE
	2. Integration of Watershed Plan into Rico Regional Master Plan, and Rico Planning efforts	Ongoing → Future	EJSGP, CWPF, 319 NP, AWPPG, CARE
Monitoring	1. Documentation – Field Sampling Plan : for Stakeholder review and Approval.	2007	EJCPS, CWPF, 319 NP, EEGP, OSM WIP, RGI, AWPPG, CFP
	2. Comprehensive Project Area Monitoring (for the sampling of water quality, aquatic life, metals load, and sediment)	2008 → Future	EJCPS, CWPF, 319 NP, EEGP, OSM WIP, RGI, AWPPG, CFP
	3. Ecological Risk Assessment and TMDL, updating the Watershed plan etc.	2008	EJCPS, CWPF, RGI, 319 NP, CFP

Table 8.2 Possible Grant-Funding Sources available for Recommended Projects. Pg 2 of 3.			
Recommendation Category	Specific Recommendation	Time-line for Completion	Possible Funding Sources
Nonpoint Source Controls	1. Stormwater Management – Pro-active planning with Riverwalk/river corridor.	ASAP → Future	CWPF, 319 NP, RGI, AWPPG, CFP, CARE
	2. Stormwater Management – Documentation and Implementation of a Stormwater Plan	ASAP → Future	CIG, NRCS PL-566 SWP, CWPF, BRNFLD, 319 NP, AWPPG, CFP, CARE
	3. Stormwater Management – Control existing Recreator and Development-related Stormwater issues to the Dolores River	ASAP → Future	CIG, NRCS PL-566 SWP, CWPF, 319 NP, AWPPG, CFP, CARE
	4. Mine-related Management – Retain Involvement with ongoing efforts and coordinate Watershed Issues	2008 → Future	EJCPS, CWPF, BRNFLD, 319 NP, NFP AMD, RGI, AWPPG, CFP, CARE
	5. Mine-related Management – Re-evaluate Existing Remedies (i.e. using TMDL process) and determine Next Steps.	2008 → Future	WPDG, AWPPG, FSRP, CFP, CARE
	6. Mine-related Management – Identify Suitable Sites for Pro-active Remedy Efforts.	2008 → Future	EJCPS, CWPF, BRNFLD, 319 NP, NFP AMD, RGI, AWPPG, CFP, CARE

Table 8.2 Possible Grant-Funding Sources available for Recommended Projects. Pg 3 of 3.			
Recommendation Category	Specific Recommendation	Time-line for Completion	Possible Funding Sources
Point Source Controls	1. WWTP Innovative technologies – use of biosolids for mine waste remedies – control of released materials	2007 → Future	EJSGP, EJCPS, CWPF, P2, RCF, CARE
	2. St. Louis Adit, Rico Boy/Santa Cruz, Silver Swam and other Point Sources – control of metals releases	ASAP → Future	EJCPS, CWPF, BRNFLD, 319 NP, RGI, CFP
Riparian/Wetland Management	1. Protect, maintain and enhance existing riparian/wetland areas along the Dolores River and Silver Creek corridors by integration of a 'protected corridor' zone for development proposals, by construction of vegetation buffer areas during significant development efforts within the river corridor, by integration of vegetative buffer zone construction for nonpoint and point pollution source controls (refer to previous Recommendation Categories of Nonpoint Source and Point Source Controls)	ASAP → Future	CIG, NRCS PL-566 SWP, CWPF, BRNFLD, 319 NP, AWPPG, CFP, CARE

SECTION 9

9 SUMMARY, CONCLUSIONS, AND NEXT STEPS

9.1 Summary

This Plan served the purpose of gathering all available information in order to characterize the *Project area* water quality, quantity and setting. For any watershed plan, there are standard pieces of information that are required to assemble a watershed plan and then be able to determine needed next steps towards accomplishing goals of water quality improvement (USEPA, 2006). As per USEPA format, a summary of the information required and obtained from this Plan is provided within **Table 9.1**. **Appendix B** provides other resources in addition to those presented within this Table. **Table 9.1** provides a summary of the links to resources from which the Town can download information as time progresses. Thus, the updated information can be integrated into this Plan and updated ad projects are accomplished.

Also, as per USEPA, CDPHE and others whose guidance directs watershed planning and associated projects, there are 'steps by which water quality improvement projects are accomplished. These steps were accommodated by the recommendations provided within this plan. Those recommendations began with the continued coordination of the watershed stakeholders group and carried through to actual on-the-ground type projects for control of nonpoint and point sources of pollution. A summary of these recommended projects as per USEPA, CDPHE planning approaches is summarized in **Table 9.2**. As shown within this Table, there are immediate projects that will cost little, and future projects that will require substantial technical and financial resources.

9.2 Conclusions

The conclusions drawn from this effort are as follows;

The *Project area* represents a sensitive, high quality watershed with unique features associated with being at high altitude and within an area will low human disturbance. The water quality is characteristic of a high mountain stream. As such it has mineralized characteristics, low buffering capacity and is sensitive to contaminant releases (due to the low buffering capacity). The amount of contaminant release this system is capable of assimilating is limited. Caution needs to be exercised in regards to any type of potential contaminant release inclusive of nonpoint and point sources.

There are point and nonpoint sources of pollution within the *Project area* that represent concerns to the water quality within Silver Creek and the Dolores River. These concerns need to be addressed before any aquatic life improvements could or should be made. The aquatic ecosystem is already 'compromised' within the *Project area* by virtue of the limitations improved by physical extremes. The flows are 'flashy' and subject to spring snow melt and summer rain falls. The stream and river channels are confined and have

high gradient. These conditions limit the amount of available fishery and would be difficult to manage. The most beneficial step that could be made within the *Project area* that could possibly improve the aquatic ecosystem would be the control of the pollutants from the point and nonpoint sources.

There are a number of recommended projects that the Town could undertake in order to make strides towards water quality improvements. The first would be to identify and solidify a Watershed Stakeholders group that could manage and continue the process of water quality improvements. From there, it is imperative the monitor water quality, sediment and aquatic life conditions throughout the *Project area*, and monitor these variables over time. Once a thorough understanding of water quality conditions has been obtained, it is possible to begin next steps towards completion of projects that could control point and nonpoint sources. Monitoring would continue pre- and post- control projects in order to measure the effectiveness of the efforts.

Water quantity is within the *Project area* is relatively stable since it is driven by natural processes above the *Project area* (no artificial draw-downs or gated-irrigation systems. However, the amount of water within the *Project area* is over-allocated due to the abundance of down-stream uses. The water balance which characterizes the natural amounts of inputs and outputs is '0' indicating there is no natural excess.

9.3 Next Steps

There are several recommended next steps for the Town of Rico, to be completed in order to address water quality and quantity concerns. These are subject to review and change in order to meet the goals of the Town of Rico. The proposed next steps formulated from this plan include;

1. Watershed Coordination and Continued Planning
2. Monitoring
3. Nonpoint Source Controls
4. Point Source Controls
5. Riparian/Wetland Management

Each of these steps require involvement of Town personnel, continued planning, funding and technical support (refer to **Table 9.1**). There are a number of funding opportunities that could be explored to achieve these projects. There has been demonstrated success from other similar mountain towns who have embarked upon watershed-scale tasks such as these. The Town of Rico is at a unique point in time in their planning process to be able to embark upon these efforts and achieve success. These efforts would protect their unique watershed and ultimately improve the water quality for years to come.

TABLES

Table 9.1 Summary of the Watershed Plan Recommendations. Pg. 1 of 3.						
Watershed Plan Recommended Projects	Components of the Project	Amount of Financial Assistance Needed	Amount of Technical Assistance Needed	Schedule	Milestones	Goals – Criteria for Achievement
Watershed Coordination and Continued Planning	1. Stakeholder Group – formulation and coordination, integration to federal, state and regional watershed efforts	15,000/year	Low	Ongoing → future	Stakeholder involvement, quarterly meetings	Stakeholder MOU
	2. Integration of Watershed Plan into Rico Regional Master Plan, and Rico Planning efforts	2,000/year[1]	Medium	Ongoing → Future	Integration into the Regional Plan	Integration into the Regional Plan
Monitoring	1. Documentation – Field Sampling Plan : for Stakeholder review and Approval.	3,500/total	Low	2007	FSP development	FSP approval
	2. Comprehensive Project Area Monitoring (for the sampling of water quality, aquatic life, metals load, and sediment)	20,000/year	Low	2008 → Future	Monitoring	Monitoring
	3. Ecological Risk Assessment and TMDL, updating the Watershed plan etc.	8,000/total	Low	2008	ERA development	ERA approval

Table 9.1 Summary of the Watershed Plan Recommendations. Pg. 2 of 3.						
Watershed Plan Recommended Projects	Components of the Project	Amount of Financial Assistance Needed	Amount of Technical Assistance Needed	Schedule	Milestones	Goals – Criteria for Achievement
Nonpoint Source Controls	1. Stormwater Management – Planning Riverwalk/river corridor.	5,000[1]/total	Medium	ASAP → Future	Proactive planning	Completed design
	2. Stormwater Management – Stormwater Plan	8,000[2]/total	Medium	ASAP → Future	Documentation of the Plan	Approval of the Plan
	3. Stormwater Management – Control existing issues	10,000[2]/total	Medium	ASAP → Future	Planning	Implementation
	4. Mine-related Management – Involvement with ongoing efforts and coordinate Watershed Issues	3,000[1]/total	Medium	2008 → Future	Involvement	Coordination
	5. Mine-related Management – Re-evaluate Existing Remedies	3,000[1]/total	Medium	2008 → Future	Re-evaluate existing plans	Implement new controls
	6. Mine-related Management – Identify Suitable Sites for Pro-active Remedy Efforts.	3,500[1]/total	Medium	2008 → Future	Evaluate Sites	Remedy Sites
Point Source Controls	1. WWTP Innovative technologies	3,000[1]/total	Medium	2007 → Future	Evaluate technologies	Implement technologies
	2. St. Louis Adit, Rico Boy/Santa Cruz, Silver Swan	-	High[3]	ASAP → Future	Evaluate technologies	Implement technologies
Riparian/Wetland Management	1. Protect, maintain and enhance existing riparian/wetland areas	-	High[3]	ASAP → Future	Plan for protection	Implement

Table 9.1 Footnotes:

1 – The level of effort for these projects involves Town of Rico administration and staff. An approximate budget based upon anticipated hours with average hourly rates was presented for these categories. Since there are existing personnel available who are able to accomplish these tasks, a 'low' level of additional technical assistance was identified.

2- These projects would require input from professional design engineers. Therefore the estimated costs have a 'medium' level of technical assistance required and the cost estimate would have to be reviewed by others.

3- These projects have a high uncertainty associated with any cost projection since the technology used, scope of project, footprint of area are all largely unknown. Since there is such a significant amount of uncertainty, there was no prepared cost estimate provided and the level of technical assistance would be high..

Table 9.2 Project Area Information Summary of Sources and Data Gaps. Pg 1 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Meteorology			
Precipitation	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. CSU : http://waterknowledge.colostate.edu/precip.htm Colorado Climate Center : http://ccc.atmos.colostate.edu
Air Temperature	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. Colorado Climate Center : http://ccc.atmos.colostate.edu
Evaporation	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. Colorado Climate Center : http://ccc.atmos.colostate.edu
Wind	None	Narrative, GIS Coverages, Tabulated Data	Intermountain West Climate Summary http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary. Colorado Climate Center : http://ccc.atmos.colostate.edu

Table 9.2 Project Area Information Summary of Sources and Data Gaps. Pg 2 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Surface Water			
Quality	Watershed –scale information lacking	Narrative, GIS Coverages, Tabulated Data	Potable Supply Water Quality: EPA Safe Drinking Water Information system – http://oaspub.epa.gov/enviro/sdw_ National Water Information System : http://waterdata.usgs.gov/nwis USEPA STORET http://www.epa.gov/storet/dw_home.html
Quantity	Baseline –above Rico area information lacking	Narrative, Tabulated Data	Gauging station hydrographs: http://waterdata.usgs.gov; or waterinform.program: http://web.frontier.net/SCAN Estimates of water use: http://water.usgs.gov/watuse/spread95
Water Rights and Permits	None	Narrative, GIS Coverages, Tabulated Data	NPDES: www.epa.gov/enviro/html/ Water quality use designation and TMDL: www.epa.gov/owow/tmdl/links.html Stormwater : www.epa.gov/npdes/stormwater CDWR databases (refer to Section 10 of this Report)
Groundwater			
Springs	Project area information lacking	Narrative some tabulated	USEPA, Walsh, 1995 and others (refer to Section 10)
Quality	Project area information lacking	Narrative, Tabulated data	USGS Water Quality : http://water.usgs.gov/osw/programs/nffpubs.html CGS, 2003 and 2004 (refer to Section 10 of this Report) USEPA STORET http://www.epa.gov/storet/dw_home.html, Refer to Section 4
Aquifers	Project area information lacking	Narrative, with some mapping	Potable Supply Water Quality: EPA Safe Drinking Water Information system – http://oaspub.epa.gov/enviro/sdw_ CGS, 2003 and 2004 (refer to Section 10 of this Report) Estimates of water use: http://water.usgs.gov/watuse/spread95
Wells, Permits and Water Rights	None	Narrative, mapping	CDWR databases (refer to Section 10 of this Report)

Table 9.2 Project Area Information Summary of Sources and Data Gaps. Pg 3 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Sediment			
Quality	Project area information lacking	Narrative with some database info	Sediment quality : www.epa.gov/waterscience/cs/nsidbas.html Refer to Section 4 of this Report
Drainage Basin Characteristics			
Watershed Morphology	None	Narrative, GIS Coverages, Tabulated Data	HUC and Watershed coverages: http://water.usgs.gov/GIS/HUC.html; www.ncgc.nrcs.usda.gov/products/ or www.epa.gov/ost/basins, CDPHE status of watersheds http://www.cdphe.state.co.us/op/wqcc/waterstatus2002/305(b) CWCB – flood plain delineations : www.CWCB
Wetlands/Riparian Areas	None	Narrative, GIS Coverages,	National wetlands inventory. www.nwi.fws.gov Drew, P. 2005 (refer to Section 10 reference list)
Terrestrial Setting	None	Narrative	Natural resource inventory : www.nrcs.usda.gov/technical/NRI, text within numerous documents describes the terrestrial setting including various SJNF documents (refer to Section 10 of this Report)
Aquatic Setting	Project area information lacking	Narrative with some database info	Aquatic Life monitoring : http://water.usgs.gov/nawqa and http://infotrek.er.usgs.gov/doc/nawqa_www/bio/bio_communitysamples.html Some data available through CDOW and others (i.e. C. Derfus, refer to Section 10 of this Report)
Soils	None	Hard copy and some GIS info.	NRCS info. www.nrcs.usda.gov/partners
Geology	None	Mostly narrative, some mapping	CGS, 2000, 2003, 2004 and others (refer to Section 10 of this Report)

Table 9.2 Project Area Information Summary of Sources and Data Gaps. Pg 4 of 4.			
Data Type	Data Gaps	Data Format	Data Location & File Name
Human Influence			
Land Use Management	None	Narrative, GIS Coverages	Mineral Use Records : www.geocommunicatorgov/Geocomm/Isis_home/home/index.html, BLM planning : www.blm.gov/planning/plans.html and http://www.co.blm.gov/sjra/sjoutfitters.htm Estimates of water use: http://water.usgs.gov/watuse/spread95
Property Ownership	None	GIS Coverages	Census US Census Bureau : http://quickfacts.census.gov, Department of Labor population projections: http://dola.colorado.gov/demog/QuickTables.cfm CDOT, COGCC and County web pages
Point Sources of Pollution	Some information available, there is need for additional characterization	Narrative listing of permits held	NPDES: www.epa.gov/enviro/html/ Stormwater : www.epa.gov/npdes/stormwater CDPHE CDPS http://www.cdphe.state.co.us/wq
Nonpoint Sources of Pollution	Some information available, there is need for additional characterization	Narrative	US Census of Agricultural use: www.nass.usda.gov/census (and livestock/crops) Agricultural chemical application rates: www.nass.usda.gov/census/research/cropland/SARSIa.htm Septic systems : www.nexc.wvu.edu/nsfc/nsfc_index.htm Colo. State Oil Inspection : http://www.epa.gov.swerust1/states/co.htm

SECTION 10

10 REFERENCES

References highlighted in ***bold italics*** were located, but never obtained nor integrated within the Watershed Plan. The citations are being provided for the Town of Rico reference and referral.

Ackerman, D.J. and T. Brooks. 1985. Ground-water data from the San Miguel River basin, southwestern Colorado: U.S. Geological Survey Open-File Report 85-191, 19 p.

AMC, (Anaconda Minerals Company), 1994. Personal communication with Bob Dent, Minerals Environmental Manager. As referred to in URS/EPA, 1996. Dated May 20, 1994.

Anonymous, date unknown. "Home History – The Written and Unwritten History of the Dolores from 1869 to 1886. File copied from the 4 Corners Region, Rico History file of the Montezuma County public Library.

Anonymous, 2002. "EPA and CDPHE support Brownfields Projects in Rico.

Anderson, D.G. 1970. Effects of urban development on floods in northern Virginia; U.S. Geological Survey Water Supply Paper 2001-C.

Anonymous, no date. No title. 'a summary report regarding a water quality study along the Dolores River completed 2002. Located on the web and appears to be a summary of the CFAR, 2001 report. http://www.fone.net/~thovezak/report.html.

Besser, J.M. 2000. Biologic studies, in USGS Interim Report on the Scientific Investigations in the Animals River watershed, Colorado, to Facilitate Remediation Decisions by the U.S. BLM and the USFS (March 29, 2000 meeting, Denver CO): USGS Open-File Report 00-245, 34 p.

BLM (Bureau of Land Management), 1990. Dolores River instream flow assessment : project report / by Vandas, Steve., United States. Bureau of Land Management Denver, CO : U.S. Dept. of the Interior, Bureau of Land Management, [1990] 783(271) D646 1990.

BLM, (Bureau of Land Management) 1987. Dolores River Corridor : Management Plan. USDI, BLM Montrose District. Ref no. 978.878827

Besser, J.M., W. Brumbaugh, S.E. Church and B.A. Kimball. 1998. Metal uptake, transfer and hazards in the stream food web of the upper Animas River watershed, Colorado, in Nimick, D.A. and von Guerard, Paul (eds.) Science for Watershed Decisions on Abandoned Mine Lands: Review of Preliminary Results (Denver, Colo., February 4-5, 1998): USGS Open-File Report 98-297, p. 20.

BLM (Bureau of Land Management). 1998. Riparian area management: a use guide to assessing proper functioning condition and the supporting science for lotic areas. D. Prichard, J. Anderson, C. Correll, J. Fogg, K. Gebhardt, R. Krapf, S. Leonard, B. Mitchell, J. Staats. TR 1737-15. BLM/RS/ST-98/001_1737. National Business Center, CO. 126 p.

BLM (Bureau of Land Management). 1999. Riparian area management: using aerial photographs to assess proper functioning condition of riparian-wetland areas. D. Prichard et al., TR 1737-12. BLM/RS/ST-96/007+1737, National applied Resources Sciences Center, CO. 52 p.

BLM (Bureau of Land Management). 2001. Surface Management Status, Mineral Management Status. Colorado Dove Creek. 1:100,000-scale topographic map.

BLM (Bureau of Land Management). 2006. Dolores River Rafting Outfitters 2005. BLM, Dolores Field Office, Dolores, Colorado. http://www.co.blm.gov/sjra/sjoutfitters.htm

BOM (Bureau of Mines), 1975). Information Report by District No. 4 Metal Mining Inspector, Thomas D. High. Dated December 5, 1974.

Bookhout, T.A. (editor). 1994. Research and Management Techniques for Wildlife and Habitats. 5th ed. The Wildlife Society, Bethesda, MD. 740 p.

BOR (US Department of Interior, Bureau of Reclamation). 1994 (as cited in USEPA, 1994) . personal communication with Jim Yahnkey, Hydrologist, and Mr. Yahnke's DRAFT summary report of Dolores River sampling analysis. May 17, 1994.

Boyle, T.P. and B. Bukantis. 1998. Use of ecological indicators as endpoints for remediation, in Nimick, D.A. and von Guerard, Paul, (eds.) Science for Watershed Decisions on Abandoned Mine Lands: Review of Preliminary Results, (Denver, Colo., February 4-5, 1998): USGS Open-File Report 98-297, p. 51.

Brown, R., M.C. Amacher, W.F. Mueggler, and J. Kotuby-Amacher, 2003. Reestablishing natural succession on acidic mine spoils at high elevations: long-term ecological restoration. http://www.fs.fed.us/rm/pubs/rmrs_rp041.pdf, available at http://www.srs.fs.usda.gov/kns/pubs_be/viewpub.jsp?index=5590

CDH (Colorado Department of Health), 1993. Authorization to Discharge Under the Colorado Discharge Permit System. – Rico Development Corporation. Effective date of February 1, 1994.

CDMG (Colorado Division of Minerals and Geology), 2006. Colorado Division of Minerals & Geology Report Sorted by Operator: 5/12/2006 (for Dolores County). http://mining.state.co.us/operatordb/report.asp

CDOLA (Colorado Department of Local Affairs). 2003. 2003 Population Estimates Summary. CDOLA web page : demographics <http://dola.colorado.gov/demog>

CDOLA (Colorado Department of Local Affairs). 2004. Colorado Preliminary Population Forecasts. November, 2004. CDOLA web page : demographics <http://dola.colorado.gov/demog>

CDOLA (Colorado Department of Local Affairs). 2006. Colorado demographic statistics – by County, Municipality, Town etc. http://dola.colorado.gov/demog/QuickTables.cfm

CDOLA (Colorado Department of Local Affairs,. 2006. Colorado economic and demographic information system: http://www.dola.state.co.us/is/cedishom.htm. January 23, 2006.

CDOLA (Colorado Department of Local Affairs,. 2006. Census data: http://www.dola.state.co.us/Demog/Census/SFHomepage.htm. January 23, 2006.

CDOW, (Colorado Division of Wildlife). 1965 Water resources data : Colorado : water year by Ugland, R. C., Cochran, B. J., Hiner, M. M., Steger, R. D., Wilson, E. A., Bennett, J. D., Jenkins, R. A., Crowfoot, R. M., Maura, R. A., O'Neill, G. B., Paillet, A. V., Ritz, G. F., Smith, M. E., Unruh, J. W., Boulger, R. W., Payne, W. F. Lakewood, CO : U.S. Geological Serv. Water Resources Div. 1965

CDOW, (Colorado Division of Wildlife). 1981. Colorado River cutthroat trout inventory; job progress report by Langlois, David L. Fort Collins, CO : Colo. Div. of Wildl. 1981

CDOW, (Colorado Division of Wildlife). 1990. Movements, distribution, and habitat selection of river otters reintroduced into the Dolores River, southwestern Colorado by Malville, Leslie E. [Boulder, CO] : Univer. of Colo. 1990

CDOW, (Colorado Division of Wildlife). 1990. Dolores River instream flow assessment : project report by Vandas, Steve Denver, CO : US Bur. of Land Manage. 1990

CDOW, (Colorado Division of Wildlife). 1993. Stream fisheries investigations; job final report by Nehring, R. Barry Fort Collins, CO : Colo. Div. of Wildl. 1993.

CDOW, (Colorado Division of Wildlife). 1993. Distribution and abundance of the fish fauna in the Dolores River from McPhee Reservoir downstream to the Dove Creek Pump Plant : June 29 - July 13, 1993.by Nehring, R. Barry, Colorado. Div. of Wildlife, U.S. Bureau of Reclamation. Durango Projects Office Durango, CO : US Bureau of Reclamation 1993

CDOW, (Colorado Division of Wildlife). 2003. Whirling disease investigations; job progress report by Nehring, R. Barry, Thompson, Kevin G.Fort Collins, CO : Colo. Div. of Wildl. 2003

CDOW, (Colorado Division of Wildlife). 2005.Whirling disease investigations; job progress reportby Nehring, R. Barry
Fort Collins, CO : Colo. Div. of Wildl. 2005

CDOT, 2006. Colorado Department of Transportation. Personal communication with Tara Galvez and Greg Roth, to Mike Thompson/Grayling Environmental. January 4, 2006.

CDOW, (Colorado Division of Wildlife) 2006. Personnel communication with Mike Japhet – Regional Aquatic Biologist. Level 2 – Stream Survey (2 pass removal) data for Dolores River #5 (2 stations – USFS road 578 adjacent to Cayton Campground and Montelores bridge).

CDOW, (Colorado Division of Wildlife) 2006. Big Game Statistics: 2005 Statistics: Harvest Survey Statistics; for Bear, Elk and Deer. http://wildlife.state.co.us/Hunting/BigGame/Statistics/

CDOW, (Colorado Division of Wildlife) 2006. Descriptions of Big Game Hunting Game Management Units. http://wildlife.state.co.us/apps/gmumaps/bgunit_descrip1.pdf

CDOW, (Colorado Division of Wildlife) 2006. Statewide Fishing Conditions: Conditions by Region. May 1, 2006. http://wildlife.state.co.us/Apps/dowfish/

CDPHE, Colorado Department of Public Health and the Environment. 1994. Correspondence to Rico Development Corp. Provided by Patricia A. Nelson/Unit Chief/Water Quality Control Division. Regarding: Delinquent Discharge Monitoring Reports for CDPS Permit No: CO-0029793; Dolores County. Dated November 10, 1994.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Delinquent Discharge Monitoring Reports for CDPS Permit No: CO-0029793; Dolores County. Dated February 10, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp and Mr. Wayne E Webster. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Reported Violation for CDPS Permit No: CO-0029793; Dolores County. Dated April 14, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Delinquent Discharge Monitoring Reports for CDPS Permit No: CO-0029793; Dolores County. Dated April 14, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp and Mr. Wayne E Webster. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Reported Violation for CDPS Permit No: CO-0029793; Dolores County. Dated May 5, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp and Mr. Wayne E Webster. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Reported Violation for CDPS Permit No: CO-0029793; Dolores County. Dated June 9, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp. Provided by Robert S. Griffith/Environmental Protection Specialist/Water Quality Control Division. Regarding: Compliance Sampling of Wastewater Treatment Facility Known as Rico development Corporation, CDPH Permit No.: CO-0029793; Dolores County. Dated June 28, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp and Mr. Wayne E Webster. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Reported Violation for CDPS Permit No: CO-0029793; Dolores County. Dated August 22, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1995. Correspondence to Rico Development Corp and Mr. Wayne E Webster. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Reported Violation for CDPS Permit No: CO-0029793; Dolores County. Dated December 12, 1995.

CDPHE (Colorado Department of Public Health and the Environment). 1995. Correspondence to Rico Development Corporation (Mr. Wayne Webster and David L. Sell/McMichael, Benedict and Multz/Denver CO.) Regarding: Reported Violation for CDPS Permit No: CO-0029793;Dolores County. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer, Permits and Enforcement Section/Water quality Control Division of CDPHE. May 5, 1995.

CDPHE (Colorado Department of Public Health and the Environment). 1995. Correspondence to Rico Development Corporation (Mr. Wayne Webster and David L. Sell/McMichael, Benedict and Multz/Denver CO.) Regarding: Reported Violation for CDPS Permit No: CO-0029793;Dolores County. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer, Permits and Enforcement Section/Water quality Control Division of CDPHE. June 9, 1995

CDPHE (Colorado Department of Public Health and the Environment). 1995. Correspondence to Rico Development Corporation (Mr. Wayne Webster and David L. Sell/McMichael, Benedict and Multz/Denver CO.) Regarding: Reported Violation for CDPS Permit No: CO-0029793;Dolores County. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer, Permits and Enforcement Section/Water quality Control Division of CDPHE. August 22, 1995

CDPHE (Colorado Department of Public Health and the Environment). 1995. Correspondence to Rico Development Corporation (Mr. Wayne Webster and David L. Sell/McMichael, Benedict and Multz/Denver CO.) Regarding: Reported Violation for CDPS Permit No: CO-0029793;Dolores County. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer, Permits and Enforcement Section/Water quality Control Division of CDPHE. December 12, 1995.

CDPHE, Colorado Department of Public Health and the Environment. 1996. Correspondence to Rico Development Corp. Provided by Robert J. Shukle/Chief/Water Quality Control Division. Regarding: Notice of Violation and Cease and Desist Order for CDPS Permit No: CO-0029793; Dolores County. Dated January 26, 1996.

CDPHE, Colorado Department of Public Health and the Environment. 1996. Correspondence to Rico Development Corp and Mr. Wayne E Webster. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer/Water Quality Control Division. Regarding: Reported Violation for CDPS Permit No: CO-0029793; Dolores County. Dated February 5, 1996.

CDPHE (Colorado Department of Public Health and the Environment). 1996. Correspondence to Rico Development Corporation (Mr. Wayne Webster and David L. Sell/McMichael, Benedict and Multz/Denver CO.) Regarding: Reported Violation for CDPS Permit No: CO-0029793;Dolores County. Provided by Kathleen L. Sullivan/Industrial Enforcement Engineer, Permits and Enforcement Section/Water quality Control Division of CDPHE. February 5, 1996.

CDPHE (Colorado Department of Public Health and the Environment). 1999. Correspondence provided to: Mr. Charles Stilwell/AR Environmental Remediation, LLC. Regarding: No action Determination Approval, Silver Swan Waste Rock Site, SW of the Town of Rico, Colorado. Provided by: Mark E. Walker/Voluntary Cleanup Program/CDPHE. December 10, 1999.

CDPHE (Colorado Department of Public Health and the Environment). 1999. Correspondence provided to: Mr. Charles Stilwell/AR Environmental Remediation, LLC. Regarding: No action Determination Approval, Columbia Tails Site, W of the Town of Rico, Colorado. Provided by: Mark E. Walker/Voluntary Cleanup Program/CDPHE. December 10, 1999.

CDPHE (Colorado Department of Public Health and the Environment). 1999. Correspondence provided to: Mr. Charles Stilwell/AR Environmental Remediation, LLC. Regarding: No action Determination Approval, Argentine Tails Site, NE of the Town of Rico, Colorado. Provided by: Mark E. Walker/Voluntary Cleanup Program/CDPHE. December 10, 1999.

CDPHE (Colorado Department of Public Health and the Environment). 1999. Correspondence provided to: Mr. Charles Stilwell/AR Environmental Remediation, LLC. Regarding: No action Determination Approval, Santa Cruz Mine Site, SW of the Town of Rico, Colorado. Provided by: Mark E. Walker/Voluntary Cleanup Program/CDPHE. December 10, 1999.

CDPHE (Colorado Department of Public Health and the Environment). 1999. Correspondence provided to: Mr. Charles Stilwell/AR Environmental Remediation, LLC. Regarding: No action Determination Approval, Grandview smelter Site, N of the Town of Rico, Colorado. Provided by: Mark E. Walker/Voluntary Cleanup Program/CDPHE. December 10, 1999.

CDPHE (Colorado Department of Public Health and the Environment). 1999. Regulation No. 41, The basic standards for ground water, effective March 2, 1999.

CDPHE, Colorado Department of Public Health and the Environment. 2000. Correspondence to Monica Heimdal/EPA Region 8. Provided by Gregory N. Brand/P.E/Water Quality Control Division. Regarding: Industrial Wastewater Discharge Inspection Report for: Rico Development Corporation St. Louis Tunnel Mine and Mill site, CDPS Permit No.: CO-0029793; Dolores County. Dated April 27, 2000.

CDPHE, Colorado Department of Public Health and the Environment. 2003. Correspondence to Darcy O'Connor/EPA Region 8. Provided by Gregory N. Brand/P.E/Water Quality Control Division. Regarding: Industrial Wastewater Discharge Inspection Report for: Rico Development Corporation St. Louis Tunnel Mine and Mill site, CDPS Permit No.: CO-0029793; Dolores County. Dated January 17, 2003.

CDPHE (Colorado Department of Public Health and the Environment). 2006. CDPHE current storm water construction permits on file: http://www.cdphe.state.co.us/wq/PermitsUnit/Active_Construction_Certifications.pdf

CDPHE (Colorado Department of Public Health and the Environment). 2006. CDPHE Current Water Quality Control Commission Regulations: 5 CCR 1002. http://www.cdphe.state.co.us/op/regs/waterqualityregs.asp

CDPHE WQCC (Colorado Department of Public Health and the Environment, Water Quality Control Commission. 2002. Status of Water Quality in Colorado: 2002. http://www.cdphe.state.co.us/op/wqcc/waterstatus2002/305(b)tableofcontents.html

CDPHE WQCC (Colorado Department of Public Health and the Environment, Water Quality Control Commission. 2002. Regulation No. 34. Classifications and Numeric Standards for San Juan River and Dolores River Basins.

CDPHE WQCC (Colorado Department of Public Health and the Environment, Water Quality Control Commission). 2002. Regulation No. 35. Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins.

CDPHE WQCC (Colorado Department of Public Health and the Environment, Water Quality Control Commission. 2004. Status of Water Quality in Colorado: 2004. The Update to the 2002 305(b) Report. April, 2004.

CDPHE WQCC (Colorado Department of Public Health and the Environment, Water Quality Control Commission. 2004. 5 CCR 1002-93, Regulation #93. Section 303(d) List Water-Quality Limited Segments Requiring TMDLs. Adopted March 17, 2004. Effective May 3, 2004.

CDPHE WQCC (Colorado Department of Public Health and the Environment, Water Quality Control Commission. 2006. Notice of Public Rulemaking Hearing Before the Colorado Water Quality Control Commission. Triennial Review Process. June 12, 2006.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 1997. Regulation No. 83: Passive Treatment of Mine Drainage Control Regulation. 5 CCR 1002-83. Effective August 30, 1997.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 1998. Colorado Water Quality Management and Drinking Water Protection Handbook.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 2000. Colorado's Nonpoint Source Management Program.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 2000. Status of Water Quality in Colorado 2000 – State 305(b) Report.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 2000. 2000 Draft 303(d) List.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 2002. Water Quality Limited Segments Still Requiring TMDLs: Colorado's 2002 303(d) List and Monitoring and Evaluation List. Water Quality Control Division. September 10, 2002.

CDPHE WQCD (Colorado Department of Public Health and the Environment, Water Quality Control Division). 2006. TMDL Development and Status. http://www.cdphe.state.co.us/wq/Assessment/TMDL/TMDLs.html

CDPHE (Colorado Department of Public Health and the Environment). 2001. Regulation No. 42, Site-specific water quality classifications and standards for ground water, effective September 30, 2001.

CDPHE (Colorado Department of Public Health and the Environment). 2002. "Rico-Argentine Mine Area Water Quality Assessment". Correspondence provided to Mr. Chuck Stilwell, PE AR Environmental Remediation. Provided by Susan Nachtrieb, Permits Unit Manager, CDPHE. January 14, 2002.

CDWR, 2000. Colorado Division of Water Resources – Division 7. District Court Water Division 7, Colorado Case No. 96CW49. Findings of Fact, Conclusions of Law and Judgment and Decree, concerning the application for water rights of the Dolores River Water Conservation District in Montezuma and Dolores Counties. February 16, 2000.

CDWR (Colorado Division of Water Resources) 2006. Water well permit database. Accessed 01/20/06.

CDWR (Colorado Division of Water Resources) 2006. Water Rights Report: Sorted by Structure Name and Admin No. Obtained from DWR Office (Mancos, CO) on June 15, 2006.

CDWR (Colorado Division of Water Resources) 2006. CDWR Documents and Records : http://water.state.co.us/pubs/research.asp

Cedar Creek Associates, 1995. Ecological Characterization: Vegetation Communities/Wildlife Habitats and Sensitive Species, Rico, Colorado. September, 1995.

CFR (Code of Federal Regulations). October 23, 2003.nonpoint Source Program and Grants Guidelines for States and Territories" Page 60653-60674.

CFAR (Citizens for Accountability and Responsibility). 2005. First CFAR Progress Report on Upper Dolores River for 2003: Preliminary Evaluation of Water quality in the Upper Dolores River of Southwestern Colorado. May, 2005.

CGS (Colorado Geological Survey). 1975. Environmental Geology No. 4, 'Reconnaissance Engineering Geology Report for Planning District 9, State of Colorado.

CGS, (Colorado Geological Survey). 1998USFS-Abandoned Mine Land Inventory Project. Final Summary Report for the San Juan National Forest, Dolores/Mancos Ranger District. By: R.G. Benson and P.W. Nichols. April, 1998.

CGS (Colorado Geological Survey). 1994. Identification and Remediation of Mine Flooding Problem in Rico, Dolores county, Colorado with a Discussion on the Use of Tracer Dyes. By M.W. Davis. CGS Division of Minerals and Geology, Department of Natural Resources. Denver, CO.

CGS (Colorado Geological Survey). 1995. Regulation of Water Quality at Colorado Metal Mining Sites and Associated Wetlands. By A.E. Barry, J.D. Arnow and D.C. Noe.

CGS (Colorado Geological Survey). 1999. CGS Water Quality Data Program. Rock Talk Vol. 2 No. 2. April, 1999.

CGS (Colorado Geological Survey). 2000. Naturally Degraded Surface Waters Associated with Hydrothermally Altered Terrane in Colorado. By: J.T. Neubert. Colorado Geological Survey, Division of Minerals and Geology. Department of Natural Resources. Denver, CO.

CGS (Colorado Geological Survey). 2000. Geology and Water Quality. Rock Talk Vol. 3 No. 2. April, 2000.

CGS (Colorado Geological Survey). 2003. Ground Water Atlas of Colorado. Special Publication 53. Topper, R., K.L. Spray, W.H. Bellis, J.L. Hamilton and P.E. Barkmann. Division of Minerals and Geology, Department of Natural Resources. Denver, CO.
CSU (Colorado State University), 2002. Precipitation: Colorado water knowledge, ,http//waterknowledge.colostate.edu/precip.htm.. Sept. 2002.

CGS (Colorado Geological Survey). 2003. Director of Colorado Water Quality Data. Information Series 66. By G.R. Weber and M.A. Sares. Colorado Geological Survey, Department of Natural Resources. Denver, CO.

Church, S.E. 1996. A watershed-scale approach to tracing metal contamination in the environment. US Geological Survey, Mineral Resources Program. Published within: Canadian Network of Toxicology Centres, Metals in the Environment Workshop Report, Far Hills, Quebec, October 21-22. http://amli.usgs.gov/reports/cntc/cntcmite.html

CLU-IN – Technology Innovation Program. "Biosolids Recycling: Restore, Reclaim, Remediate". http://www.clu-in.org/search/t.focus/id/179/

CNHP (Colorado Natural Heritage Program). 1995. Colorado's Natural Heritage: Rare and imperiled animals, plants, and natural communities. CNHP, Fort Collins, Colorado. 58 p.

Colorado Mining Water Quality Task Force, 1997. Report and Recommendations Regarding Water Quality Impacts from Abandoned or Inactive Mineral Lands. Copy available on the CDPHE WQCD web page: http://www.cdphe.state.co.us/op/wqcc/Misc/mismat.html

Colorado Outdoors. 2006. author: Kelly Brighid, "Outdoor highlights: water info now on the world wide web". May 11, 2006 pg. 15.

Colorado Outdoors. 1989. author: Al Marlowe, "Autumn on the Dolores". Vol. 38#5. Pgs 24 – 26.

Copeland, C., 1999. Clean Water Act: A summary of the law; Congressional Research Service Issue Brief, January 1999. 12 p.

CORA (Colorado River Outfitters Association). 2005. Executive Summary Commercial River Use in Colorado. 2005 Year End Report (www.croa.org).

CORA (Colorado River Outfitters Association). 2006. Colorado River Outfitters Association – web page. http://www.croa.org/media.htm.

Costello, C. 2003. Acid Mine Drainage: Innovative Treatment Technologies. National Network of Environmental Management Studies Fellow for the USEPA OSWER Innovation Office.

COSTIS (Colorado State Oil Inspection) 2006a. http://www.epa.gov/swerust1/states/co.htm. For event data: http://costis.cdle.state.co.us/ois/ois2000/event_search.asp (accessed on 3/21/2006)

COSTIS (Colorado State Oil Inspection) 2006b. http://www.epa.gov/swerust1/states/co.htm. For tank data: http://costis.cdle.state.co.us/ois/ois2000/tank_search.asp (accessed on 3/21/2006)

Cross, W. and A.C. Spencer. 1900. Geology of the Rico Mountains, Colo.: U.S.GS 21st Ann. Report. Pt. 2, p.7-165.

CSU (Colorado State University). 2006. Precipitation: Colorado water knowledge. http://waterknowledge.colostate.edu/precip.htm. January 24, 2006.

CSU (Colorado State University). 2006. Standardized Precipitation Maps (SPI), http://ccc.atmos.colostate.edu/standardizedprecipitation.php

CWCB (Colorado Water Conservation Board). No date. Dolores, San Juan Rivers Drought & Water Supply Assessment Basin Summary. Dept. of Natural Resources, Colorado Water Conservation Board. www.cwcb.state.co.us

CWCB (Colorado Water Conservation Board).2000. Memorandum: Consent Agenda Items 4-4a and 4-4b, May 22-23, 2000, Board Meeting – Approximate Hydrology Guidelines. To: Colorado Water conservation Board Members. From Ton Browning. May 15, 2000.

CWCB (Colorado Water Conservation Board).2002, San Juan/Dolores River Basin Water Use, Growth & Water Demand Projections. Dept. of Natural Resources – Colorado Water Conservation Board.

CWCB (Colorado Water Conservation Board).2003. Colorado Water Conservation Board – Instream Flow Tabulation – Streams. Water Division 7. March 13, 2003 (CWCB main web page: http://cwcb.state.co.us/isf/Downloads/Index.htm).

CWCB (Colorado Water Conservation Board).2004. Statewide Water Supply Initiative. Dept. of Natural Resources, Colorado Water Conservation Board. December, 2004.

CWCB (Colorado Water Conservation Board).2005. Copy of 'Consent Agenda Item 1.f: Case No. 7-05CW44; Dolores Water Conservancy District. CWCB\Board Meetings\November 2005\ConsentAgenda1f.DWCD.doc

CWCB (Colorado Water Conservation Board).2006. Dolores & San Juan river Basin Facts http://cwcb.state.co.us/Fact_Sheets/DoloresSJ/page001.html

CWCB (Colorado Water Conservation Board).2006. Virtual Water Resources Information Center – CWCB Document Retrieval System: Flood Plain Protection Section. http://cwcb.viis.state.co.us/Floodplain Docs.htm

CWP (Center for Watershed Protection). 2001. Rapid Watershed Planning Handbook: A comprehensive Guide for Managing Urbanizing Watersheds. Ellicott City, Maryland (www.pipeline.com/~mrrunoff/).

CWP. (Center for Watershed Protection). 2006. The Smart Watershed Benchmarking Tool. Produced for the Office of Wetlands, Oceans and Watersheds, US EPA. January, 2006.

CWP (Center for Watershed Protection). 2006. The Wetlands & Watersheds Article Series. Article 2: Using Local Watershed Plans to Protect Wetlands. http://www.cwp.org/wetlands/articles.htm

Czahor, M. 2006. Personal Communication: regarding status of storm water permits within Dolores County. Database of permits is an open- public file; provided by M. Czahor in April, 2006 (CDPHE, 2006).

Dames & Moore. 1981. Flood Hazard Areas Anaconda Mining Sites Dolores River and Silver Creek. Rico, Colorado. January, 1981.

Deidrich, J. 1999. Implementing the Wild & Scenic Rivers Act: Authorities and Roles of Key Federal Agencies. US FS. Technical Report of the Interagency Wild and Scenic Rivers Coordinating Council.

Derfus, C.S. 2001. Report of Biological & Aquatic Surveys Along the Dolores River Corridor at Rico. January, 2001. Prepared For: The Town of Rico. Prepared By: Corey Sue Derfus: Aqua-Hab, Inc.

Dils, R.E. 1953. Influence of forest cutting and mountain farming on some vegetation, surface soil, and surface runoff characteristics; Station Paper 24, Southeastern Forest Experiment Station, U.S. Forest Service, 55 pp.

Doesken, N.J. and M.A. Gillespie. 2005. A Review of the 2004 Water Year in Colorado. Hydrology Days 2005. Obtained from http://ccc.atmos.colostate.edu

Dolores County CEDS, 2006. Dolores County summary economic development – http://www.scan.org/4-DoloresCounty.pdf

Dolores County Records. 2006. Summary of permitted (and reviewed septic systems within the Project area) summarized within a table entitled "County Address Sundial Subdivision 15050 Hwy 145-Markey 15049 Hwy 145 + Lot #"

DPL (Denver Public Library), No Date. Western History Collection, Thomas M. McKee, Z-1246. View from Horse Gulch.

DPL (Denver Public Library), No Date. Western History Collection, Thomas M. McKee, Z-1201. Forest Mine.

DPL (Denver Public Library), 1890. Western History Collection, X-61734.Enterprise Mine, Rico, CO. 1890

DPL (Denver Public Library), No Date. Western History Collection, Jackson, William Henry, WHJ-664. Rico, CO.

Draper, E. No date. "Rico's silver mines leave a tarnished legacy. EPA finds lead in soil; costly cleanup looms. Denver Post Four Corners Bureau.

Draper, E. 2000. "EPA to help fix mine ponds: Rico residents fear heavy-metal sludge will drain into river." The Denver Post. April 22, 2000.

Draper, E. 2003. 11/04/2003. "Town resists cleanup proposal. Mountain burg sees EPA plan as threat. Denver Post Four corners bureau. Denver Post.

Draper, E. 2003. 12/08/2003. "EPA assures town its toxic lead woes are 'manageable'". Denver Post. Monday, December 08, 2003. www.denverpost.com/Stories/0,1413,36~53~1812869,00.html

Drew, P.W. 2005. Inventory of Wetlands and Riparian areas within the Town of Rico Urban Growth Boundary. Prepared for: the Town of Rico. November 30, 2005.

Dunne, T. and L.B. Leopold. 1998. Water in Environmental Planning. W.H. Freeman and Company. NY, NY. 818 p.

E&E (Ecology and Environment, Inc.) 1991a (as Cited in USEPA, 1994). Preliminary Assessment, McPhee Reservoir, Montezuma County, Colorado. Prepared by Kristen Cottle. September 12, 1991.

E&E (Ecology and Environment, Inc.) 1991b (as Cited in USEPA, 1994). Preliminary Assessment, Narraguinnep Reservoir, Montezuma County, Colorado. Prepared by Kristen Cottle. September 12, 1991.

E&E (Ecology and Environment, Inc.) 1984a. Site Visit Report, Rico Argentine Mine, Rico, Colorado. Prepared by Meg Babits. October 18, 1984.

E&E (Ecology and Environment, Inc.) 1984b. Sampling Plan for the Rico Argentine Mine, Rico, Colorado. Prepared by Meg Babits. October 18, 1984.

Ecology and Environment, Inc. 1994. Analytical Results for Rico-Argentine Mine, Rico Colorado. Prepared by Meg Babits. Dated July 29, 1985.

England, M. (Town Manager, Town of Rico), 2006. Personal communication to K. King regarding an inventory of water taps and septic systems within the Town of Rico.

ERIR, Environmental Release and Incident Reporting. 2006 Provided thought CDPHE, Hazardous Materials and Waste Management Division. Database accessible through their public phone information system (1-877-518-5608).

ESA Consultants Inc., 1999. Voluntary Cleanup Completion Report for Columbia and Old Pro Patria Mill Tailings, and Silver Swan Mine East Waste rock Pile Rico Colorado. Prepared for: AR Environmental Remediation L.L.C. September 17, 1999.

ESA Consultants Inc., 1995. Ecological Characterization: Vegetation Communities/Wildlife Habitats and Sensitive Species, Rico, Colorado. September, 1995.

Farish, J.B. 1892. On the ore deposits of Newman Hill, near Rico, Colorado: Colorado Sci. Soc. Proc., v.4, p. 151-164.

FEMA (Federal Emergency Management Agency. 1986. Flood Insurance Study, Town of Mancos, Colorado, Montezuma County, September 1986.

FEMA (Federal Emergency Management Agency. 1989. Flood Insurance Study, City of Durango, Colorado, LaPlata County, December 1989.

FISRWG (Federal Interagency Stream Restoration Working Group). 1998. Stream Corridor Restoration: Principles, Processes, and Practices. GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.

Fitzgerald, J.P., C.A. Meaney and D.M. Armstrong. 1994. Mammals of Colorado. University Press of Colorado. By the Denver Museum of Natural History.

Fore, L.S., J.R. Karr, R.W. Wiseman. 1996. assessing invertebrate responses to human activities: evaluating alternative approaches. J. N. Am. Benth. Soc. 15(2): 212-231.

Franke, O.L. and N.E. McClymonds. 1972. Summary of the hydrologic situation on Long Island, New York, as a guide to water management alternatives; U.S. Geological Survey Professional Paper 625-F.

Harrer, C.M. and W.J. Tesch Jr. 1959. Reconnaissance of iron occurrences in Colorado: U.S. Bureau of Mines Information Circular IC-7918, 82 p.

Heil, E.J. No date. 'Town of Rico – Water Issues'. Fact sheet provided to M. Hutchinson/EPA as point of discussion (4/2006). Copy on file.

Heil, E. no date. "Review of St. Louis/Blaine Tunnel Discharge Information. Summary of findings provided within the Town of Rico File No. 18005-001 Water, Water Quality Violations, St. Louis Tunnel.

Heil, E.J. 2004. Town of Rico Regional Master Plan. Adopted August 18, 2004. Prepared by Eric James Heil, Esq., A.I.C.P., Town Attorney and Planner.

Hem, J.D. 1985. Study and interpretation of the chemical characteristics of natural water (3rd ed.): U.S. Geological Survey Water-Supply Paper 2254. 263 p.

Hibbert, A.R. 1967. Forest treatment effects on water yield; in Forest hydrology (eds. W.E. Sopper and H.W. Lull), Pergamon Press, Oxford, pp. 527-543.

Hibbert, A.R. 1971. Increases in streamflow after converting chaparral to grass; Water Resources Research, vol. 7, pp. 71-80.

Hilsenhoff, W.L. 1981. Use of arthropods to evaluate water quality of streams. Tech. Bulletin No. 100. Dept. Nat. Res. Madison, WI.

HHFA (US Housing and Home Finance Agency) 1954. Septic tank soil absorption systems for dwellings, Division of Housing Research Construction Aid 5.
ITRC, (Interstate Technology and Regulatory Council), 2001. Phytotechnology Technological and Regulatory Guidance Document. April, 2001.

Holden, J. 2001. 07/24/2001. "Mercury study points finger at mines: Power plants also cited as source of toxic element in lakes. Cortez Journal. July 24, 2001.

Horner, et al. 1996. "Watershed Determinates of Ecosystem Functioning". In: Effects of Watershed Development and Management on Aquatic Ecosystems. Roesner, L.A. (editor). Snowbird Utah. August 4-9, 1996. Engineering Foundation.

Horton, R.E. 1945. Erosional development of streams and their drainage basins: hydrophysical approach to quantitative morphology. Geological Society of America Bulletin 56: 275-370.

ITRC (Interstate Technology and Regulatory Council), 2003. Training Guidance: Technological and Regulatory Guidance Document for Constructed Treatment Wetlands. December, 2003.

Johnson, C.W., T.C. Edwards, G. Bentrup and D. Rol. 1999 Editor: C.D. Calhoun. Conservation Corridor Planning at the Landscape Level: Managing For Wildlife Habitat. USDA.

Kelly, B. 2006 Personal communication regarding the continued sampling effort6s to be completed for the St. Louis tunnel site investigations (April 27, 2006).

Kimball, B.A., R.L., Runkel, K. Walton-Day and K.E. Bencala. 1999. Use of tracer-injection and synoptic-sampling studies to quantify effects of metal loadings, in Morganwalp, D.W., and H.T. Buxton (eds.), U.S. Geological Survey Toxic Substances Hydrology Program – Proceedings of the Technical Meeting, Charleston, South Carolina, March 8-12, 1999, v. 1, Contamination from Hardrock Mining: U.S. Geological Survey Water-Resources Investigations Report 99-4018A, p. 31-36.

Krebaucher, P. (Mine closure/DMG). 2006.Personal Communication to K. King. Regarding DMG mine closure activities within Dolores County.

Lance, L. 2003. 12/10/2003. "Rico and Points South Rico Wants to Clean Up, but Worries About Possible EPA Designation Town Not 'In Denial' www.telluridetodaylnet/11%2018%2003/rico.htm.

Lenat, D.R. 1988. Water quality assessment using a qualitative collection method for benthic macroinvertebrates. J. N. Am. Benth. Soc. 7: 222-233.

Leopold, L.B. 1968. Hydrology for urban land planning: a guidebook; U.S. Geological Survey Circular 554.

Lewis, D.C. 1968. Annual hydrologic response to watershed conversion from oak woodland to annual grassland; Water resources Research, vol. 4, pp. 59-77.

Litke, D.W. and N.A. Evans. 1987. Colorado water supply and use, in National Water Summary 1987 – hydrologic events and water supply and use: U.S. Geological Survey Water-Supply Paper 2350.

Long, E.R. and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52.

Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Lorch, B. and L. Wyatt. 2000. Erosion and Sediment Control During Construction. Summit Water Quality Committee Summit County, Colorado.

MacDonald, D.D. 1994. Approach to the assessment of sediment quality in Florida Coastal Waters. Florida Department of Environmental Protection.

Matrix Design Group, Inc. 2004. Dolores River Watershed Evaluation & Recommendations Report For the Town of Rico in Dolores County, Colorado. September 30, 2004.

McFero Grace III, J. 2002. Overview of Best Management Practices related to Forest Roads. USDA Forest Service, Southern Research Station. Paper Number: 025013, The Society for Engineering in Agricultural, Food and Biological Systems.

McKee et al. 1993. Methodology – SPI Defined. Obtained from the Colorado Climate Center http://ccc.atmos.colostate.edu.

Mimiaga, J. 2000. “Mine-tailing ponds threaten Dolores River.” Cortez Journal. April 8, 2000.

Mimiaga, J. 2000. “EPA responds to repair failing mine-tailing ponds. Cortez Journal. April 15, 2000.

Mimiaga, J. 2000. “EPA crews move in to repair tailings ponds. Cortez Journal. April 22, 2000.

Mimiaga, Jim. 2000. “EPA team fixes Rico ponds”. Cortez Journal. May 16, 2000.

Mimiaga, Jim. 2002. 05/18/2003. "Troubled legacy: Mining waste haunts Dolores River watershed. May 18, 2002. Cortez Journal.

Murry, D.T., S.A. Townsend and W.E. Sopper, 1981. Using Sludge to Reclaim Mineland. BioCycle, 22(3), 48-55.

Murray, B. 2003. 12/10/2003. "Rico told lead contamination manageable". Telluride Daily Planet. www.telluridegateway.com/articles/2003/12/08/news/top_stories/news01.txt

Nash, J.T. 2002. Hydrogeochemical Investigations of Historic Mining Districts, Central Western Slope of Colorado, Including Influence on Surface-water Quality. U.S. Geological Survey Digital Data Series DDS-73. U.S. Dept. of Interior, USGS.

Neubert, J.T., Ellis, C.E., Hannigan, B.J., Jeske, R.E., Martin, C.M., Thompson, J.R., Ruftin, S.E., Wood, R.H.II, Zelten, J.E., and Raby, A.G., 1992. Mineral approasal of San Juan National Forest, Colorado: U.s. bureau of Mines Open File Report MLA 2-92, 311 p.

Neubert, J. 2000. Naturally Degraded Surface Waters Associated with Hydrothermally Altered Terrane in Colorado. Colorado Geological Survey. Department of Natural Resources. Denver, Colorado. 2000. Open-File Report 00-16.

NPS (National Park Service). 2006. Wild & Scenic Rivers by State. http://www.nps.gov/rivers/wildriverslist.html

NRC (National Response Center) 2006. NRC Query Standard Report Database: http://www.nrc.uscg.mil/wdbcgi/wcbcgi.exe/WWWUSER/WEBDB.foia_query.show_parms (3/23/2006)

NRCS (Natural Resource Conservation Service), No date. Soil Survey of San Miguel Area, Colorado, Parts of Dolores, Montrose, and San Miguel Counties. US Dept. of Agriculture, NRCS in cooperation with US Dept. of Interior, Bureau of Land Management and National Park Service; and the Colorado Agricultural Experiment Station.

NRCS (Natural Resource Conservation Service), 1997a. Soil Survey of Animas-Dolores Area, Colorado, Parts of Archuleta, Dolores, Hinsdale, La Plata, Montezuma, San Juan and San Miguel Counties. US Dept. of Agriculture, NRCS in cooperation with US Dept. of Interior, Bureau of Land Management and National Park Service; and the Colorado Agricultural Experiment Station.

NRCS (Natural Resource Conservation Service), 1997b. Soil Survey of Cortez Area, Colorado, Parts of Dolores and Montezuma Counties. US Dept. of Agriculture, NRCS in cooperation with US Dept. of Interior, Bureau of Land Management and National Park Service; and the Colorado Agricultural Experiment Station.

NRCS (Natural Resource Conservation Service). 1998. Stream Visual Assessment Protocol. National Water and Climate Center Technical Note 99-1. December, 1998.

NRCS (Natural Resource Conservation Service). 1999. Assessing Conditions of Riparian-Wetland Corridors at the Areawide Level: Using Proper Functioning condition (PFC) methodology – an interdisciplinary assessment tool. USDA NRCS. Watershed Science Institute Technical Report. September, 1999.

NRCS (Natural Resource Conservation Service), 2001. STREAM*A*SYST: A tool to help you examine stream conditions on your property. By: G. Andrews and L. Townsend. EM8761. March, 2001.

NRCS (Natural Resource Conservation Service), 2006. Web Soil Survey: for the Animas-Dolores Area, Colorado, Parts of Archuleta, Dolores, Hinsdale, La Plata, Montezuma, San Juan, and San Miguel Counties. [Project area maps were queried, copies are provided as Figures within the Text of the Document and were obtained from: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx}

NRCS (Natural Resource Conservation Service), 2006. National Water and Climate Center. <http://www.wcc.nrcs.usda.gov/snow.html.

NRCS (Natural Resource Conservation Service), 2006. Colorado Precipitation Maps. http://www.ncgc.usda.gov/products/datasets/climate/data/precipitation-state/co.html

Paser, Kathleen. 1996. Characterization of and Treatment Recommendations for the St. Louis Adit Drainage and Associated Settling Ponds in Rico, Colorado. August 30, 1996.

Ransome, R.L. 1901. The ore deposits of the Rico Mountains, Colorado: U.S. Geol. Survey 22d Ann. Rept., pt. 2, p. 229-398.

Rickard, T.A. 1897. The Enterprise mine, Rico, Colorado: Am. Inst. Mining Engineers Trans., v. 26, p. 906-980.

Rico Bugle. 2006. Rico Recap. Volume II, Issue 6 pgs 1 and 5.

Rosenberg, D.M. and V.H. Resh. 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman & Hall. 488 p.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Ryan, R. (Bureau of Land Management). 2006. Personal communication regarding BLM river rafting recreator use patterns within the Dolores River Corridor. Copies of correspondence within project files.

Sares, M.A. 1996. The U.S. Forest Service abandoned mine land inventory in Colorado: background, progress, and preliminary findings in Bell, R.S. and Cramer, M.H. (compilers), Symposium on the Application of Geophysics to Engineering and Environmental Problems: April 28 – May 2, 1996, Keystone, Colorado, p. 221-232.

Schueler, T. 1994. The importance of imperviousness. Watershed Protection Techniques. 1(3)-100-111.

SCS (Soil Conservation Service). 1967. Soils suitable for septic tank filter fields, Agricultural Information Bulletin No. 243.

SCS (Soil Conservation Service). 1972. Hydrology; National Engineering Handbook, Section 4, Washington, DC.

SCS (Soil Conservation Service). 1999. Project Planning for Water Quality concerns. 06/21/99. Document No. 1705r99. Listed on: <http://www.economics.nrcs.usda.gov/technical/technotes/index.html>

SCS (Soil Conservation Service). 2006 National Watershed Manual. http://www.nrcs.usda.gov/programs/watershed/NWSM.html.

Seaburn, G.E. 1969. Effects of urban development on direct runoff to East Meadow Brook, Nassau County, Long Island, New York; U.S. Geological Survey Professional Paper 800-B.

SEH, no date. Technical Memorandum on Proposed Approach to Complete the Water Quality Assessment for the St. Louis Ponds Rico, Colorado. Prepared for: Atlantic Richfield Company. Prepared by: Short Elliott Hendrickson, Inc.

SEH Inc. (Short Elliott Hendrickson). 2002a. Upper Dolores River and Silver Creek Basin Water Quality and Discharge Monitoring Summary Rico, Colorado. July 2002 Sampling Event. Prepared for: Atlantic Richfield Company. December 23, 2002.

SEH Inc. (Short Elliott Hendrickson). 2002b. Upper Dolores River and Silver Creek Basin Water Quality and Discharge Monitoring Summary Rico, Colorado. October 2002 Sampling Event. Prepared for: Atlantic Richfield Company. December 23, 2002.

SEH. Inc. (Short Elliott Hendrickson). 2004. Rico Town Site Soils Final VCUP Application. February 2, 2004.

Sjodin, A. 2006. Personnal Communication regarding the status of the QUALDAT database which documents pesticide occurrence in ground water throughout the state of Colorado. No records were found for Dolores county.

Solley, W.B., R.R. Pierce, and H.A. Perlman. 1998. Estimated use of water in the United States in 1995: US Geological Survey Circular 1200, ,http://water.usgs.gov/watuse/spread95>.

Sopper, W.E. 1993. Municipal Sludge Use in Land Reclamation. Lewis Publishers: Boca Raton.

Sosiak, A., T. Hebben. 2005. A preliminary survey of pharmaceuticals and endocrine disrupting compounds in treated municipal wastewaters and receiving rivers of Alberta. Environmental Monitoring and Evaluation Branch, Alberta, Environment. Pub. No T/773.

State of Colorado, 1993. Notice of Violation and Cease and Desist Order. In the matter of: Rico Development Corporation, CDPS Permit No. CO-0029793. Dated June 29, 1993.

State of Colorado, 1994. Notice of Violation and Cease and Desist Order. In the matter of: Rico Development Corporation, CDPS Permit No. CO-0029793. Dated January 18, 1994.

State of Colorado, 1996. Notice of Violation and Cease and Desist Order. In the matter of: Rico Development Corporation, CDPS Permit No. CO-0029793. Dated January 26, 1996.

State of Colorado, 1999. Civil Action No. 99-1386. towards Rico Development Corporation: Wayne Webster and Virginia Sell. For civil action related to injunctive relief and civil penalties pursuant to Sections 309(b) and (d) of the Clean Water Act.

Steedman, R.J. 1988. Modification and assessment of an index of biotic integrity to quantify stream quality in Southern Ontario. Canadian Journal of Fisheries and Aquatic Sciences. 45: 492-501.

Steward, C. (range Management Specialist, USFS), 2006. Personal communication with K. King. Regarding range allotment use rates within the Project area.

Talone, K. , 2004. 02/25/2004. “Under the EPA gun, Rico eyes cleanup plan”. www.telluridegateway.com 25.02.2004.

Thompson, N. 2003. 06/10/2003. “EPA, State reach $290,000 settlement over Rico mine tailings discharge. June 10, 2003. Cortez Journal.

Thompson, N. 2003. 09/02/2003. "Rico residents, officials discuss cleanup of sites. Cortez Journal

Thompson, N. 2003. 12/06/2003. "Study reveals lead levels. Cortez Journal. December 6, 2003. www.cortezjournal.com/asp-bin/article_generation.asp?article_type+news&article_p.

Toffey, W. 2003. Twenty-five Years of Mine Reclamation with Biosolids in Pennsylvania. From: Conference Proceedings – Rev/Tech: Cleaning up Contaminated Properties for Reuse and Revitalization: Effective Technical Approaches and Tools, USEPA Technology Innovation Office. July 22-24, 2003.

Town of Rico, 2004. Rico Regional Master Plan. Adopted August 18th, 2004. Prepared by Eric James Heil, Esq., A.I.C.P., Town Attorney and Planner.

Town of Rico, 2006. Environmental Report – Amended. For the Town of Rico Community Wastewater System Project. By E.J. Heil and K. King. June 12, 2006.

Town of Rico, 2006. Personal communication to Karmen King/Grayling Environmental, from Mike England/Town Manager – regarding septic system information for the Town of Rico. May 23, 2006.

TU (Trout Unlimited) 2006. Press release : re. "a hydrologic study … McPhee Reservoir". hhtp://www.cotrout.org/Dolores%20press%20release.htm

Upper Arkansas River Alluvium Remediation: Biosolids Demonstration, Leadville, CO. 2000. Available at: http://faculty.washington.edu/clh/leadville.html

URS Consultants, Inc. 1994. Site Inspection Prioritization: Rico-Argentine Rico, Colorado. Provided for: ARCS Environmental Protection Agency – remedial Planning Activities. Work Assignment No. 21-8JZZ. Contract No. 68-W9-0053.

URS Consultants, Inc. 1995. Field Sampling Plan for Expanded Site Inspection of the Rico-Argentine, Dolores County, Colorado. As referred to in URS/EPA, 1996.

URS Consultants, Inc. 1995. Field Observations during Field Work. As referred to in URS/USEPA, 1996.

URS Operating Services and US EPA START (Environmental Protection Agency – Superfund Technical Assessment and Response), 1996. Analytical Results Report: Rico Argentine: Rico, Dolores County, Colorado. TDD#9511-0015: Contract No. 68-W5-0031. Dated June 19, 1996.

URS Operating Services Inc. 1996. Analytical Results Report: Rico Argentine: Rico, Dolores County, Colorado.TDD#9511-0015. Provided for the U.S. EPA: Superfund

Technical Assessment and Response Team – Region VII. Contract No. 68-W5-0031. June 19, 1996.

URS Operating Services Inc. 2006. Analytical Results Report: Rico Argentine Upper Dolores Watershed, Dolores and Montezuma Counties, Colorado. TDD No. 0509-24.. Provided for the U.S. EPA. Contract No. EP-W-05-050. February 21, 2006.

USCB (United States Census Bureau) 2006. Business Patters (NAICS) Industry Code Summary for Zip Code 81332, Rico, CO. http://censtats.census.gov/cgi-bin/zbpnaic/zbpsect.pl

USDA, (US Department of Agriculture). 2000 Monitoring the vegetation resources in riparian areas. By Alma H. Winward. General Technical Report RMRS-GTR-47. Ogden, UT: USDA, Forest Service, Rocky Mountain Research Station. 49 p. Copy available at http://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf

USDA. (US Department of Agriculture) , 2004. Guide to Effective Monitoring of Aquatic and Riparian Resources. General Technical Report RMRS-GTR-121. March, 2004.

USDOI (US Department of Interior), 2002. Office of Surface Mining. Acid Mine Drainage Treatment Techniques and Costs. Available at: http://www.osmre.gov/amdtcst.htm.

U.S. District Court, District of Colorado, 2000. Civil Action No 00 x 28 In the Matter of Rico Argentine Mine: St. Louis Tunnel and Associated Treatment Ponds, Rico Colorado. Administrative Warrant to Determine the Need for, and to Undertake, Response Action Pursuant to the Comprehensive Environmental Response, Compensation and Liability Act 42 U.S.C 9601 ET SEQ.

USEPA (Environmental Protection Agency), 1985. File Review. As referenced in URS/EPA, 1996.

USEPA. (US Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund, Volume II-Environmental Evaluation Manual, Interim Final, March 1989, EPA/540/1-89/001.

USEPA. (US Environmental Protection Agency). 1992. Framework for Ecological Risk Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R-92/001, 1992.

USEPA, (US Environmental Protection Agency), 1993. Application of restoration techniques (TMDL Program) within the framework of the TMDL process. TMDL Case Study #8, Boulder Creek, CO. EPA 841-F-93-006. June, 1993

USEPA, (US Environmental Protection Agency), 1993. Emerging Technology Summary: Handbook for Constructed Wetlands Receiving Acid Mine Drainage. EPA 540-SR-93-523.

USEPA, (US Environmental Protection Agency), 1993. Preparing Sewage Sludge for Land Application or Surface Disposal: A Guide for Preparers of Sewage Sludge on the Monitoring, Record Keeping, and Reporting Requirements f the Federal Standards for the Use of Sewage Sludge, 40 CFR Part 503. EPA 831-B-93-002a. September, 1993.

USEPA, (US Environmental Protection Agency), 1993. Technical Support Document for Land Application of Sewage Sludge, Volumes 1 and 2. NTIS PB93-110575 and PB93-110583.

USEPA, (US Environmental Protection Agency), 1993. Bioremediation Resource Guide and Matrix. EPA 542-B-93-004; NTIS PB94-112307

USEPA, (US Environmental Protection Agency), 1994. Biosolids: Beneficial technology for a Better Environment. EPA 832-R-94-009. June, 1994.

USEPA. (US Environmental Protection Agency). 1994. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Review Draft, September, 1994.

USEPA. (US Environmental Protection Agency). 1994. Site Inspection Prioritization-evaluation of the Rico Argentine site. Provided to: Mr. Bob Dent/AR. Provided by: Pat G. Smith/site Assessment Manager, Superfund Technical Section, Region VIII, USEPA.

USEPA, (US Environmental Protection Agency), 1995. Ecological Restoration: A Tool to Manage Stream Water Quality. EPA-841-F-95-007. November, 1995.

USEPA, (US Environmental Protection Agency), 1995. Wetlands Fact Sheet Number 16, Wetlands Mitigation Banking, EPA 843-F-95-001p.

USEPA. (US Environmental Protection Agency). 1998. Guidelines for Ecological Risk Assessment. U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC, EPA/630/R095/002F, 1998.

USEPA, (US Environmental Protection Agency). 1999. Storm Water Technology Fact Sheet: Vegetative Covers. EPA 832-F-99-027.

USEPA, (US Environmental Protection Agency). 1999. Storm Water Technology Fact Sheet: Wet Detention Ponds. EPA 832-F-99-048.

USEPA, (US Environmental Protection Agency). 1999. Storm Water Technology Fact Sheet: Minimizing Effects from Highway Deicing. EPA 832-F-99-016.

USEPA, (US Environmental Protection Agency). 1999. Storm Water Technology Fact Sheet: Storm Water Wetlands. EPA 832-F-99-025.

USEPA (US Environmental Protection Agency). 1999. Understanding the Safe Drinking Water Act: US Environmental Protection Agency. EPA-810-F-99-008.

USEPA (US Environmental Protection Agency). 1999. Rapid bioassessment protocols for use in streams and rivers: periphyton, benthic macroinvertebrates and fish. 2nd edition. Office of Water. Washington, DC. July. EPA 841-B-99-002.

USEPA, (US Environmental Protection Agency). 2000. Field Evaluation of Permeable Pavements for Stormwater Management. EPA-841-B-00-005B.

USEPA (US Environmental Protection Agency). 2000. Ecological Soil Screening Level Guidance. US Environmental Protection Agency, Office of Emergency and Remedial Response. July 10, 2000. DRAFT.

USEPA (US Environmental Protection Agency). 2000. Correspondence provided to Eric Heil regarding: U.S., et al. v. Rico Development Corp. et al. Civil Action 99-M-1386. Provided to: Eric J. Heil, Rico Town Manager and Attorney. Provided by: Elyana R. Sutin DOJ Special Attorney. US EPA Denver, CO. Ref: 8ENF-L.

USEPA (US Environmental Protection Agency). 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Website version last updated November 31, 2001: http://www.epa.gov/region4/waste/ots/ecolbul.htm

USEPA, (US Environmental Protection Agency), 2001. Abandoned Mine Site Characterization and Cleanup Handbook. EPA 530-R-01-002.

USEPA, (US Environmental Protection Agency), 2002. Adopt Your Watershed. www.epa.gov/adopt.

USEPA (US Environmental Protection Agency). 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. EPA-841-B-05-004. December, 2005.

USEPA, (US Environmental Protection Agency), 2005. Biosolids Remediation and Lime Addition at the California Gulch Site in Leadville, Colorado. http://www.clu-in.org/products/demos/search/vendor_details.cfm?Project_ID=70

USEPA (US Environmental Protection Agency). 2005. Handbook for Developing Watershed Plans to Restore and Protect Our Waters. DRAFT. USEPA Office of Water, Nonpoint Source Control Branch. EPA 841-B-05-005. October, 2005.

USEPA (US Environmental Protection Agency) , 2005 Guidance for Characterization, Design Construction and Monitoring of Mitigation Wetlands. Training is provided at http://www.clu-in.org/conf/itrc/mitwet_101105/

USEPA (US Environmental Protection Agency) 2005. Low Impact Development Strategies, Tools and Techniques for Sustainable Watersheds. Training is provided at http://www.clu-in.org/conf/tio/owlid_101905/

USEPA,(US Environmental Protection Agency). 2005. The ABCs of TMDLs for Stakeholders. Training is provided at http://www.clu-in.org/conf/tio/abctmdl_092805/

USEPA, (US Environmental Protection Agency). 2005 Eight Tools of Watershed Protection in Developing Areas. Training is provided at http://www.clu-in.org/conf/tio/watershedtools_062205/

USEPA (US Environmental Protection Agency). 2006a. STORET Data Warehouse (Data refreshed as of April 3, 2006). http://www.epa.gov/storet/dw_home.html

USEPA. (US Environmental Protection Agency). , 2006 Watershed Academy (provides information and training on implementing watershed approaches). Training is provided at http://www.epa.gov/owow/watershed/wacademy/ [For instance – an Introduction to the Clean Water Act can be found at http://www.epa.gov/watertrain/cwa/leftindex.htm)

USEPA, (US Environmental Protection Agency). 2006. Benefits of Watershed-based NPDES Permitting. Training is provided at http://www.clu-in.org/conf/tio/ownpdes/

USEPA,. (US Environmental Protection Agency). 2006 Draft Handbook for Developing Watershed Plans to Restore and Protect our Waters. US EPA OWOW. [copies provided to the Town, and additional copies and training can be obtained from: http://www.clu-in/org/conf/tio/owhandbk_011806/

USEPA. (US Environmental Protection Agency). , 2006 Opportunities for Citizen Involvement in the Clean Water Act. Training is provided at http://www.clu-in.org/conf/tio/owopcitinv_041906/

USEPA,. (US Environmental Protection Agency). 2006 Integrating Wetlands into Watershed Protection Efforts. Training is provided at http://www.clu-in.org/conf/tio/owinwetpro_051706/

USEPA, (US Environmental Protection Agency). 2006. An Introduction to Wetland Restoration, Creation, and Enhancement. Training is provided at http://www.epa.gov/owow/wetlands/restore/finalinfo.html

USEPA (US Environmental Protection Agency). 2006b. STORET Data Warehouse – STORET Station Descriptions. (Data refreshed as of April 3, 2006). http://www.epa.gov/storet EPA (US Environmental Protection Agency). 2006a. STORET

Data Warehouse (Data refreshed as of April 3, 2006). http://www.epa.gov/storpubl/modern/downloads/SDS20060418_101232.txt

USEPA (US Environmental Protection Agency). 2006c. STORET Data Warehouse – STORET Regular Results (Non-Biological Physical and Chemical Result Data) (Data refreshed as of April 3, 2006). http://www.epa.gov/stormodb/DW_RESULT_COUNT.

USEPA, (Environmental Protection Agency) 2006. Polluted Runoff (Nonpoint Source Pollution) – Low-Impact Develop (LID) Page. http://www.epa.gov/owow/nps/lid/

USEPA SDWIS, (US Environmental Protection Agency, Safe Drinking Water Information System) 2006. Query Results for CO0117300 – Town of Rico. http://oaspub.epa.gov/enviro/sdw_query.get_list?wsys_name=&fac_searcj=fac_beginning.

USEPA WMD. (US Environmental Protection Agency – Water Management Division). 1994. Review of Enforcement Files. May 26, 1994.

USFS (United States Forest Service), 2006. Personal communication with Recreation staff: Penny Wu, Tom Kelly and Rick Ryan (copies of correspondence on file).

USFS SJNF (United States Forest Service; San Juan National Forest). 2001. San Juan National Forest - Vicinity Map. ISBN 0-607-96867-2.

USFS SJNF (United States Forest Service; San Juan National Forest). 2006. USDA Forest Service, San Juan National Forest – GIS Coverages. http://cc.msnscache.com/cache.aspx?q=3235731738014&lang=en-US&FOR...

USGS (United States Geological Survey) 1974. Geology and Ore Deposits of the Rico District, Colorado. Geological Survey Professional Paper 723. by Edwin T. McKnight.

USGS, (Geological Survey) 1989.Analytical results and sample locality maps of stream-sediment and heavy-mineral-concentrate samples from the Dolores River Canyon Wilderness Study Areas (CO-030-290), Montrose and San Miguel Counties, Colorado / by Bullock, John H., Bullock, John H., Geological Survey (U.S.) [Denver, CO] : U.S. Geological Survey, 1989. [Denver, CO] : U.S. Geological Survey, 1989.

USGS (United States Geologic Survey) 2000a. Effects of the Paradox Valley unit on dissolved solids, sodium, and chloride in the Dolores River near Bedrock, Colorado, water years 1988-1998: US GS Water Resources Investigations report 00-4011, 7p.

USGS, (United States Geologic Survey) 2000b. Estimated Use of Water in the United States in 2000. By S.S. Hutson, N.L. Barber, J.F. Kenny, K.S. Linsey, D.S. Lumia and M.A. Maupin. U.S. Geological Survey Circular 1268. US Dept. of the Int. U.S. Geological Survey.

USGS (United States Geologic Survey). 2006. Water use in the United States. Reports and Data: Estimated Use of Water in the United States County-Level Data for 2000. http://water.usgs.gov/watuse/ and http://water.usgs.gov/watuse/data/2000/index.html.

USGS (United States Geologic Survey). 2006. Calendar Year Streamflow Statistics for Colorado. USGS 09165000 Dolores River Below Rico, CO. http://waterdata.usgs.gov/co/nwis/annual/calendar_year?

USGS (United States Geologic Survey). 2006a. Water Quality Samples for Colorado. http://nwis.waterdata.usgs.gov/co/nwis/qwdata?county_cd=08033&format=station_list&source…

USGS (United States Geologic Survey). 2006b. Ground-water Site Inventory for Colorado. http://nwis.waterdata.usgs.gov/co/nwis/qwsi?county_cd=08033&sort_key=site_no&group_key...

USGS (United States Geologic Survey). National Water Information System (NWIS) http://waterdata.usgs.gov/nwis.

Vannote, R.L., G.W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Can. J. Fish. & Aq. Sci. 37: 130-137.

Walsh Env. Sci and Eng., Inc. 1995. Phase I and Phase II Environmental Site Assessment, Rico, Colorado. March 14, 1995. Privileged and Confidential – Submitted to John R. Jacus: Davis, Graham and Stubbs. Walsh Project No. 1897-010.

Waltman, W.J. 1997. Mean annual water balance of Colorado landscapes: U.S. Department of Agriculture, Natural Resources Conservation Service, Northern Plains Region, Map Series No. 97-0005. ,http://www.np.nrcs.usda.gov/Maps-Data/assmt-region.html>. Nov., 2001.

Water Information Program. http://web.frontier.net/SCAN/wip/wiphome.html.

Waters, T.F., 1995. Sediment in Streams. Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. AFS Bethesda, Maryland. 1995.

Wilbur, C. P.E. 1995. Hazard and Constraint Report, Prepared for the Town of Rico.

WSI (Watershed Science Institute). No date$_a$. Watershed Condition Series, Technical Note 1 – Biotic Condition Indicators for Water Resources. For a copy, refer to: <http://www.wsi.nrcs.usda.gov/products/tools.html>

WSI (Watershed Science Institute). No date$_b$. Watershed Condition Series, Technical Note 2 – Index of Biotic Integrity. For a copy, refer to: http://www.wsi.nrcs.usda.gov/products/tools.html

WSI (Watershed Science Institute). No date$_c$. Watershed Condition Series, Technical Note 3 – The EPT Index. For a copy, refer to: http://www.wsi.nrcs.usda.gov/products/tools.html

Weir, J.E., Maxfield, E.B., and Zinnerman, E.A., 1983. Regional hydrology of the Dolores River basin, eastern Paradox Basin, Colorado and Utah: US Geological Survey Water Resources Investigations Report 83-4217, 53,p.

Zillich, C. 2006. Personal Communication: regarding the availability of Upper Dolores River water quality information: none located thus far, however an EPA loading study may have been completed in 2005.

APPENDIX A

Appendix A

Definitions

A

Abandonment of a Water Right – The abandonment of a water right results from an intent to abandon, coupled with an act evidencing that intent. A conditional water right may be terminated by the water court for failure to pursue a completed appropriation with diligence. The non-use of a perfected water right for an extended period may itself be evidence of intent to abandon (Vranesh, 1989).

Acre-foot – The volume of water required to cover one acre to a depth of one foot. Equal to 43,560 cubic feet or 325,851 gallons, or 1,233 cubic meters (CGS, 2003).

Adjudication – The judicial process through which the existence of a water right is confirmed by court decree (Vranesh, 1989).

Adverse ecological effects - Changes that are considered undesirable because they alter valued structural or functional characteristics of ecosystems or their components. An evaluation of adversity may consider the type, intensity, and scale of the effect as well as the potential for recovery (USEPA, 2006).

Alluvial aquifer – An aquifer formed by material laid down by physical processes in a stream channel or on a floodplain (CGS, 2003).

Alluvial fan – The fanlike deposit of a stream where it comes from a gorge upon a plain or a tributary stream near or at its junction with its main stream (NRCS, 1997a).

Alluvium – Unconsolidated clay, silt, sand, or gravel deposited during recent geologic time by running water in the bed of a stream or on its floodplain (CGS, 2003).

Appropriation – The capture, impounding, or diversion of water from its natural course or channel and its application to some beneficial use, private or personal, by the appropriator to the entire exclusion of all other persons. The appropriator must have a specific plan and intent to divert, store, or otherwise capture, possess, and control a specific quantity of water for specific beneficial uses (Vranesh, 1989).

Aquatic corridor – Areas of land and water which are important to the integrity and quality of a stream, river, or other body of water. An aquatic corridor usually consists of the actual stream or river, the aquatic buffer, and other areas which are a part of the stream's right-of-way (CWP, 2001). The types of aquatic corridors within the Project

area include perennial segments and streams, intermittent and/or ephemeral segments or streams and standing water bodies.

Aquifer – a saturated water-bearing formation, or group of formations, which yield water in sufficient quantity to be of consequence as a source of supply (CGS, 2003).

Arid – a climate characterized by dryness, variously defined as rainfall insufficient for plant life or for crops without irrigation; less than 10 inches of annual rainfall (CGS, 2003).

Aspect – The direction in which a slope faces (NRCS, 1997a).

Assessment - The analysis and transformation of environmental data into policy-relevant information that can assist decision-making and action (USEPA, 2006).

Assessment endpoint - An explicit expression of the environmental value that is to be protected, operationally defined by an ecological entity and its attributes. For example, salmon are valued ecological entities; reproduction and age class structure are some of their important attributes. Together "salmon reproduction and age class structure" form an assessment endpoint (USEPA, 2006).

Available water capacity (available moisture capacity) – the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil (NRCS, 1997a).

B

Bankfull discharge – The stream discharge (flow rate such as cfs) that forms and controls the shape and size of the active channel and creates the flood plain. This discharge generally occurs once every 1.5 years on average (NRCS, 1998).

Bankfull stage – The stage at which water starts to flow over the flood plain; the elevation of the water surface at bankfull discharge (NRCS, 1998).

Base-flow – The portion of stream-flow that is derived from natural storage; average stream discharge during low flow conditions. Basin – The largest single watershed management unit for water planning, that combines the drainage of a series of sub-basins. Often have a total area of more than a thousand square miles (CWP, 2001).

Bedrock – The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface (NRCS, 1997a).

Beneficial use – Use of water, such as domestic, municipal, agricultural, mining, industrial, stock watering, recreation, wildlife, artificial recharge, power generation, or

contaminant remediation, that provides a benefit. Water rights not put to beneficial use are subject to forfeiture (CGS, 2003).

Benthic Index of Biotic Integrity (BIBI) – A system developed by Karr (WSI, no date(c)) in Washington used to indicate the condition of the aquatic organisms and infer water quality. A suite of metrics (number of taxa, number of pollution-intolerant species, and trophic group, etc. of benthic macroinvertebrates) is used to determine a numerical index which describes condition of the streams (WSI, no date(c)).

Benthic macroinvertebrates – Organisms that inhabit the bottom substrates of freshwater habitats, for at least one part of their life cycle (WSI, no date(c)). Benthos – Bottom-dwelling or substrate-oriented organisms (NRCS, 1998).

Best Management Practice (BMP) – A structural or nonstructural device designed to temporarily store or treat stormwater runoff in order to mitigate flooding, reduce pollution and provide other amenities (CWP, 2001).

Biotic indicator – Organisms such as benthic macroinvertebrates used to evaluate the change in environmental condition (WSI, no date(c)).

Boulders – Rock fragments larger than 2 feet (60 centimeters) in diameter (NRCS, 1997a).

Brownfields – Abandoned or under-used industrial and commercial sites where future expansion or redevelopment can be directed after site remediation for possible contamination (CWP, 2001).

Buffer – An area adjacent to a shoreline, wetland or stream where development is restricted or prohibited (CWP, 2001).

Build-out – The total percentage of development in a watershed based on current zoning (CWP, 2001).

C

Calcium-bicarbonate type – freshwater that contains large concentrations of calcium (Ca) and bicarbonate (HCO_3) (CGS, 2003).

Call – The request by an appropriator for water which the person is entitled to under his decree (Vranesh, 1989).

Capillary water – Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil (NRCS, 1997a).

Catchment **–** the area that drains an individual site to its first intersection with a stream (CWP, 2001).

Channelization **–** Straightening of a stream channel to make water move faster (NRCS, 1998).

Clean Water Act **–** The federal law that establishes how the United States will restore and maintain the chemical, physical and biological integrity of the country's water (oceans, lakes, streams and rivers, groundwater , and wetlands). The law provides protection for the country's waters from both point and non-point sources of pollution (CGS, 2003).

Climax plant community **–** The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same (NRCS, 1997a).

Cobble **–** A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter (NRCS, 1997a).

Colorado Water Quality Control Act **–** Legislation to prevent injury to beneficial uses made of state waters, to maximize the beneficial uses of water, and to achieve the maximum practical degree of water quality in Colorado (CGS, 2003).

Commercial water use **–** Water for motels, hotels, restaurants, office buildings, other commercial facilities, military and nonmilitary institutions. Water may be obtained from a public-supply system or may be self-supplied (USGS, 2000).

Consumptive use **–** The part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment (USGS, 2000).

Contaminant **–** a substance not naturally occurring in water or occurring in an amount that presents a health risk (CGS, 2003).

Contaminant plume **–** zone of polluted groundwater down-gradient from a point source of pollution (CGS, 2003).

Conveyance loss **–** Water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. Generally, the water is not available for further use; however, leakage from an irrigation ditch for example may percolate to a groundwater source and be available for further use (USGS, 2000).

Cubic foot per second (cfs) **–** Rate of discharge representing a volume of one cubic foot (28.317 x 10-3 m3) passing a given point during one second. This rate is equivalent to approximately 7.48 gallons (0.0283 m3) per second (CGS, 2003).

D

Developed water – Water that is produced or brought into a water system through the efforts of mankind, where it would not have entered the water system on its own accord (Vranesh, 1989).

Discharge – The volume of water passing a particular point in a unit of time. Units of discharge commonly used include cubic feet per second (cfs) or gallons per minute (gpm) (CGS, 2003).

Diversion – A ridge of earth, generally a terrace, built to protect down-slope areas by diverting runoff from its natural course (NRCS, 1997a).

Domestic water use – Water used for all such indoor house-hold purposes as drinking, food prUSEPAration, bathing, washing clothes and dishes, flushing toilets and such outdoor purposes as watering lawns and gardens (USGS, 2000).

Domestic well use – Water used for drinking and other purposes by a household, such as from a rural well. Domestic use permits normally allow limited irrigation and outside watering uses (CGS, 2003).

Down-gradient – In reference to the movement of water, the 'downstream' direction from a point of reference (e.g., a well) (CGS, 2003).

Drainage basin – Hydrologic unit consisting of a part of the surface of the earth covered by a drainage system made up of a surface stream or body of impounded surface water plus all tributaries. The runoff in a drainage basin is distinct from that of adjacent areas. A river basin is similarly defined (CGS, 2003).

Drainage class (refers to soils) – Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Seven classes of natural soil drainage are recognized – excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained (NRCS, 1997a).

Drawdown – Lowering of the groundwater surface caused by pumping, measured as the difference between the original groundwater level and the current pumping level after a period of pumping (CGS, 2003).

E

Ecological Risk Assessment - An ecological risk assessment evaluates the potential adverse effects that human activities have on the plants and animals that make up ecosystems. The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions. When conducted

for a particular place such as a watershed, the ecological risk assessment process can be used to identify vulnerable and valued resources, prioritize data collection activity, and link human activities with their potential effects (USEPA, 2006).

Effluent – Any substance, particularly a liquid that enters the environment from a point source. Generally refers to wastewater from a sewage-treatment or industrial plant (CGS, 2003).

Embeddedness – The degree to which an object is buried in stream sediment (NRCS, 1998).

Ephemeral flow – When water flows in a channel only after precipitation (CGS, 2003).

Ephemeral stream – a stream or reach of a stream that flows only in direct response to precipitation. It receives no long or continued supply from melting snow or other source, and its channel is above the water table at all times (NRCS, 1997a).

Erosion - The wearing away of the land surface by running water, waves, or moving ice and wind, or by such processes as mass wasting and corrosion (solution and other chemical processes). The term "geologic erosion" refers to natural erosion processes occurring over long (geologic) time spans. "Accelerated erosion" generically refers to erosion that exceeds what is presumed or estimated to be naturally occurring levels, and which is a direct result of human activities (e.g., cultivation and logging) (NRCS, 2006).

Evaporation – The process by which water is returned to the atmosphere by means of vaporization (Dunne, T. and L.B. Leopold, 1998).

Evapotranspiration – A collective term for water that moves into the atmosphere from evaporation from land or water and from transpiration from plants (CGS, 2003).

F

Field moisture capacity – The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free water has drained away (NRCS, 1997a).

Floodplain – Land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage (CGS, 2003). A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially (NRCS, 1997a).

Flow – The volume of water moving past a point during a specified time; also known as discharge (CGS, 2003).

Forest land **-** A *Land cover/use* category that is at least 10 percent stocked by single-stemmed woody species of any size that will be at least 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cut over forest or abandoned farmland) and not currently developed for non-forest use. Ten percent stocked, when viewed from a vertical direction, equates to an aerial canopy cover of leaves and branches of 25 percent or greater. The minimum area for classification as forest land is 1 acre, and the area must be at least 100 feet wide (NRCS, 2006).

Forest type **–** A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands (NRCS, 1997a).

Freshwater **–** Water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids; generally, more than 500 mg/L dissolved solids is undesirable for drinking and for many industrial uses (USGS, 2000).

Full build-out **–** The total potential development in a watershed based on current zoning plans which includes existing development and expansion potential in the future (CWP, 2001).

G

Gaining stream **–** A stream that receives groundwater discharge from the zone of saturation (CGS, 2003).

Gauging station **–** Site on a stream, lake, reservoir, or other body of water where direct systematic observations of hydrologic data are obtained (CGS, 2003).

Giardia **–** A microscopic parasite found primarily in surface water. When ingested it can cause fever, diarrhea, and other gastrointestinal symptoms (CGS, 2003).

Gradient **–** Slope calculated as the amount of vertical rise over horizontal run expressed as ft/ft or as percent (ft/ft x 100) (NRCS, 1998).

Gravel **–** Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual pieces is a pebble (NRCS, 1997a).

Groundwater **–** Under ground water that is generally found in the pore space of rocks or sediments and that can be collected with wells, tunnels or drainage galleries, or that flows naturally to the Earth's surface via seeps or springs (CGS, 2003).

H

Habitat **–** The area or environment in which an organism lives (NRCS, 1998).

Hardness – A water quality parameter that indicates the level of alkaline salts, principally calcium and magnesium, and expressed as equivalent calcium carbonate ($CaCO_3$). Hard water is commonly recognized by the increased quantities of soap, detergent, or shampoo necessary to lather (CGS, 2003).

Hilsenhoff's Biotic Index – A system using benthic macroinvertebrates, developed in Wisconsin by Hilsenhoff and used to detect organic pollution based on the indicator organism approach to water quality; values are on a scale of 0 to 10, with the higher values indicating more polluted areas (WSI, no date(c)).

Hydrologic soils groups – Refers to soils grouped according to their runoff potential (NRCS, 1997a).

Hydrologic Unit Code. A hydrologic unit is a drainage area delineated to nest in a multi-level, hierarchical drainage system. Its boundaries are defined by hydrographic and topographic criteria that delineate an area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of stream forming a coastal drainage area. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to twelve digits based on the six levels of classification in the hydrologic unit system (NRCS, 2006).

Hydrology – The study of the properties, distribution, and effects of water on the Earth's surface, soil and atmosphere (NRCS, 1998).

I

Igneous rock – Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock (NRCS, 1997a).

Impervious cover – Any surface in the urban landscape that cannot effectively absorb or infiltrate rainfall (CWP, 2001).

Impervious soil – A soil through which water, air or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time (NRCS, 1997a).

Incised channel – A channel with a streambed lower in elevation than its historic elevation in relation to the flood plain (NRCS, 1998).

Index of Biotic Integrity – A system developed by Karr in Washington used to indicate the condition of the aquatic organisms and infer water quality. A suite of metrics (number of taxa, number of pollution-intolerant species, and trophic group, etc. of fish community) is used to determine a numerical index which describes condition of the streams (WSI, no date(c)).

Indicator **-** A measurement that can be used to assess the condition, status or trends of an ecological resource. The term is widely used in water resources management programs, but has many different interpretations. It is preferable in risk assessment to avoid using the term indicator and instead use the more specific terms measure of effect, measure of exposure, and assessment endpoint, as appropriate (USEPA, 2006).

Industrial water use **–** Water used for fabrication, processing, washing, and cooling, and includes such industries as chemical and allied products, food, mining, paper and allied products, petroleum refining, and steel (USGS, 2000).

Infiltration **–** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material (NRCS, 1997a).

Infiltration capacity **–** The maximum rate at which water can infiltrate into a soil under a given set of conditions (NRCS, 1997a).

Inorganic **–** not made of or derived from living matter (CGS, 2003).

In-stream use **–** Use of water that does not require withdrawal or diversion from its natural watercourse; for example the use water for navigation, recreation, and support of fish and wildlife (CGS, 2003).

Intake rate **–** The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time (NRCS, 1997a).

Interception **–** The process by which water is routed back to the atmosphere by means of vegetation cover and vaporization (Dunne, T. and L.B. Leopold, 1998).

Intermittent flow **–** Surface water flowing only during periods of seasonal runoff (CGS, 2003).

Intermittent stream **–** A stream, or reach of a stream, that flows for prolonged periods only when it receives groundwater discharge or long continued contributions from melting snow or other surface and shallow subsurface sources (NRCS, 1997a).

Irrigation water use **–** water that is applied by an irrigation system to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands such as parks and golf courses. Irrigation includes water that is applied for pre-irrigation, frost protection, chemical application, weed control, field preparation, crop cooling, harvesting, dust suppression, the leaching of salts from the root zone, and water lost in conveyance (USGS, 2000).

L

Leaching – The removal of soluble material from soil or other material by percolating water (NRCS, 1997a).

Loam – Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles (NRCS, 1997a).

Losing stream – a stream that contributes water to the zone of saturation, recharging the groundwater (CGS, 2003).

M

Macroinvertebrate – A spineless animal visible to the naked eye or larger than 0.5 millimeters (NRCS, 1998).

Maximum contaminant level (MCL) – Maximum level of a contaminant allowed in water by federal law. Based on health effects and currently available treatment methods (CGS, 2003).

Meander – A winding section of stream with many bends that is at least 1.2 times longer, following the channel, than its straight line distance (NRCS, 1998).

Milligrams per liter (mg/L) – Milligrams of a substance dissolved in one liter of water (equivalent to ppm) (CGS, 2003).

Mineral soil – Soil that is mainly mineral material and low in organic material (NRCS, 1997a).

Minimum stream-flow requirement – Water right decreed to the DWCB requiring that a set amount of water be maintained in a water course for the purpose of reasonably maintaining the environment. The minimum stream-flow right takes its place in the appropriation system in the manner of another junior water right, although diversion of the water is not required (Vranesh, 1989). Water right decreed to the Colorado Water Conservation Board requiring that a set amount of water be maintained in a watercourse for the purpose of reasonably maintaining the environment (CGS, 2003).

Mining water use – Water used for the extraction of naturally occurring minerals including solids, such as coal, sand, gravel, and other ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, milling, and other preparations customarily done at the mine site or as part of a mining activity (USGS, 2000).

Monitoring well – Non-pumping well used primarily for taking water quality samples and measuring groundwater levels (CGS, 2003).

Morphology (of soil) – The physical makeup of the soil, including the texture, structure, porosity, consistency, color and other physical, mineral and biological properties of the soil profile (NRCS, 1997a).

N

Nonconsumptive use – Use that leaves the water available for other uses. Examples are hydroelectric power generation and recreational uses (CGS, 2003).

Nonpoint source – Source of water pollution that originates from a broad area, such as agricultural chemicals applied to fields or acid rain (CGS, 2003).

Non-potable – Water not suitable for drinking (CGS, 2003).

NPDES permit – Permit issued under the National Pollutant Discharge Elimination System for companies or other entities discharging pollutants directly into the waters of the United States (CGS, 2003).

O

Off-stream use – Water withdrawn or diverted from a groundwater or surface water source for aquaculture, commercial, domestic self-supply, industrial, irrigation, livestock, mining, public supply, thermoelectric power and other uses (USGS, 2000).

Organic – Pertaining to a compound containing carbon (CGS, 2003).

Ownership - The separation of federal and nonfederal lands and the distinction between administrative units of land. Water areas are not classified according to ownership. The six categories of ownership are (NRCS, 2006):

- Private. A type of ownership pertaining to land belonging to an individual person or persons, a partnership, or a corporation (all of which are persons in the legal sense), as opposed to the public or the government; private property.
- Municipal. A type of ownership pertaining to land belonging to the local government of a town or city.
- County or parish**.** A type of ownership pertaining to land belonging to an administrative subdivision of a state in the United States, which is identified as a county or an equivalent administrative unit in areas where counties do not exist; examples are parishes in Louisiana and boroughs in Alaska.
- State. A type of ownership pertaining to land belonging to one of the states, commonwealths, or territories of the United States of America.

- Federal land. A land ownership category designating land that is owned by the federal government. It does not include, for example, trust lands administered by the Bureau of Indian Affairs or Tennessee Valley Authority (TVA) land. No data are collected for any year that land is in this ownership.
- Indian tribal and individual Indian trust lands**.** A type of ownership of land administered by officially constituted Indian tribal or individual

P

Parts per billion (ppb) Micrograms per liter, one-one thousandth of milligrams per liter (CGS, 2003).

Parts per million (ppm) Milligrams per liter, (CGS, 2003).

Percent of Normal – The current value as percent of the current date's normal value (NRCS, 2006).

Percolation – The movement of water through the soil (NRCS, 1997a).

Perennial stream - A stream or reach of a stream that normally flows continuously throughout the year (NRCS, 2006).

Permeability – The quality of the soil that enables water or air to move downward through the profile (NRCS, 1997a).

pH – Measure of the relative acidity or alkalinity of water. Defined as the negative log (base 10) of the hydrogen ion concentration. Water with a pH of 7 is neutral; lower pH levels indicate an increasing acidity, while pH levels above 7 indicate increasingly basic solutions (CGS, 2003).

Plan for augmentation – a detailed program to increase the supply of water available for beneficial use by the development of new or alternate means or points of diversion: by a pooling of water resources; water exchange projects; providing substitute supplies of water; the development of new sources of water; or other appropriate means (Vranesh, 1989).

Pollution – Contamination from human activities that restricts the uses of water.

Pollutant load or 'load' – Refers to the amount of pollutants entering a waterbody. Loads are usually expressed in terms of a weight and a time frame, such as pounds per day (lb/d) (USUSEPA, 2005).

Potable - Water that does not contain pollution, contamination, objectionable minerals, or infective agents and is considered safe for domestic consumption; drinkable (CGS, 2003).

Precipitation – Water in some form that falls from the atmosphere (rain, snow, hail, sleet) (CGS, 2003).

Productivity (of soil) – The capability of soil for producing a specified plant or sequence of plants under specific management (NRCS, 1997a).

Profile (of soil) – A vertical section of the soil extending through all its horizons and into the parent material (NRCS, 1997a).

Proper functioning condition – an interdisciplinary assessment tool for analyzing the condition of stream riparian-wetland areas and prioritizing the need for further detailed inventories and treatment.

Public-supply water use – Water withdrawn by public and private water suppliers that furnish water to at least 25 people or have a minimum of 15 connections. Public suppliers provide water for a variety of uses, such as domestic, commercial, industrial, thermoelectric power, and public water use (USGS, 2000).

Public water use – Water supplied from a public supplier and used for such purposes as firefighting, street washing, flushing of water lines, and maintaining municipal parks and swimming pools (USGS, 2000).

R

Reach – A section of stream (defined in a variety of ways, such as the section between tributaries or a section with consistent characteristics) (NRCS, 1998).

Reference condition – An area in a watershed that is least impacted in comparison to other areas. This area can be used as a baseline to judge the success of future watershed management efforts (CWP, 2001).

Return flow – Water that reaches a groundwater or surface water source after release from the point of use and thus becomes available for further use (USGS, 2000).

Riparian – The zone adjacent to a stream or any other water-body (from the Latin word ripa, pertaining to the bank of a river, pond, or lake). (NRCS, 1998).

Rooting depth – The depth of the root zone. The soil is shallow over a layer that greatly restricts roots (NRCS, 1997a).

Runoff ratings (of soil) – Determined by the slope and permeability of a soil as summarized in (source: NRCS, 1997a):

Soil Runoff Ratings						
Slope	Permeability					
Slope	Very Rapid	Rapid	Mod. Rapid	Moderate	Mod. Slow	Slow
1-3	Negligible	Very Low	Low	Low	Medium	Medium
3-6	Negligible	Very Low	Low	Medium	Medium	High
6-12	Very Low	Low	Medium	High	High	Very High
12-25	Very Low	Low	Medium	High	Very High	Very High
25+	Low	Medium	High	Very High	Very High	Very High

S

Safe Yield – The annual draft of water that can be withdrawn without any undesirable result (Dunne, T. and L.B. Leopold, 1998).

Saturation – Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into the surface (NRCS, 1997a).

Section 208 of the CWA – Establishes an area-wide approach to planning for the abatement of pollution.

Section 319 of the CWA – Establishes an area-wide approach to the inventory, evaluation and eventual control through best management practices, for the abatement of nonpoint pollution.

Self-supplied water use – Water withdrawn from a groundwater or surface water source by a use rather than being obtained from a public supply (USGS, 2000).
Snow Water Equivalent (SWE) – The liquid water equivalent of the snow-pack, expressed in terms of depth (NRCS, 2006).

Sheet erosion – The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff (NRCS, 1997a).

Slope – The inclination of the land surface from the horizontal as follows (source: NRCS, 1997a);

- Nearly level 0 to 1 percent
- Gently sloping 1 to 3 percent
- Moderately sloping 3 to 6 percent
- Strongly sloping 6 to 12 percent
- Moderately steep 12 to 25 percent
- Steep 25 to 45 percent
- Very Steep 45 percent and higher

SNOTEL (SNOwpack TELemetry) – An automated near real-time data collection network that provides mid to high elevation hydroclimatic data from mountainous regions of the western United States. A standard NOTEL station provides snow water equivalent, snow depth, precipitation, and temperature data. The SNOTEL network is maintained by the USDA Natural Resources Conservation Service Snow Survey and Water Supply Forecasting Program (NCRS, 2006).

Soil – A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time (NRCS, 1997a).

Stakeholder – Any agency, organization, or individual that is involved in or affected by the decisions made in the development of a watershed plan (CWP, 2001).

Stormwater or Stormwater Runoff – water created from a storm event (rain fall).

Stormwater pollutants - runoff picks up and carries a wide variety of pollutants into our stormwater system. These pollutants then flow into our local waterways - and on to the Bay. Some examples of stormwater runoff pollutants include:

- ***Detergent, fertilizer, pet waste, and yard waste such as leaves, grass clippings, and pine needles*** : These substances contain nutrients . The nutrients nitrogen and phosphorus not only cause grass to grow, but an excessive amount also causes algae to grow in waterways. Algae blooms cause fish kills and block sunlight for the underwater vegetation needed by fish and shellfish for food and cover. Pet waste, like human waste, is also disease-carrying raw sewage. Raw sewage in our waterways can make water unusable for fishing, swimming, and drinking.

- ***Automotive products such as motor oil and antifreeze; hazardous waste such as cleaners and paints; and pesticides (herbicides, insecticides, fungicides, rodenticides)*** These materials are toxic, so they are harmful to humans and animals as well as the environment. Antifreeze is a particular hazard to pets, which may drink from contaminated puddles.

- ***Sediment (soil, sand, silt, clay)*** Sediment from unvegetated areas clogs fish gills, blocks sunlight for underwater vegetation, and smothers fish-spawning areas. It is the largest contributor of stormwater pollution by volume.

Stream - A flow of water in a channel or bed, as a brook, rivulet, or small river (NRCS, 2006).

Stream Ordering – A method of classifying or ordering the hierarchy of natural channels within a watershed (Horton, 1945).

Stressor - Any physical, chemical, or biological entity that can induce an adverse response (synonymous with agent) (USEPA, 2006).

Sub-basin or subwatershed – A smaller geographic section of a larger watershed unit with a drainage area of between 2 to 15 square miles and whose boundaries include all the land area draining to a point where two second order streams combine to form a third order stream (CWP, 2001).

Surface Waters – Include all those sources and supplies of water that are visible at the surface, including streams, creeks, rivers, ponds, lakes, ocean (Dunne, T. and L.B. Leopold, 1998).

T

Taxa (plural of taxon) – A group of organisms systematically classified according to their natural relationship, such as a group of macroinvertebrates, which is used to represent the diversity within a sample; a taxonomic group or entity. Taxa are used as a key metric in some biotic condition indices, for example the Index of Biotic Integrity (IBI) (WSI, no date(c)).

Thalweg – The line followed by the majority of the stream-flow. The line connecting the lowest or deepest points along the streambed (NRCS, 1998).

Total Maximum Daily Load (TMDL)– A tool for establishing the allowable loadings of a given pollutant in a surface water resource to meet predetermined water quality standards (CWP, 2001).

U

Universal soil loss equation (USLE) - An erosion model designed to predict the long-term average soil losses in runoff from specific field areas in specified cropping and management systems (NRCS, 2006).

The equation is: A = RKLSCP

Where;

A = Computed soil loss per unit area
R = *Rainfall and runoff* factor
K = *Soil erodibility* factor
L = *Slope-length* factor
S = *Slope-steepness* factor
C = *Cover and management* factor
P = Support *practice* factor

W

Water Balance - A measure of the sources of water input as compared to the sources of water output (NRCS, 2006).

Water Budget – An estimation of the natural available amounts (by type: surface vs groundwater) as compared to the water demand. It is a useful tool for water planning and management (Dunne, T., and L.B. Leopold, 1998).

Water Quality Standards – Set the goals, pollution limits, and protection requirements for each waterbody, for each chemical or measure of concern (USUSEPA, 2005).

Water use – In a restrictive sense, the term refers to water that is withdrawn for a specific purpose, such as for public supply, domestic use, irrigation, thermoelectric power cooling, or industrial processing. More broadly – water use pertains to te interaction of humans with and influence on the hydrologic cycle, and includes elements such as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, return flow, and in-stream use (USGS, 2000).

Water Year – October 1 to September 30.

Watershed – All the land area which contributes runoff to a particular point along a waterway (CWP, 2001).

Watershed Plan – A comprehensive framework for applying management tools within each subwatershed in a manner that achieves the water resource goals for the watershed aw a whole (CWP, 2001).

Weathering – All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material (NRCS, 1997a).

Wetlands **-** Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly un-drained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. (Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. U.S. DUSEPArtment of the Interior, Fish and Wildlife Service.)

Z

Zoning **–** A set of regulations and requirements that govern the use, placement, spacing and size of buildings and lots within a specific area or in a common class (zone) (CWP, 2001).

APPENDIX B

Appendix B

Points of Contact and Additional Sources of Information

B.1 Points of Contact

Bureau of Land Management

Rick Ryan – Recreation	(970) 882-6845
Brenda Figueroa – Mineral Leases	(303) 239-3987
Peter Neugebauer – Mineral Leases	(303) 239-3771
Public Room – Archives	(303) 239-3600

Bureau of Reclamation

Vern Harrel (Cortez)	(970) 565—0865
Durango Office	(970) 385-6500

Colorado Department of Public Health and the Environment

Bradford Austin – GW WQCD	(303) 692-3572
Matt Czahor – Stormwater	(303) 692-3500
Loretta Houk – NPDES Program	(303) 692-3531
Aimee Knowal – WQCD	(303) 692-3530
Arne Sjodin – WQCD	(303) 692-3522
Candace Thompson – HWM	(303) 692-3399
Mark Walker	(303) 692-3449

Colorado Division of Minerals and Geology

Evan Branon – Database/Library	(303) 866-3815
Jim McArdle	(303) 866-3789
Jim Heron	(303) 832-8106

Colorado Division of Wildlife

Area Office (Durango)	(970) 247-0855
David Harper -Area Wildlife Manager	(970) 565-4102
Mike Japhet - Aquatic Biologist	(970) 375-6748
Scott Wait – Area Wildlife Bio.	(970) 375-6745

Colorado Geological Survey

Matt Sares – Program geologist	(303) 894-2174

Colorado Oil & Gas Control Commission

Debbie Baldwin	(303) 894-2100

Colorado Soil Conservation Board

Bob Zebroski	(303) 866-3381

Division of Water Resources

Durango – Main regional office	(970) 247-1845
Bob Becker	(970) 533-1333
Denise Miller – Commissioner	(970) 533-1333
Records Office	

Dolores County

Alvin Marsh – Septic Inspections	(970) 560-0435
Julie Stowe – Clerk/Recorder	(970) 677-2383
Doug Stowe – Groundwater Well Info	(970) 677-2255

Dolores River Outfitters

Buffalo Joe River Trips	(719) 395-8757
Canyonlands Field Institute	(435) 259-7750
Deer Hill Summer Expeditions	(970) 533-7492
Duranglers	(970) 385-4081
Durango Rivertrippers	(970) 259-0289
Dvorak's	(719) 539-6851
Kodi Rafting	(970) 668-1548
National Outdoor Leadership	(435) 781-0305
Peregrine River Outfitters	(970) 385-7600
Rocky Mtn. Adventures, Inc.	(970) 493-4005
Sheri Griffith Expeditions	(435) 259-8229
Telluride Outside	(970) 728-3895
Wanderlust Adventures	(970) 484-1219
Wilderness Aware	(719) 395-2112
Wildwater Incl	(970) 224-3379
Outdoor Leadership	(303) 320-0372

Environmental Protection Agency

Kim Bartels – PP Grant Coord.	(303) 312-6346
Debra Ehlert – Brownfields	(303) 312-6108
Env. Info. Center	(303) 312-6312
Marcella Hutchinson	(303) 312-6753
Linda Walters – Pollution Prev.	(303) 312-6385
BethAnn Williams – Env. Rel. & Inc. Rep.	(303)692-3429
Office of Env. Educ. (Grants)	(800) 227-8917

National Response Center

Information hotline	(800) 424-8802

Natural Resources Conservation District

Cortez	(970) 565-9045
Dove Creek	(970) 677-2229
Colorado State Office	(720) 544-2841
Patrick Drew - Wetlands	(970) 708-2081

SEH

Bill Kelly	(970) 484-3611
Steve Harris – Harris Water Eng.	(970) 259-5322

Southwester Water Conservation District

General	(970) 247-1302

US Forest Service

Switchboard – Dolores Office	(970) 882-6800
Walter.A. Brown – Minerals	(970) 247-4874
Polly Hays – Water Res.	(303) 275-5096
Annette Joseph – Range	(970) 882-6826
Kevin Joseph – Timber	(970) 882-6836
Lloyd McNeal – Recreation	(970) 882-6824
Patrick McCoy – Land Exchange	(970) 882-6845
Cliff Steward – Range	(970) 247-4874
Craig Sullivan – Range	(970) 884-1422
Penny Wu – Recreation	(970) 882-6829
Shawna Jensen – Hydrologist	(970) 882-6815
Tom Kelly	(970) 882-6813
John Neubert – AML	(303) 275-5628
Cathleen Zillich – SJNF AML	(970) 385-1239

US Geological Survey

Dave Gray	(970) 247-4140

B.2 Additional Information Resources

Antidegradation Policy

- ✓ Section 316 of the CWA: www.epa.gov/docs/epacfr40/chapt-1.info/sibch-D/htm)

Abandoned Mines Program: www.osmre.gov/acsihome.htm

County-level Population, Demographics and Housing information

- ✓ Census: http://quickfacts.census.gov

Local Cooperative Extension Offices: www.csrees.usda.gov/Extension/index.html

Mineral Leases, Property Easements, Property Ownership: www.blm.gov/LR2000 (Reports → public case records → GO report → customer : search by Township and Range)

Nonpoint Source Pollution

- ✓ Septic Information: www.nesc.wvu.edu/nsfc/nsfc_index.htm
- ✓ 319 Grants Info: www.epa.gov/owow/nps/cwact.html
- ✓ Points of contact www.epa.gov/owow/nps/contacts.html

Permit Information

- ✓ Point Sources: www.epa.gov/enviro/html/pcs/index.html) and (http://cfpub.epa.gov/npdes/indes.cfm)

- ✓ Stormwater: www.epa.gov/npdes/stormwater

Source water protection and assessment: www.epa.gov/safewater/source/contacts.html

State and Interstate Water Commissions: www.asiwpca.org

TMDL

- ✓ EPA's National Section 303(d) List and Fact Sheet (http://oaspub.epa.gov/waters/national_rep.control)

Watershed Planning

- ✓ Organizing information and resources: www.ctic.purdue/edu/KYW

Watershed Group Development etc

- ✓ Stakeholder development and responsibilities: www.epa.gov/owow/watershed/outreach/documents.
- ✓ Guidelines for group philosophy: www.epa.state.oh.us/dsw/nps/NPSMP/WAP/WAPccsustainable.html

Watershed Organizations: www.epa.gov/adopt/network.html

Wetlands

- ✓ Integrating wetlands into watershed management: www.aswm.org/propub/pubs/aswmwetlandswatershed.pdf

Volunteer monitoring Programs: www.epa.gov/owow/monitoring/volunteer

Watershed Coverages:

- ✓ USGS 8-digit watersheds: (http://water.usgs.gov/GIS/huc.html

USDA Natural Resources Conservation Service 14-digit watersheds: (www.ncgc.nrcs.usda.gov/products/datasets/watershed)

APPENDIX C

Appendix C

Well Permits and Water Rights within the Project Area

C.1 Water Rights

The following provides a summary of the water rights associated with surface water sources within the project area. This information was obtained from the most recent information available as provided by the Colorado Water Resources Management Division (Mancos, CO) from within their ' Water Rights Tabulation – alpha list – stream list- seniority list – location list (July 1, 2004). Only those rights within the project area were identified, and are summarized in **Table C.1**. It should be noted that there are water rights associated with downstream areas which affect the amount of available water within the watershed. As per Division 7, the Dolores River is over-allocated and can not meet the amount of decreed water rights at baseline flows. A comprehensive tabulation of the water rights was obtained CDWR, 2006 and can be obtained through the DWR Records Department (http://water.state.co.us/pubs/research.asp) (CDWR, 2006). A description of the tabulation codes is provided within this web page.

C.2 In-stream Flow - Water Rights Tabulation

The CWCB, Water division 7 maintains records of the total number of water rights appropriations vs the total number of stream miles. For Water Division 7, there are 705.8 total stream miles, and 82 total appropriations. Of these totals, the water rights associated with the Project Area are summarized in **Table C.2**.

Numerous CWCB in-stream flow rights have been decreed on major rivers and tributaries in Water Division 7. A summary of these decreed rights are provided in Appendix X to this report. These rights are year-round rights with seasonal variability as reflected in the range of values shown. Flow rights on small tributaries in the basins are also referenced within this summary (CWCB, 2003).

Table C.1 Summary of Water Rights Decreed within the Project Area. (source; CDWR, 2006).

ID No.	Water Right Name	Location						Use Code	Use Adj. Type	Administration No.	Decreed Amount (cfs)
		Qrtr	Qrtr	Qrtr	Sec.	TNS	RG				
508	Bemis Spring	NW	NW	NE	24	40 N	11 W	IN*	C S,AB	44559.18627	0.0266
578	Piedmont Spring	SW	NE	NW	24	40 N	11 W	NF*	C S	44559.28123	0.024
	Taylor Spring 1	SE	SE	NE	23	40 N	11 W	D	C S	44925.39446	0.0089
	Taylor Spring 2	SE	SE	NE	22	40 N	11 W	ID	C S,C,AB	44925.44924	0.055
610	Taylor HCT on Pap.	SE	NW	NW	23	40 N	11 W	ID	C S,C,AB	44972.00000	0.4
574	Mtn Spring Tunnel	NW	SW	SE	8	40 N	11 W	IN*	C O	29584.00000	0.0177
566	Mary B Spring	NE	SE	NW	25	40 N	11 W	IF*	C S	44559.4401	0.0599
602	St Louis Tunnel	SW	NE	NW	25	40 N	11 W	NDS	C S	44559.29219	1.1942
575	Original Rico Flume	SE	NE	SE	30	40 N	11 W	IM*	C S	31483.11782	0.28
	Columbia Spring 1	NW	NE	SE	26	40 N	11 W	NS	C S	45655.42929	0.022
	Columbia Spring 2	SE	SW	NE	26	40 N	11 W	NS	C S	45655.42929	0.033
509	Blaine Tunnel	NE	SW	SE	30	40 N	11 W	NFD	C S	44559.32141	0.4995
5007	DDH 0S5A Art Drill Hole	SW	NE	SW	25	40 N	11 W	N	C O	44528.00000	0.055
5006	DDH 0S4A Art Drill Hole	SW	NE	SW	25	40 N	11 W	N	C O	44133.00000	0.055
581	Propatria Tunnel	SW	NE	NE	36	40 N	11 W	NFS	C S,AB	44559.28123	0.022
542	Ginia Spring	SW	SE	NW	35	40 N	11 W	NF*	C S	44559.36159	0.088
550	Iron Clad Tunnel	SW	SE	NE	35	40 N	11 W	NF*	C S	44559.36159	0.061
519	Cowdrey Spring	SW	SW	SE	35	40 N	11 W	NS	C S	44721.00000	0.033
598	Silver Swan Tunnel	SW	SE	SE	35	40 N	11 W	NF*	C S,AB	44559.18627	0.0599
583	Ramco Spring 21	SE	NW	NW	1	39 N	11 W	NS	C S	44599.29219	0.0067
597	Silver Swan Spring	SW	SW	SE	35	40 N	11 W	NS	C S,AB	44721.00000	0.0118
622	Wamba Spring	SW	NW	NE	2	39 N	11 W	NS	C S,AB	44559.28123	0.0028

Abbreviations:

ID No. – Identification number
Qrtr – Quarter
TNS – Township
RG – Range
Use Adj. Type – Use adjudication type
Administration No. – Administration number
cfs – cubic feet per second

Footnotes:

Use Codes

A	Augmented
B	Basin exp.
C	Commercial
D	Domestic
E	Evaporation
F	Fire
F	Forest
G	Geothermal
H	Household only
I	Irrigation
K	Snowmaking
M	Municipal
m	Minimum in-stream
N	Industrial
O	Other
P	Fishery
P	Power generation
R	Recreation
S	Stock
W	Wildlife
*	All beneficial uses within a given category (e.g. N* would include, forestry, mining, etc.).

Use Adjudication Type

AB	Abandoned
AP	Alternate point
C	Conditional
CA	Condition made absolute
EX	Exchange

O Original
S Supplemental
TF Transfer from
TT Transfer to

Administration number – was developed by the DWR to provide a simple and efficient method of ranking decrees in order of seniority. The 'smaller' the number, the older the right.i.e.. 2346 is more senior to 4388.

Table C.2. CWCB In-stream Flow Tabulation for Streams within Water Division 7, that occur within the Project Area. (source; CWCB, 2003)

Stream	Case No.	Length	Amount (cfs and dates)	Appropriation Date
Barlow Creek	7-84CW287	5.3	1.5 (01/1 – 12/31)	7/13/1984
Coal Creek	7-83CW091	4.3	2 (01/1 – 12/31)	5/5/1983
Coke Oven Creek	7-84CW286	2.4	1 (01/1 – 12/31)	7/13/1984
Cold Creek	7-84CW297	2.0	2 (01/1 – 12/31)	7/13/1984
Dolores River	7-83CW092	6.0	6 (01/1 – 12/31)	5/5/1983
Dolores River	7-84CW284	12.8	20 (01/1 – 12/31)	7/13/1984
Fall Creek	7-83CW090	1.4	1.5 (01/1 – 12/31)	5/5/1983
Fish Creek	7-83CW300	13.4	3 (01/1 – 12/31)	7/13/1984
Meadow Creek	7-84CW295	3.4	0.5 (01/1 – 12/31)	7/13/1984
Priest Gulch	7-84CW292	6.9	1.5 (01/1 – 12/31)	7/13/1984
Scotch Creek	7-84CW288	4.4	1.5 (01/1 – 12/31)	7/13/1984
Silver Creek	7-83CW088	4.4	2 (01/1 – 12/31)	5/5/1983
Slate Creek	7-84CW285	3.9	2 (01/1 – 12/31)	7/13/1984
Snow Spur Creek	7-83CW084	1.9	2 (01/1 – 12/31)	5/5/1983
Wildcat Creek	7-84CW290	4.7	1 (01/1 – 12/31)	7/13/1984

C.3 Groundwater Well Permit Information

The information provided within this Appendix was obtained from the State of Colorado, Water Resources Management Division, well permits databases which are accessible to the public from their Durango branch office. The project area was queried and a summary of the following well information is provided in **Figure C.1** which depicts the locations of wells with groundwater rights within the Project area, and **Table C.3** which summarizes the capacities etc. for these same wells.. Copies of scanned well log records pertinent for yield and lithology are provided on the following pages (eight pages depicting scanned images of well logs for permitted wells).

Table C.3 Summary Well Permit Records. (source; CDWR, 2006).

Permit Number	Type of Use	Location	Sustained Yield (gpm)	Static Water Level	Total Depth
103821	Potable supply	NW ¼ of the SE ¼ of Sec. 33	5	43 ft	92 ft
255513 (and 42231)	Monitoring hole	SW ¼ SW ¼ Sec. 13: T 40 N, R 11 NMPM	400	8	143 ft
158777	Potable supply	NE ¼ SE ¼, Sec. 23: T 40 N, R 11 W.	3.5	35 ft	160 ft
68951	Potable supply - household	SE ¼ of the SE ¼ of Sec. 23: T 40 N, R 11 W NM	9	37.6 ft	49 ft
139391	Potable supply – business	NW ¼ of the SW ¼ of Sec. 25: T 40N, R 11 W. NM.	10	55 ft	70 ft
52686	Fee well – augmented	SE ¼ NE ¼, Sec. 2 T 39 N, R 11 W.	10	130 ft.	186 ft.
48053	Fee well – augmented	SE ¼ NE ¼, Sec 2: T 39 N, R 11 W	15	42 ft	109 ft
60199	Fee well - augmented	NE ¼ SE ¼, Sec. 2: T 39 N, R 11 W.	10	114	170 ft

The Upper Dolores river is defined as a 'critical water district' within the Dolores Water Conservation District. This means that all the water is allocated for a use and 'on call' for down-stream prior appropriated users. This means that any new depletions need to be replaced. In regards to establishing a ground water well, If the well was not established prior to 1972; a water right was not established by the water user, and the user would have to purchase the right and pay a fee based upon the consumed rate. There are two wells that fall within this 'augmentation' or fee-required category.

C.4 Summary of Irrigation Water Rights within the Project Area

CDWR tracks the irrigation (ditch) rights, diversion rates and consumptive use rates within the Project area. A summary of irrigation rights within and below the project area are provided in **Table C.4.** An approximate sum-total of 2,500 ac ft of combined consumptive use is required by the ultimate down-stream obligation to the McPhee/Montezuma Valley irrigation district. The amount of available water for irrigation rights is often 'back calculated' for upstream users assuming this 2,500 ac ft need. The available decreed water rights are summarized in District Court – Water Division 7 Case No. 96CW49 (February 16, 2000) (CDWR, 2000).

In the late 1980s to early 1990s, CDWR re-evaluated irrigation water rights within the Dolores River valley to determine historic use (appropriated rights) versus consumptive use of each irrigation ditch. The results were used to determine if there were any abandoned rights available, or un-used portions of rights. An evaluation of each ditch was completed. A summary of findings is provided in **Table C.4**. There are additional studies for other irrigation rights within the Dolores watershed that were not within or down-stream of the project area, but are available at the CDWR office (now located in Cortez, CO). The information within **Table C.4** can be narrated as follows using the Hammond and Clark Ditch information as an example;

- The diversion for these ditches occurs along the west bank of the Dolores River, approximately 11.5 miles northeast of Dolores in the NW ¼ SW ¼ of Sec. 11 T 38 N, R 14 W.

- The Sebastian Tam Ditch and the Hammond and Clark Ditch historically have been used to irrigate 7.7 acres and 42.8 acres, respectively, of grass harvested as hay and pasture grass for a total of 50.5 acres.

- The irrigation requirement for 50.5 acres of hay and pasture grass averaged 90.6 ac ft per year and ranged from 72 ac ft in 1981 to 106.3 ac ft in 1974.

- The historic water diversions for the Hammond and Clark Ditch as shown in the State Engineer's records averaged 114.5 ac ft per year and ranged from 0 ac ft in 1973, 1974 and 1988 to 366.1 ac ft in 1972.

- Assuming that the fields under the Sebastian Tam and Hammond and Clark Ditches were irrigated by the Hammond and Clark Ditch diversions, the historic consumptive use averaged 38.4 ac ft per year for 1971 through 1984 and ranged from 0 ac ft in 1973, 1974 and 1983 to 92.9 ac ft in 1977.

- The evaluation summarized their findings by stating that the diversion rates of 1.0 cfs for the Sebastian Tam Ditch and of 6.33 cfs for the Hammond and Clark Ditch are sufficient to irrigate effectively the hay and pasture grass under the two ditches.

Table C.4 Summary of Historical Irrigation Requirements, Diversion and Consumptive Use Rates for Irrigation Water Rights within the Project Area. (sources; provided at bottom of Table). Pg 1 of 3

Ditch	Location	Historical Use	Irrigation Requirements			Historical Diversion Rate (ac ft)			Historical Consumptive Use (ac ft)			Determined Acceptable Diversion Rate (cfs)
			Average/year	Min. (year)	Max. (year)	Average/year	Min. (year)	Max. (year)	Average/year	Min. (year)	Max. (year)	
Gould Ditch	N bank of the E Fork of the Dolores River, ~ 1.7 miles SE of Stoner: SW ¼ SE ¼ of Sec 4 T 38 N R 13 W					504.7	231.9 (1975)	1013.9 (1982)	167.9	117.4 (1975)	217.6 (1979)	6.0 (5 for irrigation, 1 for domestic/stock water)
Moriarty Ditch	S bank of the E Fork of the Dolores River, ~ 1 mile SE of Stoner: SE ¼ NE ¼ Sec 5 T 38 N, R 13 W	Irrigation of 145.1 acres of hay and pasture	248.8	194.1 (1981)	295.4 (1974)	292.6	35.7 (1973)	588.2 (1974)	121.9	14.3 (1973)	235.3 (1974)	6.5
Burch and Longwell	E bank of the Dolores River: NE ¼ of Sec 27, T 38 N, R 14 W	Irrigation of 138,5 acres of alfalfa and grass	256.1	205.8 (1981)	298.1 (1974)	603.6	352.4 (1977)	1021.5 (1972)	227.6	157.6 (1977)	285.1 (1979)	7.8
Sebastian Tam, & Hammond & Clark	W bank of the Dolores River ~ 11.5 miles NE of Dolores: NW ¼ SW ¼ of Sec 11 T 38 N, R 14 W	Irrigation of 50.5 acres of grass and hay.	90.6	72 (1981)	106.3 (1974)	114.5	0 (1973, 1974, 1983)	366.1 (1972)	38.4	0 (1973, 1974, 1983)	92.9 (1977)	7.33

Table C.4 Summary of Historical Irrigation Requirements, Diversion and Consumptive Use Rates for Irrigation Water Rights within the Project Area. (sources; provided at bottom of Table). Pg 2 of 3.

Ditch	Location	Historical Use	Irrigation Requirements			Historical Diversion Rate (ac ft)			Historical Consumptive Use (ac ft)			Determined Acceptable Diversion Rate (cfs)
			Average/year	Min. (year)	Max. (year)	Average/year	Min. (year)	Max. (year)	Average/year	Min. (year)	Max. (year)	
Roubidoux Ditch	N bank of the E Fork of the Dolores River, ` 6 miles E of Stoner: SW ¼ SW ¼ of Sec 5, T 38 N, R 12	Irrigation of 22.8 acres of crops	35.4	26.3 (1981)	43.1 (1974)	25.8	0	224.1 (1971)	4.8	0	32.4 (1971)	3.5
Lindstrom	S bank of E Fork of the Dolores River, ~ 4 miles SE of Stoner: SW ¼ NW ¼ Sec 12, T 38 N, R 13	Irrigation of 41.8 acres of pasture grass	68	51.7 (1981)	81.8 (1974)	70.3	0 (1973)	238 (1978)	23.5	0	61.7 (1974)	4.5
Monument Rock	S bank E Fork of the Dolores River, ~ 3 miles SE of Stoner: NE ¼ SE ¼ Sec 10, T 38 N, R 13	Irrigation of 93.8 acres of pasture grass	154.5	118.2 (1981)	185.2 (1974)	282.1	95.2 (1983)	460.8 (1972)	106.3	38 (1983)	166.1 (1972)	6
Lyons	S bank of the E Fork of the Dolores river, ~ 10 miles NE of Dolores: NW ¼ NW ¼ Sec 1, T 38 N, R 14 W	Irrigation of 35.3 acres of pasture and hay	62.3	49.2 (1981)	73.5 (1974)	37.5	0	221 (1974)	19.5	0	54.1 (1974)	4

Table C.4 Summary of Historical Irrigation Requirements, Diversion and Consumptive Use Rates for Irrigation Water Rights within the Project Area. (sources; provided at bottom of Table). Pg 3 of 3.

Ditch	Location	Historical Use	Irrigation Requirements			Historical Diversion Rate (ac ft)			Historical Consumptive Use (ac ft)			Ditch
			Average/year	Min. (year)	Max. (year)	Average/year	Min. (year)	Max. (year)	Average/year	Min. (year)	Max. (year)	
Ortiz	E bank of the Dolores River, ~ 6 miles NE of Dolores: NE ¼ SE ¼ Sec 33, T 38 N, R 14	Irrigation of 19 acres of alfalfa and clover	35.5	28.7 (1981)	41.2 (1974)	128.9	40.3 (1977)	314 (1984)	28.2	14.4 (1977)	37.7 (1974)	2.3
Silvey	W bank of Stoner Creek, a trib. To E. Fork of the Dolores River, ~ 1 mile NE of Stoner: NE ¼ NW ¼ Sec 29, T 39 N, R 13	Irrigation of 29.1 acres of pasture	49.1	38 (1981)	58.6 (1974)	154.8	46.8 (1977)	250.4 (1973)	48.7	38 (1981)	58.6 (1974)	3
Unnamed	W bank of Priest Gulch: SE ¼ NE ¼ Sec 3, T 38 N, R 12 W	Irrigation of 7 acres of pasture	10.3	7.4 (1981)	12.8 (1974)	8.2						0.61
King No. 1 and King No. 2	W bank of Roaring Fork Creek, ~ 12 miles E of Stoner: NE ¼ SE ¼, Sec 31, T 39 N, R 11	No. 1 irrigates 44.7 acres of pasture, No. 2 irrigates 29.5 acres of pasture	47.7 – 40.5	43 – 28 (1991)	78 – 51 (1979)	40.4 - na	0 –na	281 – na (1974)	22.5 – 14.8	0 - na	71.3 – na (1974)	4.2 – 1.66

Sources for Table C.4:

Helton & Williamsen, 1998. Dolores Water Conservation district Historic Use and Consumptive Use of the McEwen and Leavenson Ditch. January, 1998.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Burch & Longwell ditch. October, 1986.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Ortiz ditch. October, 1986.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Sebastian Tam & Hammond and Clark ditches. October, 1986.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Gould & Moriarty Ditch. November, 1986.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Lindstrom ditch. December, 1986.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Monument Rock ditch. December, 1986.

Tipton & Kalmback, Inc. 1986. Dolores Water Conservation district Historic Use and Consumptive Use of the Lyons ditch. December, 1986.

Tipton & Kalmback, Inc. 1987. Dolores Water Conservation district Historic Use and Consumptive Use of the Silvey Ditch. March, 1987.

Tipton & Kalmback, Inc. 1987. Dolores Water Conservation district Historic Use and Consumptive Use of the Roubidoux Ditch. April, 1987.

Tipton & Kalmback, Inc. 1987. Dolores Water Conservation district Historic Use and Consumptive Use of the Unnamed Ditch. April, 1987.

Tipton & Kalmback, Inc. 1987. Dolores Water Conservation district Historic Use and Consumptive Use of the King No. 1 and King No. 2 Ditches. April, 1987.

APPENDIX D

Appendix D

Copy of Most Recent CWQCC Regulations

APPENDIX E

Appendix E

Summaries of Additional Water Quality Studies Completed for the Project Area

In the process of reviewing available information pertaining to the Project area, numerous data sets were obtained. Some were pertinent to the purposes of this document, while others held information of supportive value but could not be integrated into the data set used for the water quality analysis. The following provides summaries of available information NOT ALREADY DESCRIBED IN DETAIL within the document.

E.1 Walsh Environmental Scientists and Engineers, Inc.

Walsh Inc. completed Phase I and II Environmental Site assessments for Rico Renaissance on approximately 3,000 acres of land in and around Rico in 1995. A limited number of soils and surface water samples were taken. Results indicated that there are elevated lead levels primarily related to former mining operations. Walsh categorized different types of areas where waste rock and tailings were evident. Results of the metals analysis as compared to these categories of areas indicated that areas with mine tailings, slag or spoils in surface or subsurface soils, had elevated concentrations of metals. The most relevant information gathered from these studies includes the samples of soil and surface water which are described below.

For the soils analysis;

- Samples of different types of materials were evaluated and mapped. The types of materials included; alluvium mixed with mine waste material, alluvium mixed with mill tailings, acid mine drainage, clinker/fill/alluvium, contaminated mine drainage, clinker with mine waste and dump debris.

- The analytical data from limited selective sampling indicate that concentrations of lead up to 12,000 mg/kg are present at some properties within the study area where fill material, mine tailings, waste rock, and slag are visible.

- Samples taken from properties that appeared to have native soil, contained lead concentrations ranging from 62 mg/Kg to 260 mg/Kg which is well within background levels for lead in soils.

- Properties ranked as low risk have soil lead concentrations of less than 400 mg/Kg.

- Fill material (on Lots 36 to 40, Block 1) was composite sampled and analyzed using the Toxicity Characteristic Leaching Procedure (TCLP) methodology for metals. The sample extract contained 21 milligrams per liter (mg/L) lead and the regulatory level for characteristic hazardous wastes if 5 mg/L.

For the surface water analysis (summarized in **Table E.1**);

- Samples were taken from the Dolores River, Silver Creek and from a spring near the Mountain Springs mine. Three samples were taken from the river; one from up-gradient of the study area near the ABG Mine, one directly downstream of the discharge from the Rico-Argentine Mine treatment ponds, and one at the downstream edge of the study area. The sample from Silver Creek was taken downstream of the discharge entering the creek from the Rico-Argentine Mill approximately 1 mile east of Rico. The samples were analyzed for Total metals.

- Results indicate that the highest metals concentrations were found in the sample from the Mountain Springs mine. The pH was 3.9.

- The concentrations of iron, manganese and zinc directly down-gradient of the Rico-Argentine Mine discharge were elevated when compared to the other samples taken from the river; however, the water quality standards established for these parameters in the Dolores River were not exceeded.

- The detection limits for arsenic, cadmium, copper, lead, mercury, selenium, and silver were not low enough to determine if these water quality standards had been exceeded.

- **Table E.1** summarizes the metal concentrations in the water samples collected during this effort.

E.2 EPA STORET Data Warehouse

A comprehensive database of water quality information had been built by SHE Inc. and encompassed many of the data sets of use for the project. One dataset that was integrated into the SHE data base, was the EPA STORET information. A summary of the available STORET information is as follows;

Data dating back to 1900 to present is available. For Dolores County, there are data sets for water quality and sediment quality; but no available information for biological or habitat inventories (EPA, 2006 a through 2006c).

Within the current STORET Data system, there are two sources of data for the Project area;

1) CDPHE, and
2) CDOW Riverwatch data.

There are 37 locations associated with CDPHE efforts, and 3 locations with CDOW Riverwatch information.

CDPHE sampled individual tributaries to the Dolores, aw well as locations along the Dolores and Silver Creek that characterize the main stem flows within these systems. The tributary samples were collected at points of release to the Dolores. The locations sampled by CDPHE include;

- Argentine mine effluent,
- Horse creek
- Silver Creek
- Scotch Creek
- Truby Creek
- Lizard Head at Mouth of River
- Silver Creek
- Burnett Creek
- Coke Oven Creek
- Barlow Creek
- Spruce Gulch
- Slate Creek
- Fall Creek
- Coal Creek
- Snow Spur Creek
- Fill Gulch
- Marguerite Creek
- McJunkin Creek
- Locations throughout Silver Creek
- Locations along the Upper Dolores that bracket the above listed tributaries

E.3 CFAR

CFAR, 2005 "Monitoring of the upper Dolores River was begun in 2002 by a local citizen's group (CFAR) in response to concerns about the impact of increasing development on the Dolores River Valley. Results on biological toxicity assessment (using aquatic snails) and water quality testing up to the end of 2003 are summarized in the 2005 document. Further data are forthcoming in progress reports. Measurements of water quality and biologic assessments of toxicity (exposure of aquatic snails to site sediments or soils) were conducted in the Dolores River from mining areas around Rico and Dunton near the watershed rim in the San Juan Mountains, and for 45 miles downstream to McPhee Reservoir near the Town of Dolores. Quarterly monitoring was completed at 10 sites starting in Fall of 2003.

Results pertinent to this document include the following;

- Snails exposed downstream of the abandoned mines along Silver Creek during August 2002 and September 2003, died after exposures of about one day. Snails exposed downstream at the same time, had fewer deaths.

- Results of the water quality data from 2002 and 2003 indicated that the Dolores River should be a good cold-water habitat for trout and salmon. Water temperatures and dissolved oxygen were favorable for fish survival and reproduction. Dolores River waters were chemically buffered with high alkalinity, and also contained significant hardness as expected for the area.

- The Dolores River drains part of the Western Slope of the Rocky Mountains. The outer rim of the Dolores River Basin includes mountains and snowfields that occur above 14,000 in elevation. The headwaters occur at approximately 10,000 feet in elevation. The terminus of this watershed plan occurs at the Montezuma County line which occurs prior to the McPhee reservoir that was created in 1984 to capture and store about 380,000 acre-feet of water.

- Flow within the Dolores River follows a seasonal pattern with a peak of about 4,000 cfs in the spring. The mean discharge of the river is 438 cfs, based on 90 years of records from the USGS. The estimated 100-year flood at the gauging station in Dolores is 12,000 cfs, and the lowest flow at that site was about 4 cfs.

- Dissolved zinc was the only heavy metal monitored during this survey. A concentration of 0.1 ppm was measured upstream of Rico on the main stem of the Dolores River, while a concentration of 0.48 ppm was measured from Silver Creek. The concentration of dissolved solids increased markedly as the Dolores River pass through Rico, beginning at a low concentration of 130 ppm at the 'clean water' station of Barlow Creek Bridge, then rising to 340 ppm at the highway bridge in Rico. Further downstream in Dolores the concentration of dissolved solids decreased to 230 ppm, apparently due to dilution by tributary waters.

- The pH of the river was slightly above neutral pH, probably due to the buffering by carbonate salts of calcium and sodium (alkalinity). There were indications of increased minerals and heat coming into the river at the Rico Bridge. The temperature rose from 13.7 ^{o}C at Barlow Bridge to 19.3 oC at Rico in June and July of 2002. This was much warmer than the temperature of the river upstream or downstream, and warmer than the waters in Silver creek which joins the river downstream of the bridge. The concentration of dissolved solids also increased dramatically to 337 ppm at Rico during June and July 2002. These increases are probably due to tributary flows coming from the banks immediately upstream of the bridge. There are thermal springs upstream of the Rico bridge, as well as settling ponds used for storing and treating wastes from abandoned mines. Dissolved zinc was measured in samples from the Rico area and Silver

creek, but was not detected in samples down-gradient in Dolores during the 2002 study. Coliform bacteria concentrations were very low throughout the river, indicating low contamination with human fecal material. The few indications of fecal contamination were probably from the many septic systems in Rico (a concentration of 3.1 count per 100 ml from the Silver creek sampling location). Although elevated coliform counts were detected downstream of RV parks (a concentration of 3.8 count per 100 ml at West Fork sampling location), they were not high enough to violate the state standards.

- Alkalinity and hardness were relatively high in the entire river system, with the main river containing 87 ppm of alkalinity compared to 129 ppm in the tributaries. Conversely the main river had a higher mean hardness of 200 ppm, compared to 153 in the tributaries.

Table E.1 Summary of Metal Concentrations detected in Surface Water Samples from the Walsh Env. Sampling Effort (source: Walsh, 1995).

Parameter and Units	Detection Limit	Dolores River Standard	Location				
			RW-01	RW-02	RW-03	RW-04	RW-05
Aluminum (mg/L)	0.2		ND	180	0.2	0.4	0.4
Antimony (mg/L)	0.2		ND	ND	ND	ND	ND
Arsenic (mg/L)	0.2	0.05	ND	ND	ND	ND	ND
Barium (mg/L)	0.5		ND	ND	ND	ND	ND
Beryllium (mg/L)	0.02		ND	ND	ND	ND	ND
Cadmium (mg/L)	0.02	0.0004	ND	0.33	ND	ND	ND
Chromium (mg/L)	0.05	0.1	ND	ND	ND	ND	ND
Cobalt (mg/L)	0.05		ND	0.13	ND	ND	ND
Copper (mg/L)	0.05	0.014	ND	0.12	ND	ND	ND
Iron (mg/L)	0.05	1	0.13	0.39	0.34	0.13	0.09
Lead (mg/L)	0.2	0.004	ND	ND	ND	ND	ND
Manganese (mg/L)	0.05	1	0.11	40	0.76	0.06	
Mercury (mg/L)	0.001	0.0005	ND	ND	ND	ND	ND
Molybdenum (mg/L)	0.05		ND	ND	ND	ND	ND
Nickel (mg/L)	0.05	0.05	ND	0.39	ND	ND	ND
Selenium (mg/L)	0.2	0.02	ND	ND	ND	ND	ND
Silver (mg/L)	0.1	0.0001	ND	ND	ND	ND	ND
Thallium (mg/L)	0.2		ND	ND	ND	ND	ND
Vanadium (mg/L)	0.1		ND	ND	ND	ND	ND
Zinc (mg/L)	0.05		0.22	40	0.39	0.08	ND

RW-01 Silver Creek, below mill
RW-02 Spill Mine
RW-03 Dolores River – Argentine Discharge
RW-04 Dolores River down gradient
RW-05 Dolores River up gradient
ND – Not detected at stated Detection Limit

APPENDIX F

Appendix F

NPDES History for the St. Louis Tunnel and Outfall

A review of the 'Town of Rico' file regarding Water Quality violations – St Louis Tunnel was reviewed. A summary of the actions, notices and responses are provided herein.

F.1 Overview of the Tunnel Discharge System

The discharge points which are regulated as per the CDPS are associated with the Rico Argentine Mine Site. The Rico Argentine Mine Site encompasses portions of the Silver Creek and Dolores River drainages. Site features include the Rico-Argentine Mill, Blaine Tunnel, two large tailings piles adjacent to Silver Creek, the St. Louis Tunnel adit, an inactive sulfuric acid plant footprint, two inactive cyanide heap leach basins, settling ponds and two hot spring ponds adjacent to the Dolores Rivet. The Rico-Argentine Mining Company was formed in 1915 to produce base metal ores and was shut down by 1932. The Mining Company resumed sporadic mining in 1934. A sulfuric acid plant was operated between 1955 and 1964. All mining operations again ceased in 1971 and the mine workings were allowed to flood and drain through the St. Louis Tunnel. The Company built a 300-foot by 500-foot leach pad next to the old sulfuric acid plant in 1973. A cyanide solution was used to leach silver and gold from the raw ore and an overflow of an unknown quantity of leaching liquor to the Dolores River occurred sometime in 1974 (BOM, 1974). In 1975 an additional cyanide leach pad was constructed in a settling pond originally used by the acid plant (URS/USEPA, 1996).

The Mine has two outfalls which discharge pollutants into the Dolores River and into Silver Creek. These outfalls are known as Outfall 001 (Blaine Tunnel) and Outfall 002 (St. Louis Tunnel). The wastewater discharges metals pollutants (including but not limited to cadmium, copper, lead, silver and zinc) total suspended solids and adjusted pH waters. These pollutants are defined by the CWA. Outfall 001, The Blaine Tunnel was eliminated as a discharge point from the permit in 1990 when RDC installed a concrete barrier intended to direct flow from the Blaine Tunnel through underground mine workings where it then combines with the wastewater in the St. Louis Tunnel. However, a small amount of wastewater still discharges from the tunnel. Wastewater from the St. Louis Tunnel would pass through a lime-addition treatment plant and then discharge to a series of 11 settling ponds (as per 1999 site setting conditions). The wastewater then discharges into the Dolores River at Outfall 002.

F.2 Review of Tunnel Discharge Information: E.Heil (no date)

A review of the St Louis/Blaine Tunnel discharge information had been previously documented by E.Heil (no date) and provided within the Town file. A summary of the proposed Colorado Discharge Permit system (Permit No. CO-0029793) limits for the St. Louis discharge set forth by CDPHE. The permit defines acceptable releases from the St. Louis during different flow regimes and times of the year based upon the varying degrees

of the Dolores River to be able to dilute the heavy metal discharges from the tunnel. The permit initially established daily maximum limits, the Permit states that beginning February 1, 2995; the daily maximum measured concentration was merely to be reported.

Table F.1 summarizes CDPHE's Permit Limits (first column), criteria protective of aquatic life (second column – date unknown) as compared to sample results collected from various points along the Dolores River drainage. Results indicate that the Blaine tunnel discharge has the highest release rates. The outflow from the settling ponds also exceeds recommended limits for cadmium and zinc.

Table.F.1 File Summary of St. Louis Discharge Permit Limits as Compared to Measured Concentrations along the Dolores River (units ug/L).

Regulated Parameter (metal)	Permit 30-day average limits	Criteria protective of Aquatic Life	Settling Pond Outflow RDC-2 (9/14/99)	Wetlands between settling ponds and River RDC-4 (9/14/99)	Dolores River downstream end of Settling ponds RDC-9 (9/14/99)	Blaine Tunnel outflow RDC-6 Sampling results (9/14/99)	Silver Creek by bridge RDC-8 (9/14/99)
Cadmium	4.0	1.5 – 6.3	9.0	ND	ND	1540	4
Copper	2.4	12 – 43	ND	15	ND	29500	66
Lead	9.9	74 - 400	ND	2	ND	195	8
Silver	0.1	0.12	ND	ND	ND	ND	ND
Zinc	23.7	180-5700	1650.0	2130.0	65	233000	862

F.3 Regulatory History

In 1988 The State of Colorado issued a Colorado Discharge Permit System Permit (No. CO-0029733) to Anaconda Minerals company (Anaconda), the former owner and operator of the St. Louis and Blaine Tunnels and the Water Treatment System located adjacent to the St. Louis Tunnel. The permit became effective on June 13, 1988. The permit required Anaconda to operate the treatment plant and established effluent limitations and requirements. In response to an outstanding notice of violation, Anaconda carried out several environmental efforts such as building a water treatment plant (treatment plant) at the St. Louis Tunnel, capping wells, plugging adits and stabilizing tailings and treatment ponds (Anaconda Minerals Company, 1994) In June 1988, Rico Development Corp. purchased from Anaconda certain properties including the St. Louis and Blaine Tunnels and the treatment plant. RDC became the owner and operator of the St. Louis and Blaine Tunnels and the treatment plant. On September 7, 1988 the permit was transferred from Anaconda to RDC. In 1990 CDPHE WQCD issued a Notice of Violation and a Cease and Desist Order for the company's failure to meet the compliance of its permit (USEPA, 1994). In 1993, RDC sought renewal of the permit. On December 30, 1993, CDPHE authorized RDC's permit renewal which became effective February 1, 1994. The renewed Permit expired on January 31, 1999.

In 1994, RDC sold nearly all of its holding sin the Rico area to an unrelated corporation, Rico Properties, LLC (RP). Hypothetically as part of the negotiations, RDC and RP agreed that RP was not interested and would not purchase portions of the Mine presenting environmental liabilities including the St. Louis Tunnel and the treatment plant. However, despite this agreement, the purchase documents mistakenly included and thereby transferred ownership of the St. Louis Tunnel and the treatment plant to RP. Having recognized this error during the year-long sale transaction, RDC apparently abandoned the Mine and discontinued operation of the treatment plant. On September 4, 1996 RDC notified CDPHE that they no longer owned the St. Louis Tunnel and the treatment plant. Thereafter, CDPHE corresponded with RP assuming their new ownership.

In 1995, the discharge permit conditions were violated on a number of occasions. A review of the CDPHE files for the Permit for 1993 - 1995 are summarized in **Table F.2**.

Table F.2 Discharge permit condition Violations. (units are mg/L; sources; URS/USEPA, 1996, and State of Colorado,1996)

Report Period	Parameter	Reported Results	Permit Conditions
December, 1993	Total Recoverable Lead	0.013 (30-day avg.)	0.009 (30-day avg.)
January, 1994	Total Recoverable Lead	0.065 (30-day avg.)	0.009 (30-day avg.)
January, 1994	Total Recoverable Silver	0.0113 lbs/day(30-day avg.)	0.0081 lbs/day (30-day avg.)
April, 1995	Total Recoverable Cadmium	0.0035 (30-day avg.)	0.0004 (30-day avg.)
April, 1995	Total Recoverable Zinc	0.57 (30-day avg.)	0.237 (30-day avg.)
March, 1995	Total Recoverable Zinc	1.63 (30-day avg.)	0.44 (30-day avg.)
April, 1995	Total Recoverable Zinc	2.03 (30-day avg.)	0.88 (30-day avg.)
May, 1995	Total Recoverable Zinc	0.61 (30-day avg.)	0.44 (30-day avg.)
June, 1995	Total Recoverable Zinc	0.91 (30-day avg.)	0.88 (30-day avg.)
May, 1995	Total Recoverable Cadmium	0.0065 (30-day avg.)	0.0004 (30-day avg.)
July, 1995	Total Recoverable Cadmium	0.0125 (30-dayavg.)	0.0004 (30-day avg.)
July, 1995	Total Recoverable Zinc	2.85 (30-day avg.)	0.237 (30-day avg.)
September, 1995	Total Recoverable Cadmium	0.0025 (30-day avg.)	0.0004 (30-day avg.)
September, 1995	Total Recoverable Zinc	0.37(30-day avg.)	0.237 (30-day avg.)

The CDPHE has issued a 'Notice of Violation and Cease and Desist Orders' on January 26, 1996, January 18, 1994, and June 29, 1993.

In June of 1996, a Superfund Technical assessment and Response Team investigation was documented and served as support to later USEPA emergency actions (in 2000, refer to bellow). The effort served the purpose of completing sampling throughout the area, with an emphasis in the St. Louis Tunnel and Blaine tunnel settings. The results were integrated into the water quality temporal analysis within the Watershed Plan (URS/USEPA, 1996).

On November 1, 1996 RDC was administratively dissolved by the Colorado Secretary of State due to one or more of the Individual Defendant's failure to file corporate reports on behalf of RDC. On February 21, 1997 RP contacted RDC regarding the discrepancy concerning the sale documents and executed a Correction Warranty Deed to properly reflect site ownership. Therefore, the previous RDC associated (Wayne Webster/Director and president, and Virginia Sell/Director and Secretary) are listed as the defendants in the 1999 Civil suit filed by the State of Colorado (State of Colorado, 1999).

In 1999 The State of Colorado entered into a civil defense against the then-current owners of Rico Development Corporation (Wayne Webster and Virginia Sell) to seek civil penalties from the defendants arising out of the unlawful discharge of pollutants and the failure to monitor and report the discharge of pollutants during the five years prior to the Complaint filing.

On April 17, 2000 the CDPHE WQCD conducted a site inspection of the St. Louis Tunnel Site, and the Blaine Tunnel discharge. However, due to snow levels, the Blaine Tunnel was not observed. During the site inspection it was observed that the initial settling pond was full of wastewater discharge and had a very slight amount of freeboard (estimated at only 1-2 inches). These site conditions support the Town of Rico citizen assertion that 'overtopping' and release to the Dolores River had occurred. The initial turbid water becomes clearer until it is ultimately discharged through the permitted discharge point (Outfall 002). Outfall 002 goes directly into the Dolores River (location latitude 37° 42.06 N, Long. 108° 01.83 W) and was measured at a release rate of approximately 950,000 gallons per day.

As a result of the April 2000 Site Inspection and Town of Rico supplied information, the USEPA submitted a a warrant for access application through the U.S. District Court, in order to access the St. Louis Tunnel site and begin the process of a response action due to the overtopping of the settling ponds, and potential releases to the Dolores River (US District Court, District of Colorado, 2000).

On December 3, 2002 the CDPHE WQCD conducted a site inspection of the St. Louis Tunnel Site, and the Blaine Tunnel discharge. During the site inspection it was observed that a turbid orange-yellow liquid was discharging from the St. Louis portal was entirely directed to the settling pond system. The wastewater treatment plant was entirely circumvented. The diversion likely took place in the summer or fall of 2002. There was no direct discharge to the Dolores River. At that point in time, the wastewater treatment plant had been non-operational for 6 years. The discharge from the portal flows into the settling pond system and flows from one pond to the next. The initial turbid water

becomes clearer until it is ultimately discharged through the permitted discharge point (Outfall 002). Outfall 002 goes directly into the Dolores River (location latitude 37° 42.06 N, Long. 108° 01.83 W) and was measured at a release rate of approximately 605,000 gallons per day. During the Site Inspection, the Blaine Tunnel was also visited and found to have no discharge (Outfall 001) at the time of the visit. As per the report, the site was found to be out of compliance for a suite of reasons including the following;

- The outfall water quality exhibits metals concentrations that exceed the limits for the discharge, therefore the WQCD recommends that the wastewater treatment plant be brought on-line to help control these releases.

- As per WQCD records, the last discharge monitoring report was filed in August 1996. Therefore, over 6 years of required monitoring had not been performed and reported and per permit conditions.

APPENDIX G

Appendix G

Funding Source Information

APPENDIX H

Appendix H

Response to Comments

The following Appendix provides the responses to comments received from review of the Draft Watershed Plan submitted August 19, 2006. This document now represents the Final version after acknowledgement of the comments. The document was provided for public review and comment from August 17, 2006 through September 30, 2006 as notified within the Rico Town Bugle and presented at a Public Forum on August 17 held at Town Hall. The following sections provide the comments obtained from the US Environmental Protection Agency, US Forest Service and Atlantic Richfield Company and their responses. The comments are divided by source in the following Sections.

EPA NPS program comments
September 20, 2006

Comment:
I would recommend having someone who's really good at targeting general audiences do a thorough editing job of this draft. Our target audience is largely city-planner types and business people. I am concerned that the writing in this draft is oriented toward technical/scientific watershed folks, and may loose some of our target audience. The Willow Creek Aquatic Resources Assessment is a good example of a technical document written toward a more general target audience, which is where I think this document should aim.
http://www.willowcreede.org/waterquality/WC_Assessment_110105.pdf

Response:
As per discussion with Town of Rico representatives the language style is acceptable as presented within the Plan. The Plan is (and has been in the past) being presented to Town Board members and citizens over the course of a series of presentations as an educational tool. The language, terminology etc. is being described by 'Chapter' so that it is understood and the Plan will become a reference tool. The Plan was structured to meet the original scope of work provided to Grayling which requests that it provide explanatory materials for a diversity of readers. As such, each Chapter provides a significant amount of background and detail for reader reference. In response to this comment, a brief Executive Summary Synopsis *was written (a copy is provided at the end of this Appendix) in the language style requested. This brief Executive Summary Synopsis provides a condensed summary that is hopefully easy to understand regardless of the reader's background or expertise.*

Comment:
I recommend a very short 2-4 page executive summary with no attachments. A short executive summary can make a good hand out and should grab those who won't ever read the entire report but need to be on board. The attachments are good, and I think they would make good appendices to the overall document or additions to their respective chapters. The table layout for the recommendations is very useful, and could be incorporated in place of the current discussion rather than moved.

Response:
In response to this request, a brief ***Executive Summary Synopsis*** *was written (a copy is provided at the end of this Appendix) and provided as part of this Response to Comments package. It was written as a general overview with some technical details so as to provide a summary for a diversity of audiences. The summary Tables were incorporated into this document.*

Comment:
Great maps! Consider shrinking some of them to 8.5 "x 11" to fit more easily into the document and allow for easy copying for future hand outs. A small (1/2 to 1 page) map incorporated into the executive summary would be very useful.

Response:
A diversity of formats were explored for the Figures and found to require the large 11 x 17 size in order to retain the necessary detail.

Comment:
Section titles and subtitles would be handy. The references used to put the sections together should be part of a reference section rather than the subsection titles.

Response:
There are Section and Subsection Titles throughout the document. The document however is rather large and these Titles may be difficult to track. The reference materials appear in two places; 1) at times they are placed within the actual Section or subsection describing the reference, and 2) within the References Section (section 10). All references appear in Section 10. However, in order to make this document a useful 'Guide' as well as a technical document, the references that are critical to a subject title or are important resources were placed within the text itself. This was done so that the document could be useful to others who are looking for additional references pertaining to a given topic without having to review the Section 10 list in its entirety.

USFS AMR and Fire Rehab. program comments
September 20, 2006

Comment:
You quote and map the CGS data points for what they inventoried of draining mines and significant piles that they believed were on Forest. I do not see in your "data needs" section that a similar inventory is contemplated for all other mines in other ownerships. To compare "apples to apples", sampling needs to be done for every mine in the watershed, regardless of ownership. Only then can you prioritize which ones need work. If there was a basin-wide loading study, and mines on Forest come up to the top of the list, and if work is being done on the top-ranked mines on other ownerships, then the Forest might get funding to work on their mines. I believe the data on individual mines is incomplete, and that many more would be found that have similar issues to the ones you have mapped.

Response:

Comment noted. Unfortunately the language within the Watershed Plan does not highlight the fact that a considerable amount of effort actually has been completed in regards to private mine-related impacts. The mine features including the St. Louis tunnel, Blaine tunnel, Columbia tailings, Rico and Santa Cruz adits, the Silver Swan are all private and known contributors to water quality concerns within the Project area. These features were all identified after numerous studies were completed by others since the 1980s (refer to subsection 4.3.2r the chronologic history of Project area investigations). As shown on Figure 2.19 , there is a considerable amount of private mine sites within the Project area, however as inventoried by DRMS and CGS. These areas have been studied, and are continuing to be studied by AR and others. CGS intends to publish an open file report that captures many of the private areas shown in Figure H.1 (date to be determined – potentially 2007). We feel that the privately owned sites have been mapped, studied and inventoried. There are a few that represent potentially significant concerns and are being dealt with (by Ar, the Rico North Nonprofit and others).

Atlantic RichField Company
October 4, 2006

General Response:
The author of the Watershed Plan acknowledges the comments provided by Atlantic Richfield Company and wishes to retain their record within the document by providing them in their entirety at the end of this text.

Many of the comments critique the statements regarding water quality concerns as identified by the author's interpretation of data sets made available by SEH which reflect water quality conditions in portions of the Project area through 2004. These data sets have since evolved with the addition of available flow data, additional water quality measures and data interpretation. This Watershed Plan presents findings as they were interpreted through 2004, as well as one recently made available EPA study from 2005. The readers are referred to any available Atlantic Richfield studies which document later water quality studies still being completed to-date (e.g. SEH, no date). This document can not accommodate all data changes as identified by Atlantic Richfield and therefore refers the reader to the comments (provided at the end of this text) for discussion of any disparities that may have occurred. As per Atlantic Richfields' comments, there are additional data becoming available and further studies being completed within certain portions of the Project Area. Therefore, this Plan reflects only an historic snap shot of water quality conditions in time and does contain an amount of uncertainty with the evaluation.

In addition, there are responses to Atlantic Richfield comments provided below. The author acknowledges certain comments, but retains the position of disagreement with certain aspects of Atlantic Richfield's data interpretation. As recommended within this Plan, further data collection and analysis may be required before all questions regarding potential metals loading sources can be agreed upon.

Executive Summary Comment Responses

E-1: *The language within this paragraph was accommodated in part within the Executive Summary. We agree that the language describing the cooperation between the Town, Atlantic*

Richfield and Rico Renaissance will achieve many of the identified goals within this Plan. The authors however, will not add the final statement: "Notably, previous testing of pond sediments has shown that they are non-hazardous (based on TCLP analysis)" since we have not seen the TCLP information in order to be able to incorporate this finding.

E-2 : *Based upon the findings of this Plan, the Rico Boy and Santa Cruz adits release significant metals load. Their contributions to the Dolores River were poorly definable with the data set in-hand at the time of this Plan's production. As such, the contributions from these sources either require further study or mitigation. Some of the language was altered within the Executive Summary, however the findings remain valid with the information available at the time of the Plan's production.*

E-3: *The statement within the Plan was supported by direct observation of Silver Swan site flows which exist at high flow conditions. There exist two flow sources within the Silver Swan Site which are initially captured within riprap channels and ultimately discharge either to bank-side wetlands or the Dolores River. The references to 'tailings' were removed and rewritten to reflect waste rock. The conclusions and recommendations however were not changed since the information within this Plan support these findings.*

Section 2 Comment Responses

General Comment Response:
The overview information was provided so that this document would serve the capacity of a guidance and reference document for a myriad of watershed related topics. This was one of the goals of the document as identified by the Town of Rico within the initial scope of work. Therefore, the general information provided within the text and appendices will remain.

Response to Specific Comment 2-1.*Comment noted, however the summary provided within the Plan is a direct reflection of the CDOW report. The Plan author can not change another entity's work. It is recommended that Atlantic Richfield follow up with their comment directly with the CDOW.*

Response to Specific Comment 2-2.*Comment noted. Text was changed to reflect accurate information provided by Atlantic Richfield.*

Response to Specific Comment 2-3.*Comment noted. Text was changed to eliminate generic AMD and ARD references.*

Section 4 Comment Responses

General Comment Response:
The overview information was provided so that this document would serve the capacity of a guidance and reference document for a myriad of watershed related topics. This was one of the goals of the document as identified by the Town of Rico within the initial scope of work. Therefore, the general information provided within the text and appendices will remain. In regards to the 'factual accuracy' of the summaries; the information within the summaries was directly obtained from the original sources. One of the line items within the scope of work for this Plan, was to

obtain, reference and summarize any existing water quality studies (which a large portion of Section 4 is dedicated to). None of the information presented within these previous studies was re-interpreted. Only direct language from the studies was imported into this document.

Response to Specific Comment 4-1.*The text within the bullet statement was updated with the information provided by Atlantic Richfield. If there are gaps in the information provided with the regulatory history portion of the Plan, this may be due to gaps associated with records held by the Town of Rico. If Atlantic Richfield continues to find 'numerous inaccuracies' they are respectfully requested to provide any information that will assist with clarification. Developing a chronologic history of regulatory (or lack thereof) compliance, and St. Louis tunnel concerns was a distinct scope of work line item requested by the Town to be presented within this Plan. As such, the text will remain and can be further updated if information becomes available.*

Response to Specific Comment 4-2 and 4-8.*The language provided within Atlantic Richfield's comment was incorporated into this subsection.*

Response to Specific Comments 4-3, 4-4 and 4-5, and 4-7.*It is recognized that a significant amount of work has been completed since the time of these two historic studies in question. The purpose of this subsection was to compile the existing studies, and restate their methods and findings. The purpose was not to revisit any historic findings in relation to current studies. Atlantic Richfields' concerns in regards to these studies are acknowledged by the fact that their comments appear within this Plan. The author will not revisit the historic study findings and revise their findings in response to any other study completed. This will negate the intended purpose of this section and will add considerable uncertainty to the findings.*

Response to Specific Comment 4-9.*The initial language within the Plan that states the Silver Swan "site does contribute metals load to the Dolores River" is not inaccurate and will not be adjusted. Atlantic Richfield's assessment of 'magnitude' of impact or loading assessment is acknowledged with the incorporation of their comments into the Plan.*

Response to Specific Comment 4-10.*The seep associated with the Blaine tunnel was observed during a high flow site reconnaissance effort in 2006. Therefore the language will be retained within this subsection.*

Response to Specific Comment 4-11. *The use of the CZI was considered an additional line of evidence to help understand the cumulative toxicity potential associated with two divalent metals that typically work synergistically within aquatic systems. Hazard indices are not typically quantified for metals since metals do not always act in an additive or synergistic manner. Copper and zinc however, show a combination toxicity effect. In an effort to quantify this combination of toxicity types, the CZI is one tool by which to measure their effect. It has become an indicator of toxicity potential for mine sites in mineralized areas such as Colorado and has its own unique usefulness in characterizing the risk potential within an aquatic system.*

The data relied upon within this assessment is a compilation of databases from a variety of sources. We could not trace original data validation records and therefore had to develop our own 'qualifiers' for the data analysis. Given the fact that data analysis methods, detection limits and quality have changed over the years, it is unknown if values 'below detection limits' from historic

databases "would surely be no issue" as stated within the comment. The analysis methods, detection limits for mercury is a good example. For the purposes of this document, the 'u' denotation will remain and is indicative of an unknown value.

Response to Specific Comment 4-12. The sources of uncertainty associated with the loading analysis presented by Atlantic Richfield are acknowledged. It is stated within the Plan that there is considerable uncertainty with the analysis presented due to gaps in the data sets, deficiencies in flow measures and apparent inaccuracies in measured flow values. None-the-less, there was available enough information to garner loading assessments for certain high and low flow conditions. The purpose of the 'temporal trend' was to observe any changes of loading over time at locations that have been routinely sampled. This strategy is yet another line of evidence used to determine water quality conditions associated with the receiving drainages. The analysis presented within the Plan was checked for accuracy and reviewed. Regardless, one of the first and most emphasized recommendations from the Plan was for the collection of further, more comprehensive watershed information.

Response to Specific Comment 4-13. Comment noted and acknowledged with the incorporation of AR's comments into this Appendix.

Response to Specific Comment 4-14. Comment noted and acknowledged with the incorporation of AR's comments into this Appendix.

Response to Specific Comment 4-15. Comment noted and incorporated into associated text.

Response to Specific Comment 4-16. Comments noted and incorporated into associated text.

Response to Specific Comment 4-17– 4-33. These comments are noted and acknowledged with the incorporation or AR's comments into this Appendix. It is restated, that the water quality conclusions within this Plan were drawn from an abbreviated data set as compared to AR's more comprehensive data set. Therefore, conclusions drawn by AR/SHE could not be verified with the data at hand. In summary, the authors of this plan acknowledge the fact that there are uncertainties with the conclusions presented, and in the absence of having the time to incorporate the more thorough data recently provided by AR/SEH there will remain discrepancies in our conclusions.

Section 5 Comment Responses

General Comment Response:

As previously mentioned, the overview information was provided so that this document would serve the capacity of a guidance and reference document for a myriad of watershed related topics. This was one of the goals of the document as identified by the Town of Rico within the initial scope of work. Therefore, the general information provided within the text and appendices will remain.

Response to General Comment 5-1. Comment noted and incorporated into associated text.

Section 6 Comment Responses

Response to General Comment 6-1. Comment noted and incorporated into associated text.

Response to General Comment 6-2. Comment noted and incorporated into associated text.

Response to General Comment 6-3. Comment noted, however, as per 'Response to Specific Comments 4-17 – 4-33, the authors of this Plan can not validate AR's information. Therefore no text changes were made, and the comment was acknowledged by incorporation of AR's comments into this Appendix.

Response to General Comment 6-4. Refer to Response to General Comment 6-3, and Response to Specific Comments 4-17 – 4-33

Section 7 Comment Responses

In response to AR's comments for this Section, an introductory explanation was added to both Section 7 and the Executive Summary as follows;

As per review and comment from Atlantic Richfield it is recognized that this document contains an evaluation of water quality based upon a data set with 'recent' data gaps. As such, there are uncertainties with the conclusions drawn herein. The readers are referred to Appendix H for a listing of review comments and their suggested changes. This plan recommends that there is a need for further studies to be conducted. However it should be noted that there are ongoing studies being completed by AR for the Water Quality Assessment of the St. Louis Ponds (SEH, 2005). Therefore, any future studies should be performed in coordination with these efforts. It should also be recognized that AR (as a member of the NorthRico Non-profit) intends to address the St. Louis Tunnel discharge with appropriate treatment upgrades to meet discharge permit standards ultimately established by CDPHE. AR believes that the the analysis performed as part of the CDPHE's ongoing WQA support the position that appropriate and protective permit limits can be established for the St. Louis Tunnel discharge without specifically accounting for, or requiring mitigation of, the other point sources noted within this plan.

EXECUTIVE SUMMARY SYNOPSIS

The Upper Dolores River Watershed Plan is a characterization of the water quality and quantity within the sub-basin watershed defined geographically as:

> ***" the East Fork of the Dolores River in Dolores County, stretching from the county line with Montezuma County to Lizard Head pass and the county line with San Miguel County."***

This geographic area is referred to as the ***Project area*** which encompasses 68,747 acres, and served as the focus for this Watershed Plan. This document follows standard watershed plan guidance provided within Section 208 and 319 of the Clean Water Act. The main goals of this plan are to characterize water quality concerns and provide recommendations for the maintenance of high quality water within the *Project area* and includes summaries of;

- watershed characteristics (hydrology, geomorphology, geology, climate)
- population and land use
- stream classifications and standards
- water quality characteristics
- point and nonpoint source discharges
- watershed management recommendations

The purpose of this document is to describe the watershed features within the area, determine the point and nonpoint sources of pollution to the watershed, summarize the existing data which characterizes water quality issues and finally, identify those areas requiring further information in order to complete the watershed plan, and identify those projects the **Town of Rico** can address themselves and begin the process of improving water quality conditions. This document does NOT represent a regulatory document, nor does it serve to replace any ongoing water quality documentation efforts that are being conducted by others as part of a regulatory process. It is simply, a culmination of available information that was compiled for the Town of Rico for their interests and to achieve their goals in regards to the *Project area* watershed.

This plan documented the information which describes the water quality and quantity characteristics of the *Project area*. As a result of evaluating this information, several projects were identified in order to address data gaps and water quality concerns. Therefore, this Watershed Plan identified several areas requiring further attention;

1. The continuation of watershed planning by maintaining an active, dedicated *Project area* watershed stakeholders group, by becoming an active stakeholder to other – overlapping watershed groups and land-management projects, and by integration of this plan into the Town of Rico Regional Master Plan,

2. The further characterization of the watershed water quality, sediment quality and aquatic life in order to more fully understand water quality concern sources and impacts,

3. Control of nonpoint sources of stormwater and mine-related water quality issues, and the

4. Control of potential future point sources associated with the Wastewater Treatment plant, St. Louis tunnel, other development-related sources etc..

5. The management and preservation of sensitive stream-side (and River-side) riparian areas is key and integral to the above recommendations.

In order to address the above areas requiring attention, the Watershed Plan identifies six categories of recommended projects as follows;

1. Watershed Coordination and Continued Planning

2. Monitoring to Address Data Gaps with the Completion of a Comprehensive Watershed-scale Monitoring Program.

3. Completion of an Aquatic Ecological Risk Assessment and Regulatory Documentation (e.g. TMDL)

4. Nonpoint Source Controls (e.g. Stormwater controls).

5. Point Source Controls (for point sources of the St. Louis adit and others)

6. Preservation and Possible Enhancement of Riparian/wetlands

There are a number of funding mechanisms available that would support the recommended projects within this plan. Securing funds is a timely process and should begin immediately. The watershed stakeholders group can become responsible for tracking funding opportunities and managing any acquired. This document provides a review of available, relevant grant funding sources that qualify for the recommended projects.

In summary, this Plan characterized the setting of the Project area and identified possible projects that the Town of Rico can embark upon in order to improve water quality conditions. The next steps would entail the strengthening of a Watershed Stakeholder group that can take the lead on securing funding, begin monitoring and eventually take on projects with the nonpoint and point sources of contamination. This plan will in-turn begin to be updated and evolve as water quality conditions improve, and further next steps are identified.

Atlantic Richfield Comments

Atlantic Richfield Company

October 4, 2006

Karmen King
Grayling Environmental Consulting
18050 Road G
Cortez, CO 81321

Mike England
Town Manager
Town of Rico
2 North Commercial Street
Rico, Co 81332

Re: Comments on Watershed Plan for the East Fork of the Dolores River

Dear Ms. King and Mr. England:

We appreciate the opportunity to review the draft Watershed Plan. Attached are our written comments, which reflect our understanding that the draft Plan is subject to revision based on input received from various interested parties and that the document may be circulated again for further review and commenting before it is finalized. Atlantic Richfield Company (AR) has prepared these comments with the benefit of extensive experience and knowledge of the Rico area gained from a number of assessment projects and technical analyses undertaken over the past 10 years. A good portion of AR's efforts have focused on addressing potential water quality issues in the Dolores River near Rico. It is our interest to continue that effort, particularly working with the State of Colorado's Department of Public Health and Environment (CDPHE) as well as the Town of Rico. It is in this context that we offer these comments on the draft Plan.

The Water Quality Assessment (WQA) for the Dolores River in the Rico area has been in development for over five years. CDPHE is leading this effort, and AR is providing the necessary water quality data and technical support to assist the effort. The WQA is in the final stages of development, and it is hoped that it will be finalized in the next few months. When complete, the WQA and the extensive water quality and flow dataset upon which it is based will be the foundation for action addressing remaining water quality issues at the St. Louis Tunnel discharge and in the Dolores River through Rico.

The Watershed Plan provides a high-level review of much of the available water quality data incorporated in the ongoing WQA process, and information from various documents (including an early draft of the WQA). As discussed in the accompanying detailed comments, some of the interpretations and conclusions in those earlier documents (and reported in the draft Watershed Plan) are inconsistent with the new data collected under the WQA effort in the last few years and are thus unreliable.

For your information and consideration, AR is also providing by separate overnight delivery a CD containing pdf files of additional, recent monitoring data collected in conjunction with the CDPHE analysis, as well as a document titled "*Technical Memorandum on Proposed Approach to Complete the Water Quality Assessment for the St. Louis Ponds, Rico, Colorado*", dated August 2005. This document was prepared by AR for the CDPHE to help establish a common understanding of facts related to the St. Louis Ponds site and an approach to completion of the

WQA. By incorporating this more recent data, the analyses discussed in the Technical Memorandum and other currently available information, the Plan will be better equipped to provide a screening level evaluation of the river and potential impacts to the river from various sources. We believe that should be the goal of the Watershed Plan – to serve as a planning tool that provides a framework for the Town's reference in evaluating future land use decisions for the riparian corridor and interacting with other government agencies that have primary responsibility for regulation of water quality and water rights on the river.

We offer the attached comments for your consideration in updating and revising the draft Plan. In revising the Plan, we also suggest that less emphasis be given to recommendations for extensive future water quality monitoring. In AR's view, the Plan should defer to CDPHE's expertise and the results of the WQA as the basis for evaluating future monitoring requirements, for guiding water treatment for the St. Louis Ponds discharge and for other regulatory decision making. We also encourage the Town of Rico to continue to support the completion of the WQA, in order to move toward actions that will provide further protection to the Dolores River.

If you have any questions or comments, please call me at (406) 723-1813.

Sincerely,

Chuck Stilwell, P.E.
Environmental Manager

cc: Eric Heil
Robin Bullock
Asteghik Khajetoorians, Esq.
Bill Duffy, Esq. (DGS)
Doug Yadon (SEH)
Bill Kelly (SEH)

File: Rico Project Files – External Correspondence
Chron

Comments on

Draft Watershed Plan for the East Fork of the Dolores River in Dolores County

August 17, 2006

Prepared by Atlantic Richfield Company
October 4, 2006

We appreciate the opportunity to provide comments on the Watershed Plan, and we welcome the opportunity to discuss our suggestions, if there is interest. Comments are listed and numbered sequentially based on the Section numbering in the Plan. Plan citations are provided and source page/paragraph are listed followed by relevant comments. Comments are provided largely to clarify site history and existing conditions, and suggest alternative interpretations of some of the data and conditions in the watershed.

As a global general comment, Atlantic Richfield Company is incorrectly identified as "ARCO" throughout the Plan. Although Atlantic Richfield Company was formerly known as "ARCO," that acronym has been changed, and it now refers solely to a brand of gasoline which is owned and sold by affiliated companies, not by Atlantic Richfield itself. The correct reference for Atlantic Richfield Company throughout the Plan should be either "Atlantic Richfield" or "AR."

EXECUTIVE SUMMARY

E-1: **Citation:** 8th page, paragraph labeled "1. For the St. Louis Tunnel and discharge outfall":

Comment: The point of the paragraph can be more succinctly stated as follows: "The Town should continue to cooperate with Atlantic Richfield and Rico Renaissance – particularly through the formation and operation of the NorthRico non-profit organization – in moving towards an effective treatment strategy for the tunnel and associated ponds system. As treatment and solids management technologies are implemented, further investigations should be performed in accordance with CDPHE recommendations or requirements to confirm their effectiveness in diminishing metals loading to the Dolores River. Notably, previous testing of pond sediments has shown that they are non-hazardous (based on TCLP analysis)."

E-2 **Citation:** 8th page, paragraph labeled "2. For the Santa Cruz/Rico Boy Adits": *"It appears that the existing passive treatment procedures for these combined flows are not sufficient to address the water quality concerns. Significant amounts of metals are still being released to the Dolores River as a result of these flows."*

Comment: These areas have been monitored as part of the ongoing WQA process. The effect of minor loads such as this has been considered in the Colorado Department of Public Health and Environment's ongoing WQA process for the St. Louis Ponds discharge. This analysis reveals that any metals loads contributed to the Dolores River system from the Santa Cruz/Rico Boy Adits, as well as other minor sources in the area, are not significantly affecting Dolores River water quality and do not indicate a need for mitigation.

E-3 **Citation:** 8th page, paragraph labeled "3. For the Silver Swan Adit": *"There are two 'flowing' features associated with the Silver Swan Site, the flows from the adit provide a significant metals load to the receiving wetlands. There is also, flow associated with the captured nonpoint tailings seep and stormwater collection system. These flows are routed to a settling pond and released at a distinct point to the Dolores River. The water quality associated with this point release does not appear to have been studied. The amount of metals contribution associated with the Silver Swan site needs further evaluation. Cursory information gained from the water quality analysis does indicate that there is a concern and the need for additional remedy efforts."*

Comment: See comment to Citation E-2. The conclusions and recommendations in this section do not appear to be supported in the Plan. In addition, historic monitoring has indicated minimal and infrequent discharge of flow or metals from the wetlands associated with the adit to the Dolores River. Whenever flow is observed at the wetland discharge to the river during a sampling event, that flow is measured, sampled and analyzed. The material consolidated, graded, riprap-protected and covered at the site is waste rock. We are unaware of tailings or a tailings seep or waste rock seep at this location.

SECTION 2: REGIONAL OVERVIEW OF THE DOLORES WATERSHED

General Comments: This section includes extensive background information on Project Area characteristics. Some of this information (*e.g.*, geography and regional geology) does not appear to be relevant to the goals of, and analyses presented in, the Plan. Atlantic Richfield recommends that this section be shortened and that it focus on matters more directly related to water quality and water usage issues within the Project Area itself. Similarly, the overview of water law is somewhat cursory and incomplete, and probably not relevant to the analysis. Atlantic Richfield recommends that it be deleted.

Specific Comments:

2-1: **Citation:** Page 18, Section 2.5.2, 2nd bullet: "*there is little evidence of natural reproduction of trout at this station – fingerling brown trout and catchable size rainbow trout are stocked here. Heavy metals pollution from the Rico area is probably the limiting factor" (CDOW, 2006)"*,

Comment: This conclusion by CDOW appears to be contradicted by the fact that metals concentrations in the Dolores River in the area of Rico meet existing Class I – Cold Water Aquatic Life stream standards under all flow conditions.

2-2: **Citation:** Page 19, Section 2.6, last paragraph: "*In 1926 a custom mill was built by International Smelting Company, a subsidiary of Anaconda Mining Company.*",

Comment: International Smelting Co., as a subsidiary of Anaconda Copper Mining Company, did not construct a mill but leased and remodeled the Pro Patria mill in 1926.

2-3: **Citation:** Page 30, Section 2.9, 2nd paragraph in part: *"The primary issue associated with these mining-related settings is with the production of acid rock drainage (ARD) or acid mine drainage (AMD) which affects the pH and metals content of the receiving waters."*

Comment: Although this statement is generically true, it does not necessarily apply currently in the Rico area. Extensive monitoring by Atlantic Richfield Company (especially over the past 6 years) and others indicates that the St. Louis Ponds discharge, which has a near neutral pH, is a principal source of metals loading to the Dolores River in the Pioneer Mining District. However, this monitoring also demonstrates that even with that loading, metals levels in the Dolores River do not exceed existing stream standards. Furthermore, the monitoring does not indicate any quantifiably significant effect of the other minor seeps/discharges on the pH or metals content of the Dolores River.

SECTION 4: WATER QUALITY ASSESSMENT

General Comments: Once again, background information in this Section not directly relevant to the analysis (*e.g.*, the Federal and State Regulatory Overview sections) should be shortened or removed. Also, the historical summaries contain inaccurate information and cover topics unrelated to water quality evaluations. If retained, the factual accuracy of these summaries should be verified and extraneous or incorrect information removed.

Specific Comments:

4-1 **Citation:** Pages 10-11, Section 4.3.2, 1st bullet

Comment: The descriptions of historical events, past ownership and legal proceedings in this sub-section contain numerous inaccuracies. For example, there were actually two consent decrees with RDC and its principles, the referenced lawsuit was brought by both the United States and the State, and we do not believe that Atlantic Richfield was identified as a "primary potential responsible party for the plant and permit" in either decree. This discussion (beginning with the third sentence of this bulleted paragraph, and including the

sub-list of regulatory proceedings) is not pertinent to the topic of water quality evaluations and should be deleted.

4-2: **Citation:** Page 12, Section 4.3.2, 2nd bullet on page: *"The assessment included seven point-source discharges in the area. Results indicated that during times of low flow, zinc can pose a water quality concern."*

Comment: The referenced assessment was a draft document containing numerous assumptions given the significant data gaps at that time. Since release of the 2001 draft, substantial additional data and related analyses have filled many of those data gaps. These analyses indicate that discharges other than the St. Louis Ponds are not directly relevant to the WQA for the Dolores River at the St. Louis Ponds and that the river water quality will be protected by the anticipated discharge permit limits at the St. Louis Ponds. The revised WQA that is presently being prepared by the CDPHE will address discharge standards that must be met at the St. Louis Ponds and will serve as the basis for the design of a water treatment (lime addition) system for the St. Louis Tunnel discharge. It is significant to note that the now extensive available data indicate that not only do the minor discharges not contribute significant loadings to the Dolores River, but that the river meets existing instream water quality standards even without the additional treatment of the St. Louis Ponds discharge.

4-3: **Citation:** Page 13, Section 4.3.2, first full paragraph on page: *"At the time of the USEPA, 1994 historic site investigation, an estimated 75 acres of tailings piles and settling ponds occurred along both the Dolores River and Silver Creek, with an unknown amount of tailings moved into town as street cover. The source areas were estimated to contain 400,000 tons of material. In 2003, the USEPA evaluated if mine waste material was impacting the Dolores River, Silver Creek, and ground-water potable supply aquifer areas. A human health risk evaluation was completed. Results indicated that lead occurs at elevated levels in the Dolores River corridor and in certain neighborhoods near the historic smelters."*

Comment: Detailed geologic mapping and sampling by Atlantic Richfield Company in the Town of Rico as part of the ongoing soil lead VCUP indicates that mine waste is generally identifiable and present in discreetly mappable locations, commonly in the vicinity of the three historic mines, one mill and two small smelters in or near town. The mining wastes in the residential areas of town and locally incorporated as fills and/or surfacing of some portions of the unpaved streets in town are almost everywhere waste rock and not tailings. Minor remnant tailings and waste rock are present at a few locations in the east overbank of the Dolores River floodplain between the Pro Patria mill site and the previously remediated Columbia Tailings site. Very minor slag deposits are locally present south of the Columbia Tailings site in the general vicinity of the Pasadena smelter (of which no traces can be found today) and the reclaimed Grand View Smelter site. The human health risk evaluation by EPA referenced in the citation above found no hazard to the residents of Rico from any metals (including lead) relative

to exposure to surface or groundwater. In 2006 Atlantic Richfield Company completed a comprehensive human health risk assessment for lead in soils in Rico, which has been reviewed and recently approved by CDPHE. Clean-up of residential properties with elevated soil lead concentrations began in 2004 and is ongoing.

4-4: **Citation:** Page 13, Section 4.3.2, final paragraph on page: *"The results showed Silver Creek to be a major, but not the only, source of mercury and other heavy metals in the upper Dolores River Basin."*

Comment: The conclusions cited from USBR sampling between 1989 and 1993 have not been borne out by extensive surface water monitoring by Atlantic Richfield Company from 2002 to 2006, especially in regard to mercury. In particular, during the Atlantic Richfield high-flow sampling event in 2005, sample analysis showed the highest mercury concentrations monitored during this period in the Dolores River (yet below stream standards) were above the Pioneer Mining District with minimal change from above the St. Louis Ponds to below the Silver Swan Mine. This result appears to agree with the findings cited on page 20 of the Watershed Plan from the URS, 2006 documents. During the same 2005 sampling event, the total mercury loading monitored in Silver Creek at its confluence with the Dolores River was less than five percent of the total load in the Dolores River. Additional monitoring data within Silver Creek were not available to establish that the source was outside the Pioneer Mining District as was the case on the Dolores River itself.

4-5: **Citation:** Page 15, Section 4.3.2, final paragraph on page: *"The sediment data show Silver Creek to be the major source of heavy metals, including mercury in the upper Dolores River basin."*

Comment: See comment to Citation 4-4 above.

4-6: **Citation:** Page 16, Section 4.3.2, 2nd paragraph: *"ARCO has been the responsible party for the former tailings piles due to the purchase of Anaconda Minerals during the 1980s."*

Comment: This statement is inaccurate and irrelevant to the analysis. It should be deleted.

4-7: **Citation:** Page 17, Part 4.3.2, 2nd bullet on page: *"Efforts to identify smelter products were inconclusive and more study is required to assess historic smelter impacts."*

Comment: The *Rico Townsite Soils VCUP Project Final Data Report and Data Evaluation, Volume I (Atlantic Richfield Company, 2006)* presents data and detailed statistical analyses that conclusively demonstrate that soil lead in the Rico Townsite is not the result of smelter emissions.

4-8: **Citation:** Page 18, Part 4.3.2, final paragraph on page: *"In 2001, CDPHE WQCD performed a water quality assessment at the request of ARCO, to assess potential permit limits for the Rico-Argentine mine drainage. The assessment collected new data and compiled previously collected surface water data from locations within the Project area. The assessment included seven point-source discharges in the area. Results indicated that during times of low flow, zinc can pose a water quality concern. These results were contested by ARCO. Table 4.7 presented the loading estimates provided by CDPHE for the seven point-source discharges. The findings of the assessment indicate that the combined point source discharge contributions exceed the stream's assimilative capacity (of 4.95 lbs/day) by 31.6 lbs/day. The sampling was performed during low flow conditions of the Silver Creek and Dolores River, and indicated that the capping performed by ARCO on the various former tailings piles has not eliminated the leaching from these former tailings piles and is still contributing metals loading under low flow conditions. ARCO has disagreed with the CDPHE findings and no permit application has been submitted for the adit discharge to date. The data collected by CDPHE was integrated into SEH's comprehensive data set."*

Comment: See previous comment to Citation 4-2. Additionally, the reader should be aware that the conclusions presented in the letter accompanying the draft WQA (particularly the conclusion that there were 31.6 lbs/day of excess zinc loading) were not supported by the WQA calculation/spreadsheet, the draft text document, or actual measurements during periods of low flow in the Dolores River. (Refer to Figure 4.7 in the Watershed Plan for an example of actual zinc loading during an extreme low-flow period.) The conclusion that there was a large excess zinc loading was a supposition based on modeling that was later found to be incorrect after thorough analysis of extensive, directly relevant water quality data collected by Atlantic Richfield Company over the period of 2002-2006 to support the ongoing WQA by CDPHE. The referenced draft WQA comment is no longer considered valid by the CDPHE. Calculations in the draft WQA were based on limited to no data during low flow conditions and incorrectly identified various small sources as much greater contributors of metals loading than subsequent low-flow sampling and analyses indicate. The source of the very minor metals loadings to the Dolores River from the VCUP remediated sites is not through the reclamation covers, but rather adit discharges or groundwater seeps. Any references made in the Watershed Plan to the draft WQA should be qualified in light of the analyses performed since it was first prepared, and the draft WQA should not be relied upon for making quantitative water quality determinations.

4-9: **Citation:** Page 24, Section 4.4.2, 6th bullet on page: *"Silver Swan Adit has had a VCUP involving the consolidation of mine waste, capping and routing of adit flows to a wetland associated with the Dolores River. The site occurs below gradient to the Rico Boy/Santa Cruz site. The site does contribute metals load to the Dolores River."*

Comment: See prior comments on Citations E-3 and 4-2. During the period of intensive monitoring by Atlantic Richfield, the site has had only very minor and infrequent surface water discharge to the Dolores River. Any loading from this site would be too minor to have a measurable impact on the Dolores River. Considering the limitations of in-stream flow measurements and sampling/analysis described later in the comment to Citation 4-12, any such loading could not be detected by sampling/analysis differences above and below the site.

4-10: **Citation:** Page 25, Section 4.4.2, 3rd bullet on page: *"The Blaine Tunnel feature had an historic adit release up until it was plugged thereby rerouting the adit discharge to the St. Louis. This tunnel currently has a slight seep which discharges as a nonpoint source to the Silver Creek basin. Current conditions of seep discharge water quality impacts to Silver Creek are unknown but considered to be slight given the low magnitude of release."*

Comment: The prior leak in the Blaine tunnel bulkhead has been sealed, thereby eliminating the referenced "slight seep" discharge from the Blaine tunnel workings above the bulkhead.

4-11: **Citation:** Starting on Page 26, Section 4.4.3 re: discussion of use of hazard quotient (HQ) and copper-zinc index (CZI)

Comment: We suggest that consideration be given to eliminating the presentation and use of CZI as it is potentially misleading and appears to be redundant to the use of the HQ evaluation. We understand the CZI to be a general indicator of water quality with respect to metals impacts from either copper or zinc. Because the HQ already compares appropriate parameters (including copper and zinc) to their standards for all of the water sources, the CZI does not appear to add any new insight, but does have the potential to confuse the reader. Confusion can arise by suggesting that a low level of copper is an issue when the CZI exceeds the threshold solely due to zinc (e.g., the statement on page 27 that "*results provide a conceptual indication of source areas that lend potentially toxic levels of copper and zinc*" is incorrect and misleading in suggesting that copper is potentially at issue).

Whether or not the CZI approach is retained, we suggest that the tables in the Plan include a name or other brief description of the site so that a clear distinction is made and it is easy to understand when a point source is being evaluated (which is not itself the subject of the cold water, Class I standards) versus the Dolores River or Silver Creek. It would also be helpful to the reader's understanding to calculate the HQ or CZI (if retained) for samples which had a concentration less than the method detection limit (u for undetected). Those samples would clearly have a HQ of zero and would not be a concern; whereas leaving the evaluation

with an "unknown" may create uncertainty as to the water quality (i.e., if all analysis showed "u" there would surely be no issue).

4-12: **Citation:** Starting on Page 28, Section 4.4.4, "General Trends"

Comment: General comments for all load evaluations along the Dolores River and Silver Creek follow.

The value and relevance of the "temporal trend" analyses is unclear. If it is an attempt to determine loading changes/trends since 1997, it seems irrelevant since there has been no change to the potential loading sources between 1997 and the present. The potential sources of Zn, Mn and Fe – both natural and otherwise – have been in the area for a long time and no measurable change is expected over the short period of time analyzed.

In general, any single measured instantaneous flow at a given site should be used with caution in calculating and assessing loading changes between sites for the following reasons:

- There is typically a significant lag time between when a flow at one location reaches a downstream location.
- Measurements and sampling are completed starting downstream and progressing upstream along the river reach to avoid disturbing sampling; therefore, the same flow wave is not being sampled at the various sites.
- Any given flow measurement is subject to considerable error due to normal measurement tolerances, compounded with the irregularity of the river bottom.
- There are frequently days which have considerable diurnal variation in flow throughout this section of the river, making it impossible to make exact comparisons since flow changes significantly even at a given site throughout the day.
- Flow measurements are often taken on different days due to the length of time required to complete sampling at all of the sites.

Measurements are of most value when evaluating trends and relationships where sufficient multiple occurrences are considered to compensate for the normal variations encountered in any given measurement.

We have not endeavored to check the headings, data and/or calculations in all tables and figures in the Plan; however, during the course of the review we have examined some of the information in the tables and figures and its interpretation and found errors in tables and inconsistencies between interpretations presented in the text and information presented in the tables and figures. Although we do not believe it is appropriate to draw conclusions between individual measurements of loading (for the reasons cited directly above), if that approach is retained, then all

of the tables and figures should be checked and corrected and interpretations and conclusions in the text modified accordingly.

4-13: **Citation:** Page 29, Section 4.4.4, 1st bullet on page: *"**For the year of 2003 – Table 4.15**: Data was available for fall, low flow conditions only. From the tunnel location to the outfall, concentrations of cadmium, chromium, copper, iron, lead, manganese and zinc decrease, while concentrations of mercury, nickel, selenium and silver increased (along with hardness). These increases were slight, yet highlight the unique water chemistry associated with these elements. It is possible that pH in the various ponds could have affected the solubility of these elements. It is also possible that the analytical results are at levels low enough to cause analytical error. Regardless, the released concentrations of mercury, nickel, selenium and silver at the outfall are not of concern in regards to their concentration and thus, potential effect to aquatic life."*

Comment: Mercury concentrations in sampling completed along the Dolores River and at the St. Louis Ponds have been reviewed in relationship to detection of mercury in field blanks. It should be noted that the level of mercury in the St. Louis Ponds discharge has actually been less than that in associated blanks which, according to EPA guidance for Method 1631 ultra-low level analytical procedures employed, suggests that the slight rise noted in the above citation was based on invalid data. Note that the situation with regard to mercury blanks may be relevant to other discussion of mercury in the Plan.

4-14: **Citation:** Page 29, Section 4.4.4, 1st full paragraph on page: *"The amount of 'load' however [from the settling ponds], needs further evaluation. In addition, the potential settling pond sediment release is a point of consideration since over-topping, or breaching of the settling pond berms would release significant precipitated metals from the ponds to the Dolores River. This condition was previously observed (year) and remains a potential threat to the Project area. [clarification in brackets added]"*

Comment: The focus of the ongoing WQA by CDPHE for the St. Louis Ponds has been to identify the metals loads that can be released under a discharge permit and still be protective of the Dolores River. As noted previously, this effort is anticipated to be completed sometime in 2007.

Atlantic Richfield has taken steps to alleviate the potential for overtopping of the berms, enhance spillway protection and control beaver activity within the site (which was largely responsible for the earlier condition observed).

4-15: **Citation:** Page 29, Section 4.4.4, subsection titled "Silver Creek"

Comment: Analyses performed as part of the St. Louis Ponds WQA indicate that appropriate and protective permit limits can be established for the St. Louis Ponds discharge without specifically accounting for the metals loadings from Silver

Creek to the Dolores River (like the minor seep/adit loadings discussed elsewhere) . It is also recognized that there is a TMDL process initiated for Silver Creek that will appropriately examine water quality issues and identify potential best management practices.

4-16: **Citation:** Page 30, Section 4.4.4, bulleted text

Comment: This comment addresses several separate issues in the text cited above. First, SVS-22 is a sampling station in Silver Creek above the Argentine Tailings Seep – not the seep; SVS-12 is the Argentine tailings seep at its source.

Second, it would be helpful to the reader to clarify what is meant by metals "spikes". It is unclear to us what the "spike" concentration or load is relative to, and whether temporal and/or location differences are implied.

Finally, although the concentrations of metals discharged from the small adit at SVS-26 are elevated, the actual loadings from this source are relatively small as compared to the loads in Silver Creek. For example, the loadings of zinc and cadmium are on average less than 2 percent of the total load in Silver Creek.

4-17: **Citation:** Page 31, Section 4.4.4, 1st bullet on page: *"**For the year of 2002- Table 4.20, and Figures 4.7 and 4.8** Distinct spikes in iron, manganese and zinc are observed during both high and low flow conditions for the Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet, and the Silver Swan adit. Significant copper releases occur during high flow indicating a surface water carriage/source related condition, while cadmium demonstrates a chemistry that appears to be groundwater related (and of concern during low flow conditions)."*

Comment: Conclusions in this paragraph are not supported by the cited data in the Plan. The inferred source of the copper and cadmium releases is unclear in the text. Based on cited data for the Dolores River, metals "spikes", or increased concentrations or loads, have not been observed. Furthermore, the loadings of copper and cadmium to the river from the adit/seep sites are low to non-existent during the extensive sampling conducted by Atlantic Richfield in 2002-2006. Finally, our evaluation of both low and high flow conditions has not identified times when copper concentrations have exceeded stream standards for the Dolores River, or when these minor sources have had any measurable affect on cadmium concentrations in the river. Specifically, cadmium was not detected at any of the sampled sites on the Dolores River below DR-1 during the very low flows in July 2002.

4-18: **Citation:** Page 31, Section 4.4.4, 2nd bullet on page: *"**For the year of 2003 - Table 4.21 and Figure 4.9** The St. Louis tunnel and settling pond outfall contributes cadmium, chromium, iron, manganese, mercury and zinc to the Dolores River. Distinct spikes in iron, manganese and zinc are observed for the Columbia tailings seep, Rico boy/Santa Cruz wetlands outlet, and the Silver Swan*

adit. Cadmium and zinc also demonstrate a spike at the Rico Boy/Santa Cruz combined flow outfall. Increased concentrations of copper were associated with the Columbia and Silver Swan adits."

Comment: The conclusions drawn in this section of the Plan are not supported by the cited data. See prior comments to Citation 4-13 relative to absence of mercury from the St. Louis Ponds system discharge. The basis for the comment regarding "*increased concentrations of copper…*" is unclear. In Table 4-21 of the Plan copper concentrations at the Columbia and Silver Swan adit discharges are very low and less than the otherwise low concentration in the river, and thus would not be a source of increased concentration in the river. Furthermore, the flow from the Silver Swan adit is so small that its relatively low copper concentration could not be providing a measurable increase in load to the river, and only a small fraction of the adit flow has been observed very infrequently to discharge past the local wetland to the river.

4-19: **Citation:** Page 32, Section 4.4.4, 1st full bullet on page: *"**For the year of 2004 – Table 4.22 and Figures 4.10 and 4.11….** In general, metals gain in concentration above the Silver Creek confluence, are significantly increased by the Silver Creek confluence, and then gain/lose over the remaining length of the River in relation to nonpoint and point source discharges associated with the Columbia, Rico Boy, Santa Cruz and Swan mine areas."*

Comment: These conclusions are not supported by the cited data in the Plan, and cannot be relied upon due to the factors discussed in the comment to Citation 4-12. DR-7 is the Dolores River site above Silver Creek and DR-2 SW is the site below Silver Creek. Comparing the data for 2004 for these two sites, as cited above, we are unable to identify a consistent increase between these points just above and below Silver Creek. Rather, we see concentrations which are at times greater above the confluence and at times greater below, consistent with the typical sampling results variation that may occur at a given site (e.g., in one event zinc dropped from 29 ug/l to 20 ug/l going from DR-7 to DR-2-SW, and in the next event it increased from 170 ug/l to 180 ug/l, with neither apparent change being significant). We are also unable to see the referenced gain/loss in metals concentrations relative to other sites along the Dolores River as the only other Dolores River station below Silver Creek with data in Table 4.22 is that at DR-4-SW below Silver Swan and it did not show consistent changes from DR-2-SW. This comment also applies to other periods evaluated in the Plan.

4-20: **Citation:** Page 33, Section 4.4.4, 1st bullet on page: *"Results for the St. Louis outfall and tunnel indicate that copper and zinc levels are of potential concern at both the tunnel and the outfall. These results are consistent each year and coincide with the HQ results previously described."*

Comment: Although zinc levels in the St. Louis discharge (without active treatment) have been greater than associated standards per the HQ analysis

presented, the Dolores River below the St. Louis area has met zinc water quality stream standards under all sampled flow conditions, including flows essentially at regulatory low-flow levels. Copper has never been a water quality concern in the Dolores River nor in the current discharge. Copper concentrations in the St. Louis Ponds discharge are quite low, and are always much lower than the stream standard for the Dolores River. Contrary to the above citation, the HQ results in Tables 4-14 through 4-16 show no risk for copper at the outfall and for the tunnel only one value of four had a HQ ratio as great as 1. According to the information in the Plan, the HQ ratio would have to have been between 2 and 10 to be classified as "uncertain potential for risk" and greater than 10 to indicate a potential for risk. This is an example of where the CZI methodology results in an unfounded concern for copper.

4-21: **Citation:** Page 33, Section 4.4.4, 2nd bullet on page: *"Results for Silver Creek highlight the need to further evaluate the unnamed adit (identified by SEH as being located below the overhead tramway) and the Argentine seep. Consistently elevated levels are associated with both of these locations."*

Comment: Refer to the prior comments on Citation 4-16 regarding the minimal metals loadings from the unnamed adit.

4-22: **Citation:** Page 33, Section 4.4.4, 3rd bullet on page: *"Results for the Dolores River sampling areas indicate that there is a need to evaluate the copper and zinc releases associated with the Rico Boy/Santa Cruz outfall areas. The measured values yield CZI levels above 1 every year where sufficient information was available."*

Comment: See the comment to Citation 4-11 regarding the CZI methodology used in the Plan.

4-23: **Citation:** Page 34, Section 4.4.4, 3rd bullet on page: *"**Zinc**: Comparison of zinc load from the upstream to downstream location has shown increased load during all years (1997, 2002, 2003 and 2004). The year 2002 demonstrated a significantly low rate of increased load. Similar to iron and manganese, this may be attributable to the affects related to the drought. The years 1997 and 2003 had similar measures of load increase indicating that there has been little to no measurable decrease in load over this span of time."*

Comment: See comments to Citation 4-12 above. Although we do not endorse the approach of using individual measurements to assess changes along the river between sites or from year to year for the reasons cited previously, this is one example where correcting the tables could lead to a different conclusion. For 2003 (cited in the last sentence) the change between the two sites per Figure 4.9 was a decrease from 130 ug/l (11 ppd) to 110 ug/l (10 ppd) from DR-2 to DR-4-SW, not an increase. If Table 4.24 is corrected for 2003 (i.e., the subtraction of the value in the DR-2-SW column from that in the DR-4-SW column) it would

show a decrease of 0.11 lbs/cfs (not an increase of 0.29), and the data could be used to conclude that there was a decline in zinc from 1997 to 2003 – although we disagree with using the data in that manner.

4-24: **Citation:** Page 35, Section 4.4.4, 2nd paragraph from bottom of page: *"The July results from the lower Dolores River capturing the Rico Boy/Santa Cruz (combined adit release) and Silver Swan indicate that these two point sources are potentially significant sources of zinc load, however the percent contribution could not be determined due to a lack of flow measurements at points downstream of these releases."*

Comment: These potential sources result in very low metals loading to the Dolores River. Loading from the Rico Boy/Santa Cruz combined adits and the Silver Swan adit, respectively, were 0.35 ppd and 0.19 ppd in the July sampling event cited. The concentration of zinc in the Dolores River on that day was an extremely low value of 10 ug/l. At the Santa Cruz site, the loading leaving the wetlands and entering the Dolores River (0.01 ppd) was less than 3 percent of the 0.35 ppd discharged from the combined adits. This loading was thus only on the order of 0.1 percent of the loading in the river.

Also, the conclusion that "percent contribution could not be determined due to lack of a flow measurement" should be reconsidered. A sample was not taken at the outlet from the wetlands at the Silver Swan, but it is usually zero discharge (no water flowing) under such low flow conditions. An obvious alternate conclusion is that "there is little or no contribution from the Rico Boy/Santa Cruz to the Dolores" due to no surface flow reaching the river. Another obvious conclusion is that these loadings did not have a material effect on the Dolores River as evidenced by its extremely low concentration of zinc at DR-4-SW of 10 ug/l (compared to the stream standard of 289 ug/l).

4-25: **Citation:** Page 35, Section 4.4.4, final paragraph on page: *"Results from the St. Louis tunnel and outfall indicate that the tunnel is a significant source of zinc. Due to the lack of zinc data below the outfall (from DR 7) the load contribution to the Dolores River could not be determined. Review of sample results around the confluence of silver Creek identify an error in the flow measurements. There is roughly a 5 lb contribution of zinc that is unaccounted for between the Silver Creek outfall, and the sampling point representing the Silver Creek mixing zone (2-SW). The October results from the lower Dolores River capturing the Columbia tailings, Rico Boy/Santa Cruz (combined adit release) and Silver Swan indicate that these sources contain significant metals load, but it is controlled by the wetlands which buffer their release to the Dolores River. Results from the October Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient, but remains a significant source to the Dolores*

River with a percent contribution of zinc at 25% 2.19 lbs of 8 lbs measured at DR-2-SW)."

Comment: Refer to the comment for Citation 4-12. On the referenced sampling date, zinc at DR-7 was undetected at a MDL of 10 ug/l, implying that the concentration was less than 10 ug/l in the Dolores River. After review of the data for that event, we are unable to identify the inferred flow measurement error and assume the problem with the mass balance is a compounding of measurement and analysis tolerances as discussed in part under the comment for Citation 4-12. The discussion on the unnamed adit as contributing a significant zinc load is incorrect. Figure 4.8 correctly shows the load from the unnamed adit at 0.04 ppd which is only 0.5 percent of the total load at DR-2-SW (not 25% as stated in the Plan); the load in Silver Creek above the unnamed adit is noted at 2.04 ppd at SVS-8 on the figure (i.e., nearly all of the load at the confluence with the Dolores River). The 2.19 lbs cited is the total load from Silver Creek to the Dolores River, not the load contributed by the unnamed adit. Note that the zinc concentration at DR-2-SW during this sampling event was again very low at only 40 ug/l.

4-26: **Citation:** Page 36, Section 4.4.4, 1st bullet on page: *"**For the year of 2003**: **Figure 4.9** demonstrates the change in iron, manganese and zinc load at each sampled location during low flow. There are uncertainties associated with the data sets from 2003 as follows;*

- ***Only one sampling event representing low flow conditions was captured**. This sampling event blended from October through December which introduces a temporal uncertainty. The sampling likely represents several time periods and may have limits to its comparability.*
- ***For the 2003 data set, there is a lack of flow information for key locations which bracket the water quality footprint of effects associated with the St. Louis tunnel** (missing flow data for DR 20 and DR 2, and zinc analysis for DR 20 and DR 2).*

For the October through December, 2003 sampling event results for the upper Dolores which captures the St. Louis ponds were lacking information for sample points adjacent to the ponds…. Review of sample results around the confluence of Silver Creek identify Silver Creek as a significant contributor of the zinc load within the Dolores River immediately below the confluence. Silver Creek supplies 5.65 lbs of the measured 11 lbs, contributing 51% of the load...Results from the Silver Creek analysis indicate that there is a steady gain in load of metals (in particular iron, manganese and zinc) over distance and is related to the Argentine Seep and the unnamed adit. The unnamed adit, with its very slight flows, contributes a significant load to the Silver Creek system. The load dilutes progressively down-gradient."

Comment: There were two separate sampling events in 2003, the first occurred in late October extending into early November, and the second occurred in early

December. Flow and results of zinc analysis for DR-2 are available for both sampling events. DR-20 is only sampled intermittently and was not sampled during those two events. If retained, it is suggested that Figure 4.9 be replaced by two separate figures and conclusions in the Plan narrative be reviewed and corrected if/as necessary. See also comments under Citation 4-12 relative to the reliability of conclusions drawn from the type of analysis presented in Figure 4-9 (and other similar analyses).

There appears to be a contradiction in the text between "*there is a steady gain in load"* and *"The load dilutes progressively"*. See also the comment for Citation 4-16. Note Figure 4.9 shows the zinc load for the unnamed adit at 0.07 ppd compared to a total load of 6 ppd in Silver Creek at the confluence (i.e. approximately 1.1 percent).

4-27: **Citation:** Page 37 through the top of page 39, Section 4.4.4, 1st bullet on page: *"**For the year of 2004: Figures 4.10 and 4.11**"*

Comment: The previous detailed comments relative to the Plan discussions of temporal and individual annual and location trends in the comment to Citation 4-12 (among others) are generally applicable to this citation. The narrative discussion in this citation further highlights the challenges and questionable conclusions associated with the type of loading analyses attempted in the Plan.

4-28 **Citation:** Page 39, Part 4.4.4, 1st bullet on page: *"The St. Louis settling ponds are losing water to either or both the Dolores River or the groundwater. As shown in **Tables 4.25 and 4.26** there are measured flow losses between the tunnel (DR 3) and the point of discharge (DR 6) to the Dolores River. As shown in **Table 4.25**, the amount of flow loss ranges from 38 to 85 % and indicates that the ponds are not capturing and containing all of the tunnel flows. It is unknown of the waters are seeping directly from the ponds to the Dolores River, or into the underlying groundwater which will also release to the Dolores River. This is a significant concern given the water quality associated with the tunnel water. These results indicate that the St. Louis tunnel and associated settling ponds are a potentially significant contributor of metals load to the Dolores River. As shown in **Table 4.26**, there is a metals load loss that is likely, largely attributable to the settling ponds, but also may be an indication of load lost to the Dolores River. These results indicate the need for addition remedy efforts to capture and control the tunnel water."*

Comment: Available water quality data show that existing water quality standards are met in the Dolores River adjacent to and downstream throughout the study area. In addition, the metals loading from the St. Louis Tunnel will be addressed/controlled once the planned treatment system is in place, further improving the water quality in the Dolores River. See also comment for Citation E-1.

We suggest use of the term "removal" rather than "loss" when referring to reduction in metals across the treatment ponds which occurs due to precipitation and settling. In addition, there appear to be inconsistencies in column headings and table entries in Table 4-26 (e.g., the data/calculation entries for 2002 and 2003 are the same for table 4-25 and 4-26 and the heading of "Flow Loss" in Table 4-26 is incorrect).

4-29: **Citation:** Page 39, Section 4.4.4, 2nd bullet on page: *"The Rico Boy/Santa Cruz mine sites have had a VCUP action that has consolidated the mine waste, capped the materials and tried to control adit flows as well as run-on and run-off Stormwater flows. At the time of the production of this document, these sites were visited and observed during both high and low flow settings (further described in* ***Sections 6 and 7****). The adit flows from these two mines, are combined and routed into a singular settling pond. From there, the flows go into a well-vegetated wetland before entering the Dolores River. This setting creates a combination of both point and nonpoint sources of water contamination as related to these sites. The water quality information indicates that the settling pond and wetlands are serving as a good buffer to controlling metals releases from the mines to the River. Wetlands however, have a seasonal limitation during winter conditions when the vegetation dies back and can not serve as a buffering capacity. The water quality released from these mines is of concern and is causing degraded water quality within the Dolores River. This system needs to be further evaluated and reviewed in regards to the effectiveness of the current remedy."*

Comment: See comments to Citations E-2 and 4-2. Also, water quality data collected since 1997 suggest that there is significant "buffering capacity" (i.e., natural metals reduction) in this existing system, even in the winter. As a check of wetlands performance, a review of dissolved zinc in the wetlands discharge for the period 1997 through 2004 (the dataset utilized in the Watershed Plan) was completed. The data showed an average winter (months of December through March) discharge concentration from the wetlands of 137 ug/l (well below stream standards), with a maximum concentration of 231 ug/l. It should also be noted that water quality discharged from the wetlands showed a trend of improvement between 1997 and 2004.

4-30: **Citation:** Page 40, Section 4.4.4, 1st bullet on page: *"The Columbia tailings are a significant body of tailings that has had a VCUP associated with it. Historic information indicates that a side channel associated with these tails had significantly degraded water quality. The current conditions regarding this site are not known and need review. It is likely that the VCUP cap has curtailed a significant amount of nonpoint source from this feature, however further study may be required in order to determine if any further action is needed."*

Comment: The extensive data collected under the WQA process indicate that the Columbia Tailings are not a significant source of metals to the Dolores River at the critical regulatory low-flows, and that existing stream standards for metals

are met under all flow conditions in the reach below this site (as well as everywhere else on the Dolores River within the Pioneer Mining District).

4-31: **Citation:** Page 40, Section 4.4.4, 3rd bullet on page: *"The Silver Swan Mine is similar to the Rico Boy/Santa Cruz mine sites in that it has received much attention in the form of VCUP actions and investigative studies. This site also is a mix of nonpoint and point source releases to the Dolores River. This Site has the capacity to release significantly degraded water quality to the Dolores River and does not have as much of a wetlands buffered capacity as the Rico Boy/Santa Cruz. Further study and evaluation of the VCUP remedy effectiveness is required."*

Comment: See comment to Citations E-3 and 4-2.

4-32: **Citation:** Page 40, Section 4.4.4, Final bullet on page: "*Unless the mine-site related nonpoint and point sources are controlled or abated, the metals loading and resulting concentrations will continue and remain an issue. Of particular concern is the potential for the St. Louis ponds to breach their containment and release significant amounts of precipitated metals downstream into the Dolores River. Of secondary concern are the point sources related to the unnamed adit within Silver Creek, the Rico Boy/Santa Cruz outfall, and the Silver Swan, and the nonpoint sources related to the Argentine tailings seep (within Silver Creek) the Columbia tailings area and combined groundwater discharge to the Dolores River."*

Comment: See comments to Citations 4-2, 4-8 and 4-14 above.

4-33: **Citation:** Page 41, Section 4.5, final paragraph on page: *"Silver Creek has at least two uncontrolled source areas associated with the Argentine tailings seep and the unnamed adit below the overhead tramway. The Dolores River has several point sources (Rico Boy, Santa Cruz and the Silver Swan) and nonpoint sources (Columbia tailings and groundwater) of potential concern. The effect of these combined sources to downstream areas is unknown due to the lack of available data."*

Comment: See comments to Citations 4-2, 4-4, 4-8, 4-9 and 4-16, among others, above.

SECTION 5: WATER & WASTEWATER FACILITIES

5-1 **Citation:** Page 1, Section 5.2, 2nd bullet in section: *"**Historic Permits**: There was an historic discharge permit associated with the St. Louis tunnel issued in 1990 by Colorado Department of Health (Colorado Discharge Permit system -Permit No. CO-0029793 – establishes the limits for the St. Louis discharge set forth by CDPHE). However, due to negligence exhibited by the original permit holder, all rights and responsibilities associated with the permit were revoked by CDPHE as*

*documented in **Appendix F** which provides the chronology of events related to the discharge and the associated regulatory actions."*

Comment: The statement that the referenced permit was revoked by CDPHE is not correct. Rather, the permit expired by its own terms and was not renewed. As noted previously, the discussion of historical events, past ownership and regulatory and legal proceedings here and in Appendix F contain several inaccuracies, and the discussion is not pertinent to the goals of, and the analyses discussed in, the Watershed Plan. Appendix F should either be significantly cut back or deleted.

SECTION 6: NONPOINT SOURCE POLLUTION

6-1 **Citation:** Page 2, Section 6.2, first paragraph in section: *"Examples of discharges of wastes into subsurface environments that can affect groundwater (and subsequently surface water), that are relevant to the Project area include septic systems, buried or capped mine waste piles and materials, and land disposal of residential soil/lead materials at the repository."*

Comment: Runon/runoff controls (including surface grading, ditches, berms, etc.), compaction of near surface soils, and reclamation of the surfaces by revegetation or the placement of "rock mulch" as implemented under previous VCUP actions have significantly reduced the leaching and transport of metals from "capped mine waste piles and materials" to underlying groundwater. In the case of the soil lead repository, the geocomposite liner (GCL) and pipe drain system installed at the base of the repository intercepts any leachate from the pile and conveys it to the Ponds system for treatment.

6-2 **Citation:** Pages 11-12, Section 6.2, subsection titled: *"<u>Stormwater – Elevated Metals in Soils</u>"*

Comment: Recent detailed mapping of surficial geology and mine waste materials is presented on Figure II-2 in *Rico Townsite Soils VCUP Project Final Data Report and Data Evaluation, Volume I (Atlantic Richfield Company, 2006).* This mapping was conducted specifically to identify and locate visible mine waste materials within the Rico Townsite. The mapping documents that mine waste materials occupy only local areas, mostly associated with the historic mine and mill sites in town and some larger road fills in the vicinity of those historic sites. These areas are estimated to comprise only about 11 percent of the surface area within the Townsite. Some of the surface gravel on unpaved roads (mostly in the northeast corner of town) also contains some amount of waste rock. To the degree that metals may be dissolved from soils and mine wastes in town and carried in stormwater runoff, the very substantial majority of any such metals load would be generated from natural soils (alluvium and colluvium) and not mine waste materials. Also, nearly all of the mine waste materials in the Townsite are comprised of coarse-grained (gravel to boulder size) waste rock that is much less

susceptible to metals dissolution by stormwater runoff than fine-grained (silt to sand size) tailings would be. See also comments to Citation 4-3.

In regard to lead in surficial soils in the river corridor, Atlantic Richfield has performed extensive sampling and analysis to identify areas with elevated lead concentrations and will remediate those areas (if any) that exceed the applicable health-risk based actions levels for this area that are currently being developed in cooperation with CDPHE under the soil lead VCUP.

6-3 **Citation:** Page 12, Section 6.2.2, last portion of final paragraph: *"As studied by Nash (2002) and others, mine sites within Central Western Slope, Colorado; most sites that have 'self mitigating' circumstances have cadmium and zinc as their major metals of concern which typically occur at concentrations 1x to 2x greater than chronic exposure standards protective of aquatic life. Such is the case for the Project area which grapples with these and other metals loading issues within Silver Creek and the Dolores River."*

Comment: The citation should be clarified to recognize that the Dolores River in the Project area meets existing stream standards, including "chronic" standards, established to be protective of aquatic life.

6-4 **Citation:** Page 14, Section 6.2.2, 2nd bullet on page: *"As per results from the **Section 4** water quality analysis, it appears that there are several mine-related nonpoint (and point) sources within the Silver Creek and Dolores River basins. Of significance to water quality concerns are the Argentine mine, an unnamed adit within Silver Creek, St. Louis tunnel and ponds, Columbia tailings, Rico Boy/Santa Cruz mines, and the Silver Swan Mine. Results do indicate that these features require further evaluation and possible remedy development. **Figures 6.1 and 6.2** depict conceptual models of the Rico Boy/Santa Cruz mine sites, and the Silver Swan mine site. As shown within these figures, these sites encompass both nonpoint and point sources of water contaminant releases. There has been a considerable amount of remedy development as part of the voluntary clean-up program (**Figure 6.3**), yet these sources of water quality concern still remain. The recommendations provided within this document (this Section and **Section 8**) describe that these particular features (in addition to the Argentine, unnamed adit, the St. Louis system, Columbia tailings etc.). Require further evaluation and effort in order to control these sources."*

Comment: See various previous comments, especially to Citations 4-2 and 4-16.

SECTION 7: WATER QUALITY MANAGEMENT GOALS AND RECOMMENDATIONS

7-1 **Citation:** Page 3, Section 7.2.1, 2nd check from bottom of page: *"The Silver Swan Adit (according to CDPHE studies) is considered a point source discharge to the Dolores River and is contributing to the zinc load in the stream."*

Comment: As noted previously, the referenced study by CDPHE was a draft WQA that is in the process of being extensively modified. Relative to the WQA for the St. Louis Ponds, the CDPHE appears to agree that discharge limits necessary to protect water quality in this reach of the Dolores River can be established for the St. Louis Ponds system without specifically accounting for loads from the Silver Swan (or other minor seeps/discharges).

7-2 **Citation:** Page 3, Section 7.2.1, final check on page: *"The Santa Cruz and Rico Boy Adits, and the Columbia Tailings are considered a point source discharge to the Dolores River (according to CDPHE studies) and are contributing to the zinc load in the stream."*

Comment: See comment to Citation 7-1 above which also applies to these minor sources.

7-3 **Citation:** Page 4, Section 7.2.1, 1st check on page: *"The St. Louis Ponds and adit are considered a point source discharge to the Dolores River and is a major contributor to the zinc load in the stream."*

Comment: As noted in previous comments, a WQA is being finalized by CDPHE that will be the basis for establishing permit discharge limits for selected metals (including zinc) at the St. Louis Ponds. These limits will be protective of the Dolores River from the Ponds discharge to below the Silver Swan Adit based on the extensive sampling and analyses by Atlantic Richfield in support of the WQA process.

7-4 **Citation:** Page 4, Section 7.2.1, 2nd check on page: *"There is a need to perform a new feasibility study to address technically effective technologies to treat the mine discharge from the St. Louis Ponds."*

Comment: Atlantic Richfield is actively evaluating treatment technologies and developing preliminary designs appropriate to meeting the anticipated permit discharge limits at the St. Louis Ponds.

7-5 **Citation:** Page 12, Section 7.3.2, final paragraph on page: *"An item within the Rico Regional Plan that is currently of potential concern in regards to this plan is the statement that "The Columbia Tailings site was reclaimed by ARCO in 1996. This site is proposed for use as visitor parking, river trail access and picnic tables.". As per review of the water quality information, it appears that the Columbia may be associated with some metals release to the Dolores River. Until that amount is more thoroughly understood, it is recommended that any development be curtailed. It may be possible to achieve the Town's goals for this piece of property and also install water quality improvement features. The renovation of this site should be planned to achieve multiple goals, one of which is to improve the released water quality from the Columbia."*

Comment: As previously commented (see Citation 4-29), available data indicate that the Columbia Tailings are not a significant source of metals loading to the Dolores River at low flows. Furthermore, the VCUP actions dictate that future land use should be consistent with the in-place remedy. The future land use suggested by the Regional Plan seems appropriate.

7-6 **Citation:** Page 15, Section 7.4, "Monitoring to Address Data Gaps"

Comment: This section provides broad-sweeping recommendation for more monitoring. As discussed before, extensive and focused monitoring has/is being performed under the ongoing WQA. This monitoring and subsequent action taken to address impacts determined significant by CDPHE will be focused on protecting the Dolores River. Much of the monitoring suggested in this section may be nice to have to satisfy scientific curiosity, but is not needed to best protect the Dolores River as defined and regulated under CDPHE environmental regulations.

7-7 **Citation:** Page 25, Section 7.6, "Nonpoint Source Control"

Comment: The ongoing WQA process has evaluated Dolores River water quality, and intends to address the single largest point source – the St. Louis Tunnel discharge. Results from the extensive monitoring performed under this process show contributions from smaller point sources and potential non-point sources to be minimal. Furthermore, existing water quality standards are being met for the Dolores River through the Rico area, suggesting that there is not a significant point or non-point metals load remaining undiscovered in the area.

7-8 **Citation:** Page 35, Section 7.7, "Point Source Control"

Comment: As commented previously, Atlantic Richfield (as a member of the NorthRico Non-Profit) intends to address the St. Louis Tunnel discharge with appropriate treatment upgrades to meet discharge permit standards ultimately established by CDPHE. Atlantic Richfield believes that the analyses performed as part of the CDPHE's ongoing WQA support the position that appropriate and protective permit limits can be established for the St. Louis Tunnel discharge without specifically accounting for, or requiring mitigation of, the other point sources noted in this section of the Plan.