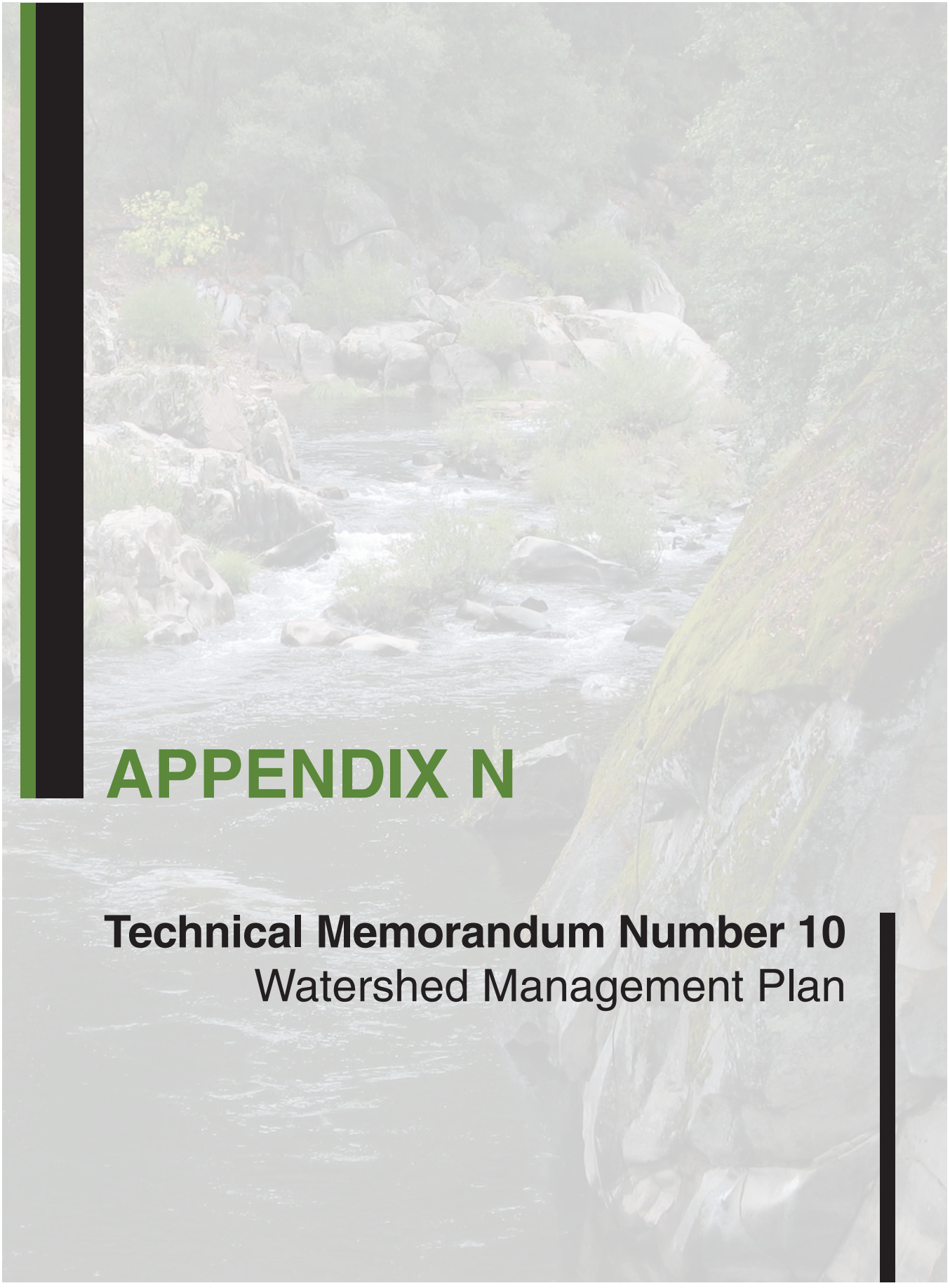


APPENDIX N

Technical Memorandum Number 10
Watershed Management Plan

Technical Memorandum No. 10

To:	Eileen White, Upper Mokelumne River Watershed Authority Rob Alcott, Upper Mokelumne River Watershed Authority
From:	Karen Johnson, Project Manager Alyson Watson, Deputy Project Manager Persephene St. Charles Steve Skripnik
Date:	July 31, 2007
Subject:	Upper Mokelumne River Watershed Assessment and Planning Project Watershed Management Plan

INTRODUCTION

This Technical Memorandum Number 10 (TM No. 10) has been prepared for the Upper Mokelumne River Watershed Authority (Authority), the Upper Mokelumne River Watershed Assessment and Planning Project (project) Project Advisory Committee (PAC), and the funding and administration agencies: CALFED, and the State Water Resources Control Board (SWRCB), respectively. TM No. 10 describes the linkage between the watershed assessment and the management plan recommendations, outlines recommended management measures, and presents implementation activities.

TM No. 10 is organized by the following topics.

- Linkage between Assessment and Recommendations
- Agencies with Watershed Water Quality Control
- Management Measure Recommendations
- Prioritization of Management Measures
- Implementation

LINKAGE BETWEEN ASSESSMENT AND RECOMMENDATIONS

Watershed Assessment Overview and Findings

The watershed assessment process, described in Technical Memorandum Number 9, was based on the following key steps.

- Characterize the watershed and land uses
- Establish baseline water quality
- Establish benchmarks for human and aquatic health
- Assess water quality (observed and simulated) using the benchmarks
- Identify parameters of interest
- Identify areas of vulnerability

Benchmarks are numeric values against which the watershed baseline water quality and WARMF-simulated water quality was compared to determine the health of the watershed from a water quality perspective. The benchmarks serve as a point of comparison to determine whether concentrations of parameters in the watershed are of potential concern for human and aquatic health. Benchmarks were obtained from a variety of sources. For human health benchmarks, SWRCB Central Valley Region (Region 5) Basin Plan objectives, US EPA and California Department of Health Services (DHS) drinking water Maximum Contaminant Levels, and DHS microbiological standards were identified as appropriate benchmarks for most parameters. Similarly, National Toxics Rule and California Toxics Rule ambient water quality criteria and Region 5 Basin Plan water quality objectives served as aquatic heath benchmarks for most parameters. If the monthly average concentration of a given parameter at a specific downstream location on the North Fork, Middle Fork, South Fork, or Main Stem was found to exceed the benchmark identified for that parameter, then the parameter was deemed a parameter of interest. This process was applied to baseline and simulated water quality data for all parameters to assess watershed health from a water quality perspective.

Assessing water quality data to identify benchmark exceedences allowed identification of associated parameters of interest. Parameters of interest in the watershed are: alkalinity, aluminum, nitrate, pathogens (fecal coliform, *E. coli, Cryptosporidium*), and turbidity. Observed exceedances are presented in Table 1. Detailed baseline water quality information can be found in TM No. 5, Baseline Water Quality and TM No. 9, Watershed Assessment. Predominant causes of elevated turbidity and low levels of alkalinity are expected to include natural watershed processes such as erosion and weathering. Aluminum is one of the most abundant metals on earth; elevated concentrations of this parameter are observed throughout the watershed likely resulting from natural weathering processes, though the large number of abandoned mines in the lower watershed may be a contributing factor as well. Elevated nitrate concentrations are expected to result both from natural watershed conditions and anthropogenic conditions such as failing septic systems that can contribute significantly to nutrient loading, and to a lesser extent, agriculture and grazing practices.

The elevated pathogen concentrations observed throughout the watershed are of primary interest for further evaluation. Elevated fecal coliform concentrations have been observed along the Middle Fork, with high peaks also seen on the South Fork. *E. coli* concentrations on the Main Stem and Middle Fork have exceeded the single sample benchmark, and concentrations on the Middle Fork have also exceeded the geometric mean benchmark. *Cryptosporidium* concentrations on the Main Stem have historically exceeded the human health benchmark, and based on the similar sources and expected loading for *Cryptosporidium* as compared to fecal coliform and *E. coli*, concentrations along the Middle and South Forks – though not currently monitored – are likely to exceed concentrations observed along the Main Stem.

Because the assessment is intended to serve as a tool for ongoing planning, and because the goal of the project is to take a proactive approach to protecting and improving source water quality in the watershed, it was requested by the PAC that long-term mean values for each parameter be developed for representative locations. While these long-term values are not intended to replace the more rigorous water quality analysis developed for baseline water quality, they do provide a general

Table 1: Observed Benchmark Exceedances[1]

Parameter of Interest	Units	Location of Benchmark Violation	Concentration of Maximum Benchmark Violation	Benchmark Concentration
Fecal coliform	#/100mL	Middle Fork	240	200
Cryptosporidium	oocysts/L	Main Stem	0.10	0.075
E. coli - single sample	#/100mL	Middle Fork	300	235
		Main Stem	500	235
Turbidity	NTU	Middle Fork	8	6
Nitrate	mg/L as N	Middle Fork	0.04	0.04
		South Fork	0.05	0.04
		Main Stem	0.04	0.04
Alkalinity	mg/L	North Fork	7	20
		Middle Fork	14	20
		South Fork	17	20
		Main Stem	9	20
Aluminum	mg/L	Middle Fork	0.10	0.09
		South Fork	0.09	0.09

1. While benchmark exceedances were not identified for copper on an average monthly basis, tributaries to the North Fork below Lower Bear Reservoir are listed as impaired for copper based on elevated copper concentrations. Ongoing monitoring and source identification should be implemented to identify and control the copper source causing these exceedances.

characterization of current water quality conditions for each major tributary for each parameter. These mean values were calculated as the long-term average observed concentration of each parameter at a representative location on each major tributary.

Project Goal and Objectives

The PAC-developed project goal: ***Maintain and Improve Source Water Quality***, implicitly suggests two sets of project objectives. One set of objectives responds to the maintain portion of the project goal by focusing on the existing water quality parameters in the Upper Mokelumne River watershed which do not currently exceed benchmarks. For these parameters, the objective is to **maintain** source water quality conditions as reflected in baseline water quality conditions. The second set of objectives responds to the **improve** portion of the project goal. This set of objectives focuses on parameters which currently exceed either human or aquatic health benchmarks. Watershed management recommendations are focused on improving concentrations of these parameters. Because watershed management recommendations frequently address multiple parameters simultaneously, implementation of recommendations targeted at improving concentrations of parameters of interest is expected to provide ancillary benefits by improving the concentrations of parameters not currently considered to be of interest.

For each parameter exceeding a human or aquatic health benchmark in one or more subwatersheds, the load reductions or increases that would be necessary to achieve benchmark concentrations have been calculated. The total load from a subwatershed represents the mass quantity of a parameter reaching the stream segment from the land that comprises that subwatershed. The calculated change in loading is the total change in loading per unit time that would be needed to reduce or

increase the in-stream concentration of each parameter of interest to concentrations at the benchmark. The changes in loads are calculated based on the loading observed during the month of peak observed or simulated concentrations; as a result, they represent the change in loading that would be necessary to remedy the worst-case condition. Target changes in loading for each parameter of interest are presented in Table 2.

Table 2: Calculated Changes in Contaminant Loading to Reach Benchmark[1,2]

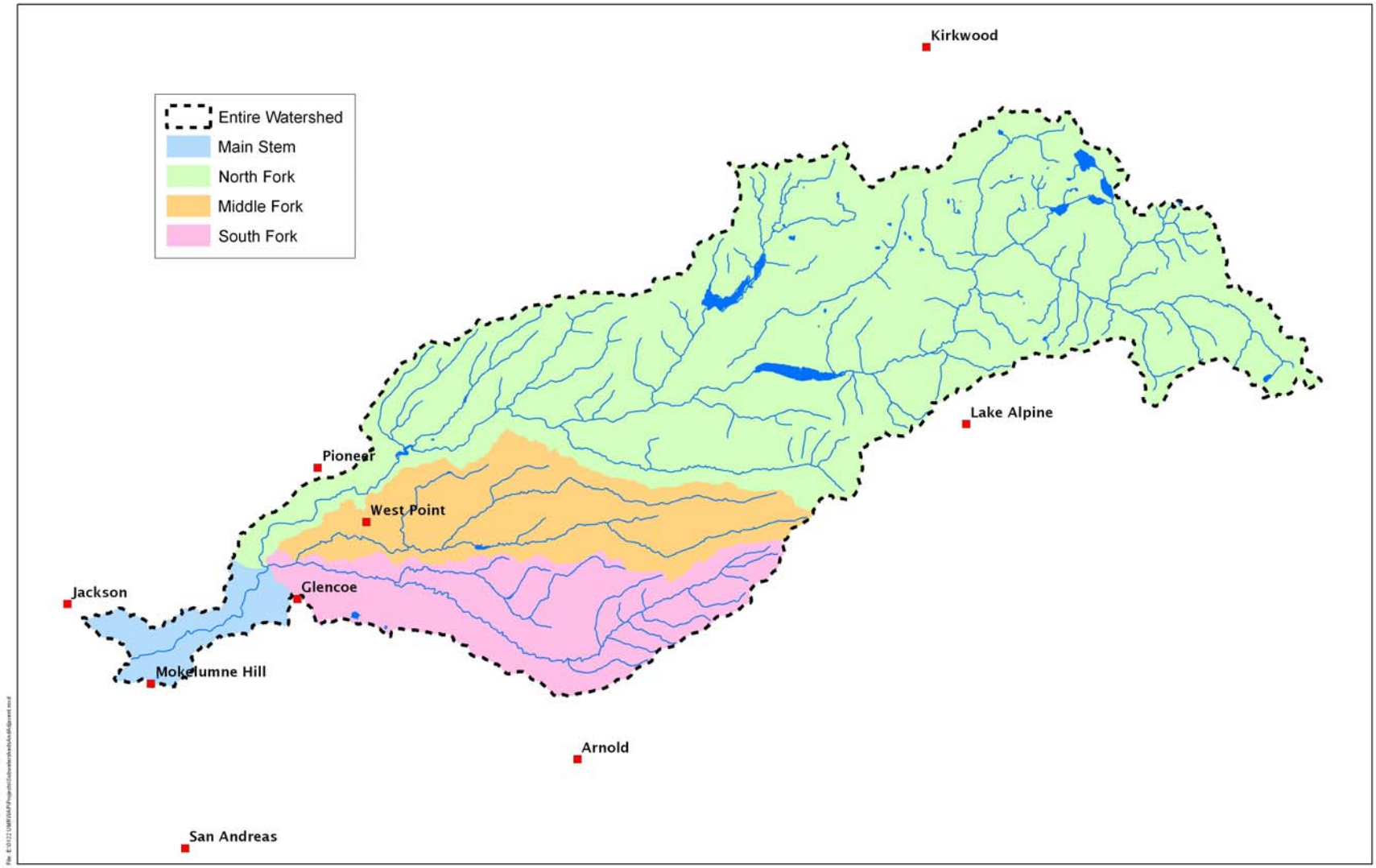
Parameter of Interest	Units	Desired Change	Change in Loading to Achieve Benchmark During the Month of Greatest Benchmark Violation				
			Entire Watershed	North Fork	Middle Fork	South Fork	Main Stem
Fecal coliform	#/month	Decrease	N/A	N/A	2.9E+10	N/A	N/A
Cryptosporidium	oocysts/month	Decrease	1.8E+09	N/A	N/A	N/A	N/A
E. coli - single sample	#/month	Decrease	1.0E+13	N/A	8.6E+10	N/A	1.0E+13
Turbidity	NTU	Decrease	N/A	N/A	N/A	N/A	N/A
Nitrate	tons/month as N	Decrease	0.31	N/A	0.01	0.18	0.11
Alkalinity[2]	tons/month as $CaCO_3$	**Increase**	579	1,213	86	40	0
Aluminum	tons/month	Decrease	11.8	N/A	0.1	0.1	12.0

1. Main stem loading reductions/increases were calculated by subtracting load reductions/increases for the North Fork, Middle Fork, and/or South Fork subwatersheds from load reductions/increases for the entire watershed (calculated based on monitoring information at Highway 49).
2. Copper is not included in this table because exceedances have not been identified using the methodology implemented in this project. Copper loading contributing to exceedances of water quality standards should be minimized.
3. Because low alkalinity is the result of natural, pristine conditions in the watershed, management measures have not been developed to increase alkalinity in the watershed. Changes in loading to achieve benchmarks are presented for informational purposes only.

Main Stem loading does not include loading from the North Fork, Middle Fork, or South Fork subwatersheds; a change in loading from an individual subwatershed would be expected to reduce observed water quality concentrations on the Main Stem, but would not reduce loading from the land area classified as being within the Main Stem subwatershed. Figure 1 presents the boundaries of each subwatershed as well as the entire watershed as referred to in Table 3. Refer to Appendix A for detailed information on calculation of changes in loading for parameters of interest. In general, if it is feasible to reduce or increase the concentrations of parameters of interest to remedy the observed or simulated benchmark exceedence(s), management measures have been developed to facilitate this change in loading. For all parameters except alkalinity, loading would need to be reduced to achieve the benchmark. For alkalinity, loading would need to be increased to achieve the benchmark. Because low alkalinity is the result of natural, pristine conditions in the watershed, management measures have not been recommended to increase alkalinity in the watershed.

It should be noted that, depending upon the parameter, loading may be more or less important than concentration in determining potential impacts to human and aquatic health. For example, metal toxicity is largely a function of concentration, whereas impacts associated with nutrients may be more effectively managed by controlling loading rather than reducing concentrations.

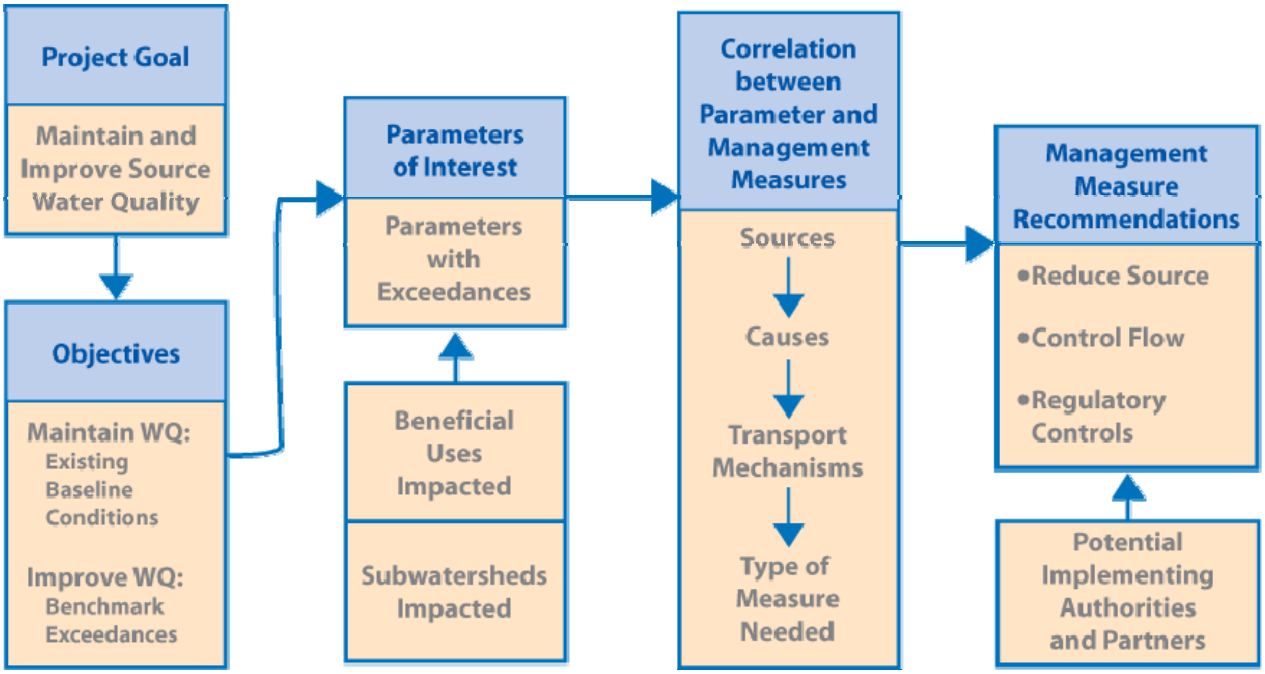
Figure 1: Subwatershed Boundaries for Load Reductions



Linkage Between Objectives and Recommendations

In order to reduce loading of parameters of interest, and to maintain current concentrations of other parameters, management measure recommendations have been developed. An overview of the linkage between the project goal and objectives, the parameters of interest identified through the assessment process, and the process used to identify management measures is presented in Figure 2. For each water quality parameter identified as being of interest, potential sources have been identified. In addition to the source of each parameter of interest, the cause of loading (i.e., how the source gets released into the environment), and the physical watershed processes related to transporting the source to a waterbody, are identified in Table 3.

Figure 2: Linkage between Watershed Assessment and Management Measures



The potential contaminant sources identified in Table 3 are organized into the same groupings as those presented in the watershed assessment: microorganisms; particulates; general properties; nutrients; metals, cations, and anions; and synthetic organic compounds (SOCs), volatile organic compounds (VOCs), and pesticides. The parameter of interest is identified by the subwatershed in which benchmark exceedances are observed or simulated, and for which target load reductions have been developed. The beneficial uses which may be impacted by these parameters of interest are also identified.

Management measures aimed at reducing loading of parameters of interest are presented in the following categories.

1. Reduce Sources of Contaminants
2. Manage Contaminated Flows/Sediment
3. Encourage Regulatory/Institutional Controls

Table 3: Correlation Between Parameters of Interest and Management Measures

MICROORGANISMS			
Maintain or Improve Subwatersheds - Objectives			
	North Fork:	No Exceedance: Maintain baseline water quality	
	Middle Fork:	Load reduction to achieve fecal coliform, *E. coli* and turbidity benchmarks	
	South Fork:	No Exceedance: Maintain baseline water quality	
	Main Stem:	Load reduction to achieve E. coli and *Cryptosporidium* benchmarks	
Beneficial Uses at Risk			
	Body contact recreation		
	Drinking water		
Sources/Activities	**Causes**	**Physical Processes**	**Management Measure Groupings**
Failing septic systems	Improper maintenance of aged systems	Groundwater transport; surface discharge to waterbody; surface runoff of pathogens	1. Reduce Sources 3. Regulatory Controls
Livestock grazing	Loadings in areas vulnerable to transport to waterbodies	Direct deposition and surface runoff of pathogens	1. Reduce Sources 2. Manage Flows
Pets	Loadings in areas vulnerable to transport to waterbodies	Surface runoff of pathogens	1. Reduce Sources 2. Manage Flows 3. Regulatory Controls
Wildlife	Loadings in areas vulnerable to transport to waterbodies	Direct deposition and surface runoff of pathogens	No Recommendations
Non-body contact recreation	Loadings proximate to waterbodies	Surface runoff of pathogens	1. Reduce Sources 3. Regulatory Controls
Body contact recreation	Direct loadings to waterbodies	Direct deposition	1. Reduce Sources 3. Regulatory Controls
Waste Water Treatment Plant (WWTP) overflows	High precipitation causing WWTP failure or direct discharge of sewage spills and overflows	Surface runoff of pathogens	1. Reduce Sources 3. Regulatory Controls
Flooding	Inundation of floodplains	Surface runoff of pathogens	1. Reduce Sources 2. Manage Flows 3. Regulatory Controls

Table 3, continued

PARTICULATES			
Maintain or Improve Subwatersheds – Objectives			
	North Fork:	No Exceedance: Maintain baseline water quality	
	Middle Fork:	Load reduction to achieve turbidity benchmark	
	South Fork:	No Exceedance: Maintain baseline water quality	
	Main Stem:	No Exceedance: Maintain baseline water quality	
Beneficial Uses at Risk			
	Drinking water		
	Aquatic species		
Sources/Activities	**Causes**	**Physical Processes**	**Management Measure Groupings**
Development Impacts	Disturbance of vegetation or soils	Soil particle transport in surface runoff	1. Reduce Sources 2. Control Flows
Recreational Impacts	Disturbance of vegetation or soils	Soil particle transport in surface runoff	1. Reduce Sources 2. Control Flows
Timber Harvest	Disturbance of vegetation or soils	Soil particle transport in surface runoff	1. Reduce Sources 2. Control Flows
Livestock Grazing	Disturbance of vegetation or soils	Soil particle transport in surface runoff	1. Reduce Sources 2. Control Flows
GENERAL PROPERTIES			
Maintain or Improve Subwatersheds - Objectives			
	North Fork:	Load increase would be needed to achieve alkalinity benchmark. Because low alkalinity results from pristine natural watershed conditions, management measures are not recommended to increase alkalinity.	
	Middle Fork:		
	South Fork:		
	Main Stem:		
Beneficial Uses at Risk			
	Drinking water		
	Aquatic species		
Sources/Activities	**Causes**	**Physical Processes**	**Management Measure Groupings**
Weathering of rocks and soils	Exposure to rain	Transport in surface runoff	2. Control Flows

Table 3, continued

NUTRIENTS			
Maintain or Improve Subwatersheds - Objectives			
	North Fork:	No Exceedance: Maintain baseline water quality	
	Middle Fork:	Load reduction to achieve nitrate benchmark	
	South Fork:	Load reduction to achieve nitrate benchmark	
	Main Stem:	Load reduction to achieve nitrate benchmark	
Beneficial Uses at Risk			
	Drinking water		
	Body contact recreation		
Sources/Activities	**Causes**	**Physical Processes**	**Management Measure Groupings**
Air	Wet deposition in rain and dry deposition onto land cover	Rainfall and surface runoff	3. Regulatory Controls
Decomposing organic matter	Death of aquatic and terrestrial organisms and vegetation	Direct deposition, transport in surface runoff	1. Reduce Sources
Failing septic systems	Improper maintenance of aged systems	Groundwater transport; surface discharge to waterbody; surface runoff of pathogens	1. Reduce Sources 3. Regulatory Controls
Livestock grazing	Loadings in areas vulnerable to transport to waterbodies	Direct deposition and surface runoff of nutrients	1. Reduce Sources 3. Regulatory Controls
Pets	Loadings in areas vulnerable to transport to waterbodies	Surface runoff of nutrients	1. Reduce Sources 2. Control Flows 3. Regulatory Controls
Wildlife	Loadings in areas vulnerable to transport to waterbodies	Direct deposition and surface runoff of nutrients	No Recommendations
Non-body contact recreation	Loadings proximate to waterbodies	Surface runoff of nutrients	1. Reduce Sources 3. Regulatory Controls
Body contact recreation	Direct loadings to waterbodies	Direct deposition	1. Reduce Sources 3. Regulatory Controls
Waste Water Treatment Plant (WWTP) overflows	High precipitation causing WWTP failure or direct discharge of sewage spills and overflows	Surface runoff of nutrients	1. Reduce Sources 3. Regulatory Controls
Timber Harvest	Disturbance to vegetation and soils	Surface runoff and associated loading of organic matter	1. Reduce Sources 2. Control Flows 3. Regulatory Controls

Table 3, continued

Sources/Activities	Causes	Physical Processes	Management Measure Groupings
Wildfire	Disturbance to vegetation and soils	Surface runoff of associated loading of organic matter	1. Reduce Sources 2. Control Flows 3. Regulatory Controls
Over application of fertilizers	Loadings in areas vulnerable to transport to waterbodies	Surface runoff of associated loading	1. Reduce Sources 2. Control Flows 3. Regulatory Controls
Flooding	Inundation of floodplains	Surface runoff of nutrients	1. Reduce Sources 2. Manage Flows 3. Regulatory Controls
Presence of ammonia	Nitrifying bacteria	Oxidation of ammonia to nitrate	1. Reduce Sources
METALS, CATIONS, AND ANIONS			
Maintain or Improve Subwatersheds - Objectives			
	North Fork:	Load reduction to reduce copper loading on North Fork[1]	
	Middle Fork:	Load reduction to achieve aluminum benchmark	
	South Fork:	Load reduction to achieve aluminum benchmark	
	Main Stem:	Load reduction to achieve aluminum benchmark	
Beneficial Uses at Risk			
	Drinking water		
	Aquatic species		
Sources/Activities	**Causes**	**Physical Processes**	**Management Measure Groupings**
Disturbance of vegetation or soils	Exposure to rain, human development, recreation, animal activity	Soil particle transport in surface runoff	1. Reduce Sources 2. Control Flows 3. Regulatory Controls
Abandoned mines without restoration	Leaching of soils with high content of metals	Surface runoff	2. Control Flows 3. Regulatory Controls
Mineral deposits	Exposure to rain	Transport in surface runoff	2. Control Flows

[1] While benchmarks exceedances were not identified for copper on an average monthly basis, tributaries to the North Fork below Lower Bear Reservoir are listed as impaired for copper based on elevated copper concentrations. Ongoing monitoring and source identification should be implemented to identify and control the copper source causing these exceedances.

Table 3, continued

SOCs, VOCs, and Pesticides	
Maintain or Improve Subwatersheds - Objectives	
North Fork:	No Exceedance: Maintain baseline water quality
Middle Fork:	No Exceedance: Maintain baseline water quality
South Fork:	No Exceedance: Maintain baseline water quality
Main Stem:	No Exceedance: Maintain baseline water quality
Beneficial Uses at Risk	
Drinking water	
Aquatic species	

AGENCIES WITH WATERSHED WATER QUALITY CONTROL

The Upper Mokelumne River Watershed Authority does not have jurisdiction over water quality in the watershed, and therefore does not have the authority to implement management measures. Agencies within the Upper Mokelumne River watershed with water quality control authority are listed in Table 4. Many of these agencies are identified under the discussion of management measures as potential partners to implement specific management measures. However, the more comprehensive list provided as Table 4 can be used in the future as the project implementation is adapted to changing conditions.

Table 4: Agencies with Watershed Water Quality Control

AGENCY	PERMIT/APPROVAL/ISSUE OF CONCERN	DISCUSSION
Federal Agencies		
Bureau of Land Management	Use Authorization Permits	Permitting of activities on BLM lands
Department of the Army - Corps of Engineers	404 permit	If dredged or fill materials are discharged into waters of the US
	Section 10 permit	If any structures or work will be in or affect navigable waters of the US
Department of Agriculture - Natural Resources Conservation Service	Resource conservation and soil protection and protection of natural resources	Provides technical information on soil resource management practices. Promotes public education and implements projects to protect and enhance natural resources
Department of Agriculture - Forest Service	Use permits for all activity on or over USFS lands	Eldorado and Stanislaus National Forests land and resource management plans provide guidance; Bear Valley ski area has a permit
	Timber Harvesting Contracts	Authorizes timber harvesting on USFS lands

Table 4, continued

AGENCY	PERMIT/APPROVAL/ISSUE OF CONCERN	DISCUSSION
Department of Agriculture - Forest Service (cont'd)	Grazing or Livestock Uses Permit and Allotment Management Plans	Authorizes grazing and livestock use on USFS lands
	Restricts off-road vehicle usage	The Mokelumne Wilderness Area is off-limits; other national forest lands may or may not be closed permanently or seasonally.
Department of the Interior-Fish and Wildlife Service	Endangered Species Act	Protection of federally-listed species, including aquatic and riparian
Federal Energy Regulatory Commission	Regulates hydropower facilities in the watershed through licensing	Authorizes, monitors, and relicenses hydroelectric projects+C30
State Agencies		
Amador County Air Pollution Control Board	Authority to Construct and Permit to Operate	Permit for projects with sources of emissions
Calaveras County Air Pollution Control Board	Authority to Construct and Permit to Operate	Permit for projects with sources of emissions
California Department of Fish and Game	Endangered Species Act compliance	Protection of state-listed species, including aquatic and riparian.
	Lake and Streambed Alteration Agreement	Controls activities within the natural state of a river, stream, or lake or supporting riparian vegetation.
	Suction Dredging Permit	Permit for suction or vacuum dredging of any river, stream, or lake.
	Hunting and fishing licenses	Regulations limit extent and severity of potential impacts by regulating intensity of use and number of users.
California Department of Forestry and Fire Protection (CalFire)	Fire prevention and suppression	Responds to wildland fires
	Timberland Conversion Permit	Required for conversion of timberland to other land uses
	Timber Harvesting Plan	Regulate timber harvesting on private lands, including controlling erosion impacts, and approval of Timber Harvest Plans
Department of Health Services - Sanitary Engineering Section	Domestic Water Supply Permit	Primary agency for setting safe drinking water standards; protection of drinking water supplies; and regulation of public water supply, treatment, and distribution systems
Department of Toxic Substances Control	Regulation of hazardous waste generation and storage	
Department of Transportation	Encroachment Permit	If any activity involves state highway right-of-way

Table 4, continued

AGENCY	PERMIT/APPROVAL/ISSUE OF CONCERN	DISCUSSION
Department of Transportation (cont'd)	Construction and maintenance of, and stormwater collection on state and federal roads. Hazardous materials spill response.	Maintenance of spill records for state and federal rights-of-way
Department of Water Resources	Monitoring of stream flows and determining quantity of water stored in snow	
Highway Patrol	Controls hazardous materials transport on state highways	
State Lands Commission	Land Use Lease for Encroachments on State Lands	If state owned lands are impacted by a project (e.g., road right-of-way)
	Dredging Permit	If state owned lands up to near high tide line are dredged or altered.
State Water Resources Control Board - Regional Water Quality Control Board, Central Valley Region	Waste Discharge Requirements and NPDES Permits	Regulation of waste discharge into surface waters and stormwater discharge, including wastewater treatment plants, mining activities and abandoned mines, and stormwater runoff discharges.
	Waiver of Waste Discharge Requirements for timber harvest activities	Delegates primacy to CDF and USFS to implement Water Quality Management Plan; and Water Quality Management for National Forest System Lands in California, respectively.
	General Construction Activity Stormwater Permit	Required for stormwater runoff associated with construction activity
	Underground tank permit	For storing hazardous substances
Local Agencies		
Alpine County		
Alpine County Agricultural Commissioner's Office	Restricted Materials Permit	Enforcement agency for restricted pesticides
Alpine County Board of Supervisors	General Plan Amendments	General Plan amendment decisions ultimately reside with Board of Supervisors.
Alpine County Health and Human Services - Environmental Health Services	Approval of sewage disposal facilities including septic tanks	Construction of septic systems and other sewage collection and disposal facilities
	Underground storage tanks, hazardous materials Business Plan, and other hazardous materials management	Local Implementing Agency; Certified Unified Program Agency for consolidating all matters related to hazardous materials; Calaveras County also accepts hazardous waste from Alpine County

Table 4, continued

AGENCY	PERMIT/APPROVAL/ISSUE OF CONCERN	DISCUSSION
Alpine Environmental Health Services (cont'd)	Small public water systems	Primacy agency for management of small potable water supply, quality, treatment, and distribution systems
Alpine County Local Agency Formation Commission	Approves annexations and adopts Sphere of Influence boundaries	Approval needed for changes to sewage collection service area boundaries
Alpine County Planning Development	General Plan and zoning approvals and changes, use permits and environmental compliance	Regulates the ability to develop lands consistent with existing planning documents, or provides approvals for changing land use designations
Alpine County Public Works	Stormwater collection and disposal	Construction and maintenance of stormwater collection, particularly from county roads
	Erosion control and vegetation management	Construction and maintenance of county roads and park maintenance
Amador County		
Amador County Agriculture Department	Restricted Materials Permit	Enforcement agency for restricted pesticides
Amador County Board of Supervisors	General Plan Updates (and Amendments)	Amador County is undergoing a general plan update. Decisions ultimately reside with Board of Supervisors.
Amador County Building Department	Grading approvals	Reviews grading plans as a part of development projects
Amador County Environmental Health Department	Liquid Waste Program	Construction or repair of septic tanks and alternative disposal methods
	Underground storage tanks, hazardous materials Business Plan, and other hazardous materials management	Local Implementing Agency; Certified Unified Program Agency for consolidating all matters related to hazardous materials
	Small public water systems	Primacy agency for management of small potable water supply, quality, treatment, and distribution systems
Amador County Local Agency Formation Commission	Approves annexations and adopts Sphere of Influence boundaries	Approval needed for changes to sewage collection service area boundaries
Amador County Recreation Agency	Management of park lands and activities	Recreational activities coordinated with the cities and county
Amador County Planning Development	General Plan and zoning approvals and changes, use permits and environmental compliance	Regulates the ability to develop lands consistent with existing planning documents, or provides approvals for changing land use designations
Amador County Public Works	Stormwater collection and disposal	Construction and maintenance of stormwater collection, particularly from county roads
	Erosion control and vegetation management	Construction and maintenance of county roads

Table 4, continued

AGENCY	PERMIT/APPROVAL/ISSUE OF CONCERN	DISCUSSION
Amador County Waste Management Department	Manage solid waste disposal sites and household hazardous wastes	Unsure of relationship with Environmental Health Department
Calaveras County		
Calaveras County Department of Agriculture/Weights & Measures	Restricted Materials Permit	Enforcement agency for restricted pesticides
Calaveras County Board of Supervisors	General Plan Updates (and Amendments)	Calaveras County is undergoing a general plan update. Decisions ultimately reside with Board of Supervisors.
Calaveras County Environmental Management Agency - Department of Environmental Health	Underground storage tanks and other hazardous materials	Local Implementing Agency; Certified Unified Program Agency for consolidating all matters related to hazardous materials
	Groundwater protection	
	On-site sewage complaint program	Investigates complaints of failed septic systems
	Small public water systems	Primacy agency for management of small potable water supply, quality, treatment, and distribution systems
Calaveras County Local Agency Formation Commission	Approves annexations and adopts Sphere of Influence boundaries	Approval needed for changes to sewage collection service area boundaries
Calaveras County Community Development Agency	General Plan and zoning approvals and changes, use permits, environmental compliance, grading approvals	Regulates the ability to develop lands consistent with existing planning documents, or provides approvals for changing land use designations
Calaveras County Community Development Agency - Building Department, On-site Sewage Division	Permit and construction of new septic tanks	
Calaveras County Public Works	Stormwater collection and disposal	Construction and maintenance of stormwater collection, particularly from county roads
	Erosion control and vegetation management	Construction and maintenance of county roads
Calaveras County Public Works - Solid Waste Division	Manage solid waste disposal sites and household hazardous wastes	Also collects household hazardous waste from Alpine County residents
Fire Protection		
Alpine Volunteer Fire Department: Markleeville	Fire response	Works with private landowners to manage fire fuels around homes
Amador Fire Protection Authority and Amador Fire Protection District	Fuels management and fire response	Works with private landowners to manage fire fuels around homes

Table 4, continued

AGENCY	PERMIT/APPROVAL/ISSUE OF CONCERN	DISCUSSION
Calaveras County Fire and Emergency Services	Fuels management and fire response	Works with private landowners to manage fire fuels around homes
Fire Safe Planning Programs for each county	Public education and program funding	Promotes defensible space education, public outreach, fuels reduction projects, Firewise planning, enforcement of ordinances.
Water and Wastewater Agencies		
Alpine County Water Agency	Management of potable water supply, quality, treatment, and distribution	Responsible for potable water supplies in Alpine County
Amador Water Agency	Management of potable water supply, quality, treatment, and distribution	Potable water purveyor diverting from the watershed
Bear Valley Water District	Management of potable water supply, quality, treatment, and distribution; management of sewage collection and treatment system	Potable water purveyor and wastewater agency for the Bear Valley ski area within watershed
Calaveras County Water District	Management of potable water supply, quality, treatment, and distribution; management of sewage collection and treatment system	Potable water purveyor and wastewater agency (West Point) within the watershed
Calaveras Public Utility District	Management of potable water supply, quality, treatment, and distribution	Potable water purveyor within the watershed
East Bay Municipal Utility District	Management of potable water supply, quality, treatment, and distribution	Potable water purveyor with source waters in watershed
Jackson Valley Irrigation District	Management of irrigation water supply and distribution	Irrigation water purveyor diverting from the watershed
Mokelumne Hill Sanitary District	Management of sewage collection and treatment system	Wastewater agency within the watershed (Mokelumne Hill)

MANAGEMENT MEASURE RECOMMENDATIONS

Table 5 presents a summary of the management measures specifically developed to change the sources, causes, and or transport of contaminants as well as encourage regulatory actions to eliminate or prevent degradation of source water quality. The rigorous analyses and resulting findings associated with the watershed water quality assessment justify the need to implement these recommendations. The Upper Mokelumne River watershed lands contribute to the high quality waters found in the forks and Main Stem of the river that must be continually watched and extensive efforts made to maintain. Particularly in light of the concerns associated with microorganisms presently in the water and the development pressures which could significantly degrade water quality in the future.

The management measures are grouped by categories which are not exact – reducing the presence of a source often requires regulatory controls, for example. But the categories group the recommendations to avoid redundancy and highlight the importance and similarities involved in controlling a source versus managing the contaminant once it is moving within the watershed towards a waterbody.

Table 5: Summary of Management Measure Recommendations and Water Quality Parameters Addressed

		Water Quality Parameter Addressed					
Management Measure Recommendations		Microorganisms	Particulates	General Physical	Nutrients	Metals	S/VOCs & Pesticides
Reduce Sources of Contaminants							
S1	Eliminate leakage from septic systems	♦			♦	♦	♦
S2	Increase bulky waste pickup programs and collection of illegally dumped trash (e.g., abandoned cars, appliances, pharmaceuticals)					♦	♦
S3	Provide toilets and trash/debris receptacles at informal recreation sites	♦			♦		
S4	Manage fire fuels for landowner and water quality objectives		♦	♦	♦	♦	♦
Manage Contaminated Flows/Sediment							
F1	Implement measures to control abandoned mine flows/sediment		♦	♦	♦	♦	
F2	Implement green streets principles for reducing peak flows, minimizing runoff, and removing contaminants during flow	♦	♦	♦	♦	♦	♦
F3	Implement road maintenance practices intended to minimize water quality impacts	♦	♦	♦	♦	♦	♦
F4	Enhance grazing practices to encourage off-stream watering	♦	♦		♦		

Table 5, continued

	Management Measure Recommendations	Water Quality Parameter Addressed					
		Microorganisms	Particulates	General Physical	Nutrients	Metals	S/VOCs & Pesticides
Encourage Regulatory / Institutional Controls							
R1	Implement water quality and temperature monitoring	♦	♦	♦	♦	♦	♦
R2	Educate public on contaminant source reduction and impacts of contaminated stormwater to waterbodies	♦	♦	♦	♦	♦	♦
R3	Include watershed water quality protection policies in general plan update along with ordinances and design guidelines for high vulnerability zones	♦	♦	♦	♦	♦	♦
R4	Encourage compact development in the general plan updates for water quality protection	♦	♦	♦	♦	♦	♦
R5	Purchase land and/or development rights, and encourage landowners to obtain conservation easements in high vulnerability areas	♦	♦	♦	♦	♦	♦
R6	Supplemental Watershed Assessments for Non-Water Quality Conditions**		♦	♦		♦	

* Management measure recommendations are to be encouraged; the Authority does not have authority to implement.

** This management measure is not targeted as maintaining or improving source water quality, but may generate incidental water quality benefits.

Management measures for the projects are provided here. The measures are described using the following information.

- Subwatershed location
- Parameters addressed
- Potential partners to implement
- PAC advocate
- Description of the measure
- Opportunities and constraints
- Short and or long term outcomes

PAC advocates were identified for measures that had a strong personal commitment by a PAC member or the agencies they represent to advocate for its implementation. The Foothill

Conservancy volunteered to be the advocate for unassigned measures since these measures reflect the organization's interests and activities in the watershed. It is anticipated that the PAC Advocates will report to the Authority, on a quarterly or semi-annual basis, the status of pursuing the implementation of the measure(s). Since the PAC Advocate speaks for many pubic interests including local residents, water districts, and non-governmental organizations, their actions in pursuing these measures should be supported by the Authority as well as other potential partners/agencies, wherever feasible.

S1. Eliminate Leakage from Septic Systems

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Alpine County: Department of Health and Human Services – Environmental Health Services, Assessors Office, Department of Planning, LAFCO; Amador County: Environmental Health Department (liquid waste program), Assessors Office, Planning Department, LAFCO; Calaveras County: Department of Environmental Health, Community Development Agency, Assessors Office, Planning Department, LAFCO; SWRCB and EPA (funding agencies)

PAC ADVOCATE: Pete Bell, Dan Brown, Bob Dean, Susan Snoke, UMRWC

PRIORITY: Highest

Subwatershed	Management Measure S1: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Nutrients	N/A
Middle Fork	N/A	▪ Microorganisms ▪ Nutrients
South Fork	▪ Microorganisms	▪ Nutrients
Main Stem	N/A	▪ Microorganisms ▪ Nutrients

DESCRIPTION:
The majority of the residents that live in the Upper Mokelumne River watershed live in homes with septic systems. Given the terrain and age of many of the homes in the area, it is expected that many of these systems were either built before permits were required or are in need of repair or replacement. Failing or poorly maintained septic systems are likely a primary pollution source in the watershed. In addition, the sheer number of septic systems proximate to streams poses a potential threat to water quality. There are many ways that septic leakage can be reduced. Although not yet implemented, the State of California has drafted general state-wide system guidelines. Until those requirements are enforced, it falls on local counties and agencies to take steps that will reduce the impact of failing septic systems. The following are options from which local agencies can chose to implement individually or in concert with each other. Funding should be pursued to implement any of the options.

Collection System Expansion
Extending wastewater collection and treatment systems by local agencies is likely the most effective option to reduce microorganisms reaching the watershed waterbodies (including local groundwater supply sources). However, given the rural nature of the region, expanding the existing collection and treatment systems and/or creating new systems is very costly. With growth in the watershed anticipated, and particularly if compact development is specified in the updated general plans (see Management Measure R4 - Compact Development), such costs per household could be reduced. New development could be required by the county to be connected to a new or existing sewer collection and treatment system.

The formation of a new wastewater collection district could require property owners to vote to cover wastewater system improvements by a tax increase. The Carpinteria Sanitary District in Southern California is receiving strong public support for a planned septic-to-sewer conversion project. While a rate increase or new tax is likely to be required to fund collection system costs, state grants and loans are also available to offset costs. The formation of a septic system assessment

district is another option to self-impose an assessment for regular inspections; repair costs remain with the property owner. This approach may be in-lieu of a state-mandated program.

While local wastewater agencies may not have the funding necessary to extend their collection system infrastructure, some funding is available through state grants and loans. This measure would support these agencies in applying for such funds to allow for expansions. One such program available is the SWRCB Small Communities Wastewater Grant. The following eligibility requirements would be suitable to the Upper Mokelumne River watershed.

- Communities that lack or may have historically lacked the staff or resources to successfully compete for various funding opportunities.
- Communities with a relatively low MHI.
- Communities that may reflect environmental justice considerations.
- Communities facing other cultural or financial barriers that limit their access to funding opportunities.

Septic Inspections

Of the estimated 3,000 permitted septic systems in the Upper Mokelumne River watershed, it is expected that a substantial number are failing and in need of repair. Since no regular monitoring is required for septic permits, there is no way of documenting just how many of the systems are not functioning properly and therefore contributing concentrations of pollutants into the watershed. Once way to document some of these systems and isolate the need for necessary repair or replacement is to require septic systems inspection. There are two primary inspection cycles being discussed at a state level.

- Mandatory 5-year inspections: the burden of implementation would fall on the counties, but would provide a consistent and regular means for repair enforcement. This would however have minimal impact on those systems installed without proper permits throughout the county.
- Point-of-sale: This would require that a septic inspection be conducted in advance of property changing ownership. The burden of implementation would occur during the home purchase process and so there is concern it will delay and increase the expense of the selling process. This would however capture non-permitted septic systems if properties are sold, and provide benefits without the huge costs of implementing a 5-year program. In addition to inspection, a point-of-sale septic transaction fee could be collected to invest in future septic system inspection activities or contribute to collection system infrastructure.

The County of Marin has developed county inspection requirements on a bi-annual basis. Marin County also undertook an outreach process in the Tomales Bay watershed (an impaired waterbody) to offer free inspections for septic systems within 100 feet of a waterbody. This anonymous program was funded by grants. These requirements were primarily developed as an interim step given the costly and often longer-term process of collection system extensions.

Education

The need for mandatory inspections and septic system maintenance may be alleviated by increasing septic system education within the watershed. By encouraging septic system maintenance companies to proactively contact residents regarding maintenance, homeowners will become more aware of the need for periodic septic system maintenance.

An outreach program is recommended. This program could inform both residents and owners of second homes in the watershed of how septic systems work, how to conduct regular maintenance and inspections, cost effective repairs, and county permit requirements. A good example can be found at www.septicmatters.org.

Figure 3: Photos of Failed Septic Systems

OPPORTUNITIES AND CONSTRAINTS:

Any type of septic system regulation will be controversial. Besides costs, many rural residents may not agree with the idea that septic systems contribute pollutants in quantities that could impact human health. Given that they do not see the correlation or cannot afford the solution, asking residents to pay more to remedy such a situation is even more difficult. Early education is needed on how individual septic system leakage compounded across an entire watershed can lead to these issues. Certainly increases in population will only exacerbate conditions unless new requirements are put in place in advance of people moving into the area and buying existing homes or building new ones. The potential costs involved in implementing a septic system improvement program should be shared with the public early in on in the development of the program.

The identification of the species of origin, as discussed in management measure R1, would document the correlation between leaking septic systems and microbial contamination and the extent of the problem of failing septic systems. This documentation may aid in obtaining funding. In addition, counties within the watershed should be open to permitting new septic system technologies that may provide increased reliability and efficiency while maintaining an acceptable level of environmental safety.

Amador and Calaveras Counties are currently undertaking an update to their general plans. Changes could be incorporated in these general plans as described in management measure R3 regarding compact growth to encourage more cost effective collection system extensions. This is also an opportunity for the counties to require new development to contribute to a regional collection and treatment system.

SHORT AND/OR LONG-TERM OUTCOMES:

Given that funding must be identified, applied for, received coupled with the planning and environmental documentation for collection expansions, the results will be improved water quality immediately but not for some time. This measure must be coupled with septic system regulations on existing and new systems to provide the near-term water quality improvements. The longer-term impacts of initiating sound septic system requirements will pay-off as eventually the State will require such regulations at potentially higher costs.

S2. Increase Bulky Waste and Household Hazardous Materials Pickup Programs

Subwatershed	Management Measure S2: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ SOCs, VOCs, and pesticides	▪ Metals
Middle Fork	▪ SOCs, VOCs, and pesticides	▪ Metals
South Fork	▪ SOCs, VOCs, and pesticides	▪ Metals
Main Stem	▪ SOCs, VOCs, and pesticides	▪ Metals

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Calaveras County and Alpine County Department of Public Works, Amador County Waste Management Department, each county Environmental Health Departments

PAC ADVOCATE: Kent Lambert, EBMUD

DESCRIPTION:
Illegal disposal of cars, large appliances, household hazardous waste and pharmaceuticals, and other potentially hazardous waste particularly on roadsides and in streambeds is common in rural areas and occurs in the Upper Mokelumne River watershed. This action is exacerbated in lieu of a bulky waste pickup program. Bulky waste pickup programs provide inexpensive or free means (for residents) for disposing of large objects that can contaminate surface and groundwater. In addition to bulky waste, pharmaceuticals can also be hazardous to receiving waters when disposed as regular waste or disposed of in toilets due to high levels of hormones and other emerging contaminants. The pharmaceutical program could be accompanied by the current Calaveras and Alpine County public education programs to convey the importance of hazardous waste disposal and the negative environmental effects of improper disposal.

Bulky Waste Drop-off and Pick-up Programs
Currently, Calaveras and Amador counties provide a bulky waste drop-off program at several locations on a continuous, fee-free basis. Calaveras and Amador counties also sponsor an annual Household Hazardous Waste Disposal Day that is free to residents

Additionally, periodic bulky waste pickup programs, where bulky items are picked up from homes when scheduled ahead of time, also minimize the interest in illegally disposing of potentially hazardous items. The counties should schedule and advertise bulky pick-up days several times throughout the year. In addition to household hazardous waste programs that deal with paint, oil, and other chemicals, programs should be established that deal directly with larger appliances and other sources of contamination.

Pharmaceutical Drop-off Programs
A pharmaceutical drop-off program should be established to facilitate the collection and disposal of unwanted or expired pharmaceuticals. Septic tanks, and water and wastewater treatment plants are unable to completely treat endocrine disruptors associated with pharmaceuticals. These chemicals are not only harmful to humans, they can also accumulate in aquatic species in receiving waters.

San Mateo County provides an example of a pharmaceutical drop-off program. It allows for the year-round collection and disposal of pharmaceuticals that might otherwise be improperly disposed-of. In order to lawfully accept all pharmaceuticals, including controlled substances, drop boxes are located at law enforcement stations.

The Bay Area Pollution Prevention Group, an association in the San Francisco Bay Area made up of municipalities and water stakeholders, sponsored a one-time regional pilot pharmaceutical collection event that collected and disposed of 3,634 pounds of pharmaceutical. Pharmaceuticals were collected at Walgreens, senior centers and city halls while law enforcement handled the disposal of the substances. It is typically unlawful to be in possession of a controlled substance or pharmaceutical that is not prescribed to you.

OPPORTUNITIES AND CONSTRAINTS:

Expanding on existing bulky waste programs in terms of frequency and pharmaceuticals, offers an opportunity to improve water quality in the watershed while informing the public about contamination implications. However, solid waste agency budgets may be limited to expand programs.

SHORT AND/OR LONG-TERM OUTCOMES:

Outcomes of this measure include the immediate reduction in illegal dumping and subsequent improvements to water quality. In the long-term, water quality will improve within the watershed with the reduction of improperly disposed-of pharmaceuticals and bulky waste.

S3. Provide Toilets and Trash/Debris Receptacles at Informal Recreation Sites

Subwatershed	Management Measure S3: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	N/A	▪ Microorganisms ▪ Nutrients
Middle Fork	▪ Microorganisms ▪ Nutrients	N/A
South Fork	▪ Microorganisms	▪ Nutrients
Main Stem	▪ Microorganisms ▪ Nutrients	N/A

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Bureau of Land Management; Natural Resources Conservation Service - Central Sierra Resource Conservation and Development; Department of Agriculture - Forest Service; Department of Fish and Game; Department of Forestry and Fire Protection; Department of Health Services - Sanitary Engineering Section; Alpine County Health and Human Services - Environmental Health Services; Alpine County Public Works; Amador County Environmental Health Department; Amador County Public Works; Amador County Waste Management Department; Calaveras County Environmental Management Agency - Department of Environmental Health; Calaveras County Community Development Agency - Building Department, On-site Sewage Division; Calaveras County Public Works; Calaveras County Public Works - Solid Waste Division; Alpine County Water Agency; Amador Water Agency; Bear Valley Water District; Calaveras County Water District; Calaveras Public Utility District; East Bay Municipal Utility District; Jackson Valley Irrigation District; Mokelume Hill Sanitary District; Pacific Gas & Electric Company

PAC ADVOCATE: Tracey Towner-Yep, Kent Lambert

DESCRIPTION:
The watershed is a popular destination for outdoor enthusiasts, and is home to a wealth of recreation opportunities including hiking, camping, fishing, hunting, rafting, boating, swimming, rock climbing, and other outdoor activities. The Eldorado and Stanislaus National Forests contain multiple campgrounds along with wilderness camping and hiking opportunities. Several campgrounds are located at or near Salt Springs Reservoir, Bear River Reservoir, and the Blue Lakes area. The U.S. Forest Service campgrounds are concentrated around Bear River Reservoir, Salt Springs Reservoir, the Blue Lakes, and along the North Fork. Salt Springs Reservoir also has boat-in camping on the eastern shore.

In addition to formal recreation areas, there are a variety of informal recreation sites in the watershed where body contact recreation occurs regularly. Because these locations are informal, toilet facilities and debris/trash receptacles are frequently not present. The lack of appropriate facilities for disposing of fecal and non-fecal waste increases the likelihood of improper waste disposal. Because many of these informal recreation areas are adjacent to the river and its tributaries, this improper disposal is likely to occur within watershed areas designated as high or very high vulnerability for pollutant transport. Provision of toilets and/or waste disposal facilities would be expected to reduce loading of a variety of constituents to adjacent waterbodies, including pathogens, nutrients, metals, particulates, and SOCs/VOCs. The users of these facilities could include homeless people if placed near known encampments.

Several alternatives for outdoor toilet facilities and trash receptacles exist. Select examples are described below.

Pit Toilets

Pit toilets may be constructed to provide bathroom facilities in remote, undeveloped areas. Pit toilets consist, in the most basic sense, of a hole dug into the ground and covered by a toilet riser, with privacy screens. Pit toilets can include moldering or composting processes to encourage biodegradation. It is important to note that vault toilets, flush toilets, and composting toilets, which are generally common in recreation sites, are not considered pit toilets and must meet requirements for toilet buildings. Pit toilets should be sited in low vulnerability zones.

Vault Toilets

Unlike pit toilets, where much of the liquid portion of the deposited waste is lost to surrounding soil, concrete or polyethylene vault toilets are designed to retain all deposited waste. Vault toilets must be periodically pumped, and waste must be hauled to a treatment facility. Because vault toilets are capable of storing hundreds of gallons of waste, they can generally accommodate weeks or months of use in remote areas prior to being pumped. The frequency with which they require pumping is dependent on use patterns.

Composting Toilets

Composting toilets rely on unsaturated conditions to break down waste to between ten and 30 percent of its original volume through aerobic bacterial and fungal action. Composting toilets are classified as either active or passive. Active composting systems may include automatic mixers, heaters, and other equipment designed to increase the composting rate. Passive composting toilets are generally simple systems that are allowed to decompose through uncontrolled natural decay processes. These toilets require periodic pumping and waste disposal.

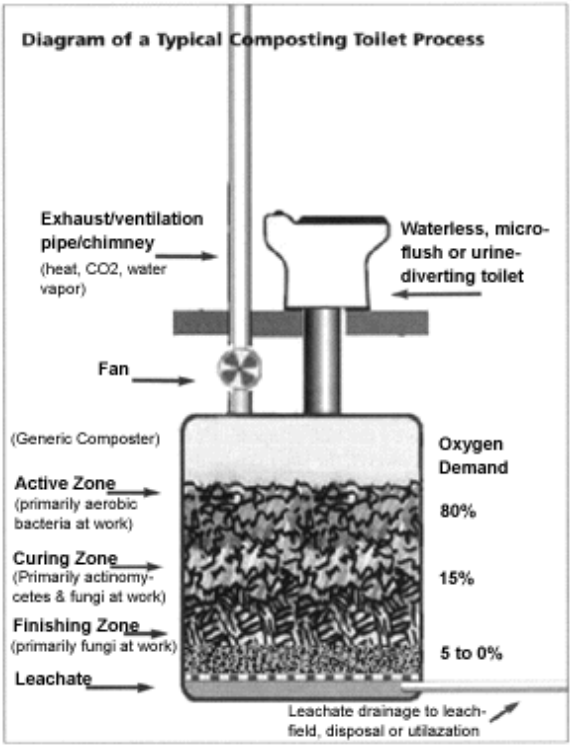
Tree bogs

A Tree bog is a type of composting toilet that has willows, nettles and nutrient-hungry plants planted around it. In this type of toilet, the feces is held in a chamber open to the air, allowing it to decompose rapidly and feed the trees around it. Tree bogs, if properly sized, convert feces to biomass without requiring periodic pumping.

Trash Receptacles

Several manufacturers offer outdoor trash receptacles of varying sizes, materials, and capacities. Periodic trash removal is required to maintain capacity.

Figure 4: Typical Composting Toilet Process[2]



OPPORTUNITIES AND CONSTRAINTS:

There is no additional funding for purchase, placement, or maintenance of toilets and/or trash receptacles through this project. However, because pathogens are of particular concern for the watershed, potential funding may be secured for the purchase of these facilities for placement in highly vulnerable areas.

SHORT AND/OR LONG-TERM OUTCOMES:

Providing outdoor toilets and/or trash receptacles in informal recreation sites would be expected to reduce the loading of pathogens, nutrients, metals, particulates, and SOCs/VOCs associated with these sites.

[2] http://oikos.com/library/compostingtoilet/ accessed 2/23/07.

S4. Manage Fire Fuels for Landowner and Water Quality Objectives (e.g., minimize ignitions or impacts)

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Bureau of Land Management; Department of Agriculture - Natural Resources Conservation Service; Department of Agriculture - Forest Service; Department of Forestry and Fire Protection; State Lands Commission; Alpine County; Amador County; Calaveras County; Alpine Volunteer Fire Department: Markleeville; Amador Fire Protection Authority and Amador Fire Protection District; Calaveras County Fire and Emergency Services; Fire Safe Planning Programs for each county; Sierra Pacific Industries

Subwatershed	Management Measure S4: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals

PAC ADVOCATE: Chuck Loffland,

DESCRIPTION:
The effects of wildland fires on water quality are strongly influenced by the location, extent, and severity of the fire. Wildland fires generally effect hydrology and water quality through a variety of mechanisms. Streamflow generally increases following fire due to reduced canopy resulting in a decrease in interception storage, reduced infiltration resulting from a increased soil repellency, decreased evapotranspiration due to replacement of deep-rooted plants by shallow rooted grasses, and increased snow accumulation and melting. Observed increases in streamflow following fires can range from two to 30 percent, with peak flows increasing from nine to 100 percent.[3]

Water quality can also be severely impacted by wildland fires. Increased overland flow can result in increased erosion, leading to sediment loading. Reduced canopy cover causes soil to be more exposed, and more detachment is observed. Wildland fires cause organic nitrogen to be converted to ammonia, which is quickly nitrified to nitrate, causing increases in nitrate loading. Similarly, organic phosphorus is converted to inorganic phosphorus, which may adsorb onto sediment and be transported to nearly waterbodies. Phosphorus and ammonia are also commonly found in flame retardants, increasing soil concentrations of these nutrients. Wildland fires may also consume homes and other buildings within the burn area contributing to the pollutant loads entering soil and groundwater.

[3] United States Department of Agriculture. Wildland Fire in Ecosystems: Effects of Fire on Soil and Water, September 2004.

Metals concentrations may also be strongly affected by wildland fires. As sediment becomes more exposed and readily transported to nearby waterbodies, adsorbed metals become more likely to be carried to streams, increasing concentrations of metals, particularly during first flush following fires. The combined effect of all of these hydrologic and water quality changes in an area can cause significant changes to water quality that can take years to equilibrate. Meanwhile, elevated sediment and metal concentrations can be harmful to aquatic organisms, and can pose challenges for drinking water treatment.

Because of the potential water quality impacts associated with fires and the strong influence of fire severity and extent on water quality degradation, fuel management should be designed to minimize ignitions, spread, and/or fire severity in vulnerable areas of the watershed. Potential fuel management approaches such as prescribed burning, harvesting of biomass fuel followed by prescribed burning, and sanitation-salvage or group-selection harvests with slash and landscape fuel treatments have been shown to minimize average fireline intensities, heat per unit area, rate of spread, area burned, and scorch heights. It should be noted that while reduction of understory may provide significant benefits from a fire protection and water quality standpoint, there may be air quality impacts associated with excessive removal. Potential air quality impacts of all measures should be considered. All of the treatments described in this section may have potential water quality impacts, though these effects are expected to be lower in magnitude and shorter in duration those resulting from wildfire.

Prescribed Burning

Prescribed burning involves applying fire to forest fuels on a specific land area under specific weather conditions to accomplish predetermined objectives. Prescribed burning is a highly effective, relatively inexpensive method for reducing fuels, and carries much less risk to habitat, site and soil quality than other methods. However, without proper planning by a professional prescriptionist, prescribed burning could result in serious loss of property and life. Prescribed burning is becoming increasingly difficult to implement on a large scale due to increasingly stringent air quality restrictions and extended fire seasons.

Harvesting of Biomass Fuel

Buildup of small trees and other biomass in the understory of forests throughout the watershed can exacerbate the effects of wildland fires. Biomass harvesting reduces excess fuels, improving tolerance to fire. Excessive harvesting can have negative water quality effects as the protective layer over soils is removed.

Sanitation-Salvage or Group Selection Harvests

Trees damaged by natural catastrophes such as fire, windstorms, or ice storms, or those infested with insects or disease could pose a threat to the remaining stand. In sanitation-salvage harvests, these trees are removed.

In group selection harvests, small groups are harvested rather than individual trees. This creates openings that resemble small (<1 acre to 5 acres) clear cuts. Because the openings are small, edge trees still provide a protected environment for the developing regeneration in the group opening. This method is similar to single tree selection in that harvests are frequent. Its advantage is that it is

easier for the logger to avoid damaging the residual stand. It should be noted that ground disturbance is experienced when trees are removed in this form of treatment. In addition, these treatments are often followed by soil disturbance associated with planting, herbicide use, and extended stand management, all which have the potential to cause water quality effects of their own.

Establish a Long-Term, Comprehensive, Interagency Fuel Management Program

Because the watershed spans multiple jurisdictional boundaries, establishment if a long-term, comprehensive interagency fuels management program would provide an effective vehicle to oversee implementation of appropriate fuels treatment methods.

Figure 5: Wildfires Can Cause Significant Water Quality Impacts

OPPORTUNITIES AND CONSTRAINTS:

There is no additional funding to implement fuels management measures through this project.

SHORT AND/OR LONG-TERM OUTCOMES:

In the short-term, effective fuels management will result in reduced occurrence, intensity and/or extent of wildland fires. Over the long-term, this reduction in wildland fire occurrence, severity, and/or extent is expected to result in water quality improvements.

F1. Control Abandoned Mine Flows and Sediment

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
State Department of Conservation, Bureau of Land Management, U.S. Forest Service, Regional Water Quality Control Board, County Environmental Health Departments, individual landowners

PAC ADVOCATE: Foothill Conservancy

DESCRIPTION:
Many abandoned mining locations exist throughout the Upper Mokelumne River watershed, 63 known, identified sites. However, they are difficult to locate for inspection due to the inaccessibility and vegetative cover of much of the watershed lands. There is very little known about the capability and risks of these mines to contribute contaminated runoff and sediment. Specific water quality modeling would be needed to determine the extent of water contamination.

Subwatershed	Management Measure F1: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Particulates ▪ Nutrients ▪ Metals	▪ General Physical
Middle Fork	N/A	▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Particulates	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates	▪ General Physical ▪ Nutrients ▪ Metals

While active mining operations have measures in place to prevent or minimize water contamination, historic mining operations had little regard for environmental impacts and the sites did not require reclamation plans when operations ceased. Abandoned mines contributing high levels of metals from exposed soils and tailings and from runoff pose the greatest risk to aquatic species and humans.

The Department of Conservation is currently undergoing a study to determine the location of abandoned mines throughout the state. Abandoned mines contributing to water contamination may be remediated through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), although this is a lengthy process.

There are several approaches to controlling contaminated abandoned mine flows.

- Isolation, removal, or treatment of toxic materials (such as tailings or exposed rock)
- Stabilization of disturbed lands
- Regeneration of native vegetative cover
- Maintenance of site

The regeneration and reclamation of abandoned mines is site-specific requiring an understanding of the source of contamination associated with each mine. Generally, mine reclamation activities include covering or filling the mine with appropriate soils and regenerating native vegetative cover. Care should be taken to acknowledge and consider the original state of the mine area. Monitoring

should occur after reclamation has occurred to track water quality with pre-existing environmental conditions (USDA, Wildland Waters, Issue 4).

While funding is often limited for abandoned mine programs, grants exist to aid in mine remediation. In 1984, the State of California Lahontan Regional Water Quality Control Board (RWQCB) purchased the Leviathan Mine in Alpine County. Once the RWQCB had ownership of the mine, they developed a revegetation strategy to establish self-sustaining native vegetation at the site of the mine. Due to the high costs associated with land purchase and restoration, it is unlikely that Regional Boards will purchase abandoned mines in the future. (California Office of Mine Reclamation, www.consrv.ca.gov).

OPPORTUNITIES AND CONSTRAINTS:

Reclamation of abandoned mines on private lands is further complicated by the fact that mineral rights for the mine may be owned by a party other than the landowner, causing complications in determining responsibility for cleanup. Opportunities exist it is difficult to enforce and may be difficult to find a responsible party to fund the remediation or reclamation.

SHORT AND/OR LONG-TERM OUTCOMES:

Outcomes include decreased particulate and metals contaminating runoff originating from the mine areas.

F2. Implement Green Streets Design Principles for Reducing Peak Flows, Minimizing Runoff, and Removing Contaminants During Flow

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
County Department of Public Works, Caltrans, County Planning Departments, U.S. Forest Service, Bureau of Land Management

PAC ADVOCATE: Foothill Conservancy

DESCRIPTION:
Street design has a powerful impact on stormwater quality. In a rural watershed, streets can form the majority of impervious surfaces and is often the primary cause of erosion. As the Upper Mokelumne River watershed develops with more suburban communities, streets can make up 60 percent to 70 percent of the total impervious urban area.

Subwatershed	Management Measure F2: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

Green street principles are taken from the recent metropolitan Portland area (agency name: Metro) work that recognized that streets and other large impervious lands affect stormwater runoff and water quality. They define a "green" street or parking lot as having incorporated a system of stormwater treatment within its right-of-way, minimized the quantity of water that is piped directly to streams, incorporated the stormwater system into the aesthetics of the community, etc. ("Green Streets - Innovative Solutions for Stormwater and Stream Crossings". Metro, 2002).

The "hydro-modification" and runoff water quality treatment associated with green streets are similar to those associated with Low Impact Development (LID) concepts. This is accomplished for planning and retrofitting street networks through several methods.

- Reduce peak flows through infiltration
- Naturally filter surface water runoff to decrease pollutant transport
- Decrease impermeable surfaces

Road Design

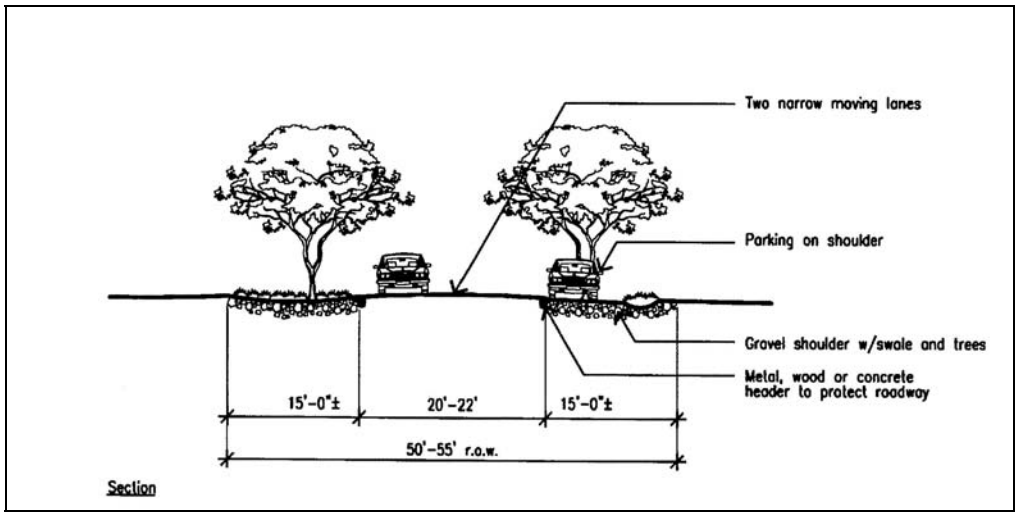
As addressed in the R4-Compact Development management measure, there are design principles associated with green streets and low impact development specific to road design and construction. Roads should be designed to safely handle traffic flow while minimizing width and impervious area. Implementing green streets and low impact development principals in street design will decrease

impervious areas, and intercept rainfall before allowing direct runoff. Figure 6 shows a typical rural street designed with these methods. These principals include the following.

- Pedestrian oriented street and road design
- Trees planted along road sides to create a rain interception canopy
- Vegetative swales instead of rigid curb and gutter
- Road widths designed for traffic flow (thinner roads for less traveled areas)

There are many common road design best management practices that should also be required for site specific conditions of new construction and repair of existing problematic roads and associated drainage systems (Bay Area Stormwater Management Agencies Association, *Start at the Source.* 1999*)*. The Lake Tahoe area has imposed innovative and very restrictive stormwater management practices on development to minimize erosion and other stormwater contaminants (http://www.tahoebmp.org/).

Figure 6: Rural Road Development Implementing Management Measures[4]



Curb Design

Curbs are important in street design for several purposes. Curb and gutter systems collect stormwater, protect the pavement edge, provide distinct right-of-way barriers, and allow the use of stormwater gutter collection. Curbs also increase a street's impact on stormwater quality. Runoff is retained on the street and routed into underground delivery systems, or concentrated surface runoff.

In rural areas and areas where a rigid curb barrier can be avoided, road shoulders should taper to the edge without a curb to encourage dispersed runoff into the soil around the road. The runoff can be routed through an aggregate filter strip, grass filter strip, bio-swale, or bio-swale with basins to encourage infiltration instead of concentrating the runoff. In areas where a rigid curb barrier is required, curbs can be designed to empty into vegetated drainage swales instead of underground pipes and culverts through the following curb options.

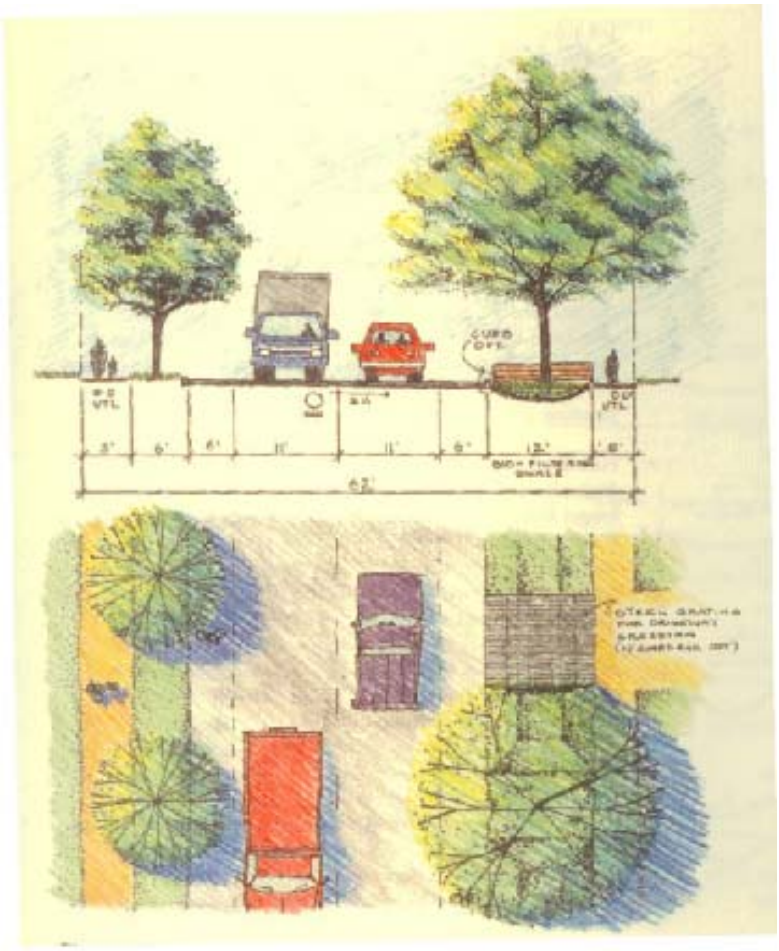
[4] Bay Area Stormwater Management Agencies Association.

- Invisible curb with a lip for overland flow
- Double invisible curb with sediment trench to an infiltration area
- Rumble strip with sediment trench to an infiltration area
- Curb inserts to empty flows to swales
- Perforated curbs to empty flows to swales

Runoff Areas

To reduce peak flows and filter water quality, stormwater should be given the opportunity to infiltrate into the soil before concentrating as surface runoff. Drainage swales provide an opportunity to convey large amounts of stormwater runoff while also filtering the water and allowing it to infiltrate. As presented in Figure 7, bio-filters and bio-retention areas are man-made design features that allow stormwater to be detained and filtered before allowing it to runoff to receiving waters.

Figure 7: Rural Road with Bio-filtering Swale[5]



While it is necessary to convey stormwater in order to prevent flooding, impermeable surfaces increase peak runoff flow during rain events. This peak flow can increase erosion and downstream flooding, and the transport of metals and other pollutants. By providing runoff infiltration and interception, peak flows decrease and allow pollutants to be filtered naturally through contact with soil and vegetation. The use of alternate stormwater management techniques such as the floodplain or detention basins can lessen the impact of peak flows, also reducing public costs and providing a more diverse and attractive environment. For information on two parking lot case studies, see www.epa.gov/owow/nps/bioretention.pdf)

In order to prevent highly concentrated flows from stormdrain outlets from causing streambank

[5] Green Streets – Innovative Solutions for Stormwater and Stream Crossings, Metro, 2002

and surface erosion, roads should be designed to spread flows uniformly. In areas where water exits existing storm drain outlets and spreading out flows is not feasible, encouraging vegetative growth and growth of native plants will greatly reduce soil erosion at the outlet. One method to produce this goal is to use a vegetative mat (Figure 8) that reduces erosion and provides the support for vegetation to grow. Another common method includes placing rip-rap, or small rocks, at the storm drain outlet. While this will decrease the concentrated flow energy, it can increase erosion and be displaced if not used correctly.

Figure 8: Erosion Control Mat[6]

On-site Improvements

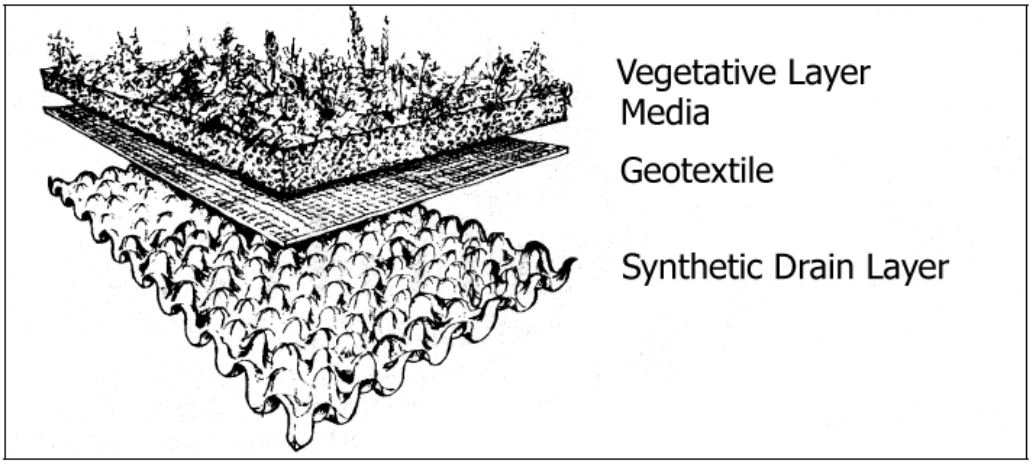
While the watershed is largely rural, rural residential areas contain impervious areas that increase peak flows and contaminant runoff. These flows can be managed by using on-site solutions such as the following.

- Rainwater detention
- Using native vegetation (see Sacramento Stormwater Quality Partnership: www.sacramentostormwater.org/SSQP/Riverfriendly)
- Limiting the impermeable surface area of footprints (sidewalks, driveways, patios, sheds)
- Using permeable pavement or gravel for parking lots, driveways, and sidewalks
- Diverting rainwater to a "rain garden", or similar beneficial use before allowing runoff (see Kansas City, MO example: www.rainkc.com)
- Planting vegetation along roof drip-line to collect roof runoff

An innovative measure to further decrease the amount of impermeable surfaces is to install a vegetative roof. A vegetative roof replaces typical asphalt or other impermeable roof surface with a natural medium that has the ability to use rainwater before running off. Figure 9 shows the components of a vegetative roof from a Philadelphia demonstration project (contact Roofscapes, Inc.: cmiller@roofmeadow.com).

[6] ScourStop (http://www.scourstop.com)

Figure 9: Components of a Vegetative Roof[7]



Native plants tend to naturally decrease stormwater runoff and provide filtering mechanisms for contaminated runoff. Native plants typically require less irrigation, have deeper root structures, require less fertilizer and maintenance, and can provide native habitat for wildlife and other beneficial organisms.

OPPORTUNITIES AND CONSTRAINTS:

As the Upper Mokelumne River watershed develops, now is an opportunity to incorporate these principles into general plans and standard street design ordinances and guidelines.

On-site green streets principles require information campaigns to encourage public acceptance since curbs and gutters are often associated with a higher design standard for rural areas and adding vegetative roofs are not standard practices.

SHORT AND/OR LONG-TERM OUTCOMES:

Since much of the watershed is rural, many of the benefits of green street design will be observed as future street development occurs. Long-term outcomes include improved runoff water quality, reduced peak flows, and decreased erosion from concentrated flows.

[7] EPA, Low Impact Development (2000)

F3. Implement Road Maintenance Practices

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
County Public Works Departments, Caltrans, U.S. Forest Service, Bureau of Land Management, Sierra Pacific Industries

PAC ADVOCATE: Foothill Conservancy

Subwatershed	Management Measure F3: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

DESCRIPTION:
As a source of impermeable surface with its resulting erosion, increased peak runoff, and transport of contaminants in runoff to the Upper Mokelumne River, road maintenance is an important factor reducing pathogens, particulates, and metals. Even with well designed streets (as described in management measure F2), proper maintenance practices are required to minimize water quality impacts of stormwater runoff. Streets collect sediment, metals, and trash during dry periods that is washed away with rain and runoff. For paved roads, regular street sweeping, especially during dry periods, can effectively prevent contaminants from collecting on the street. Curbs and gutters should be cleaned regularly to eliminate trash and debris buildup, especially in areas used for concentrated runoff. For dirt and gravel roads, sediment is a major source of runoff contamination. Seasonal closing of rural dirt and gravel roads during periods of high runoff will decrease erosion and sediment runoff potential.

Dirt and gravel roads require regular maintenance to ensure safety and decrease water quality impacts. Roads should be regularly maintained to ensure proper crown height, smooth surface, and uniform grade to facilitate dispersed drainage to the surrounding ground surface. Roads that are not graded properly can deteriorate and erode during a storm event. Storm drains, where applicable, should be cleaned regularly and remain free of debris to prevent flooding and contaminant build-up. Standards should be developed with regard to the grading of dirt and gravel roads and disposal of earthen spoils.

In addition to road maintenance practices, standards should be established throughout the watershed for road shoulder pesticide use. Proper shoulder pesticide use reduces unnecessary pesticide runoff. Native vegetation planting along road shoulders will lessen the need for pesticide application.

OPPORTUNITIES AND CONSTRAINTS:

Typically in urban areas, storm drain fees can be increased to fund local road maintenance activities. Funds for improved road maintenance must be obtained from other sources. Enacting these measures as requirements before widespread development in the watershed will aid in implementation.

SHORT AND/OR LONG-TERM OUTCOMES:

Long-term outcomes include improved stormwater runoff water quality and reduced erosion.

F4. Enhance Grazing Practices to Encourage Off-stream Watering

Subwatershed	Management Measure F4: Targeted Objectives & Parameters	
	Maintain Concentration	**Improve Concentration**
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Metals
South Fork	▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Metals
Main Stem	▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Metals

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
U.S. Forest Service, Bureau of Land Management, Sierra Pacific Industries

PAC ADVOCATE: Foothill Conservancy

DESCRIPTION:
Grazing, particularly high densities of cattle in riparian areas and other high water quality vulnerability zones, may contribute contaminants, although data do not indicate that this is a significant source of pathogens in the watershed. In areas where high concentrations of cattle access streams as a water source, livestock may trample stream banks and release waste onto lands and into the water. Both deposition of waste onto proximate lands and direct waste deposit into surface water may contribute to the contamination of a waterbody with pathogens. Encouraging livestock practices that provide an incentive for cattle to avoid waterbodies can reduce the risk of contamination.

Providing alternate water sources located away from streams can encourage cattle to leave stream areas to drink. However, due to the remote and inaccessible terrain found throughout much of the watershed, there are no easy solutions for providing alternate water sources. Where practical, provision of alternate water sources should be encouraged. These sources may include the following.

- Watering troughs with small stream diversions providing a supply (if no water rights needed) (Figure 10)
- Spring water supplies diverted away from sensitive areas
- Hauled-in water supplies

OPPORTUNITIES AND CONSTRAINTS:
Due to the topography of the Upper Mokelumne River watershed, which limits access to grazing areas, as well as the extremely low densities of cattle grazing in the watershed, reducing this potential source of pathogens is not likely to have a significant impact on reducing microorganism levels in the Middle and South Forks. While cattle management is currently a part of Forest Service grazing permits, additional practical, cost-effective methods to encourage cattle watering and grazing away from waterbodies should be developed.

Figure 10: Watering Trough in North Fork subwatershed

SHORT AND/OR LONG-TERM OUTCOMES:

Decreasing livestock access to rivers and streams could result in a reduction in loading of microorganisms and nutrients. Based on the very low density of cattle grazing in the watershed, it is unclear whether this reduction in loading would be sufficient to achieve reductions in observed microbial concentrations. Long-term effects of reduced access to rivers and streams may include decreased turbidity and suspended sediment in the rivers and streams due to decreased stream bank erosion. Again, due to the low density of cattle grazing in the watershed, these reductions may not be sufficient to produce reductions in observed turbidity and suspended sediment concentrations.

R1. Implement Water Quality and Temperature Monitoring

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
State Water Resources Control Board - Regional Water Quality Control Board, Central Valley Region, Amador County Environmental Health Department, Calaveras County Environmental Management Agency - Department of Environmental Health, FERC, Alpine County Water Agency, Amador Water Agency, Bear Valley Water District, Calaveras County Water District, Calaveras Public Utility District, East Bay Municipal Utility District, Jackson Valley Irrigation District, Mokelumne Hill Sanitary District

PAC ADVOCATE: Foothill Conservancy, Alpine Watershed Group

DESCRIPTION:
The following parameters were assessed through the UMRWAP. Parameters in bold face were identified as being of potential interest in one or more watershed.

Subwatershed	Management Measure R1: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

- **Fecal Coliform**
- Total Coliform
- ***Cryptosporidium***
- *Giardia*
- ***E. coli***
- Total Dissolved Solids
- Total Suspended Solids
- **Turbidity**
- **Alkalinity**
- Dissolved Oxygen
- Hardness
- pH
- Temperature
- Electrical Conductivity
- Total Organic Carbon
- Ammonia
- **Nitrate**
- Nitrite
- Total Kjeldahl Nitrogen
- Orthophosphate
- Total Phosphate
- Potassium
- **Aluminum**
- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Calcium
- Chromium
- Copper
- Iron

- Lead
- Magnesium
- Manganese
- Mercury
- Nickel
- Selenium
- Sodium
- Sulfate
- Thallium
- Zinc
- 2,4-D
- Alachlor
- Benzene
- Carbon Tetrachloride
- Glyphosate
- Hexazinone
- Methyl Tertiary-Butyl Ether
- Thiobencarb
- Vinyl Chloride

Track Changes in Baseline Water Quality

In general, it is recommended that monthly monitoring be implemented on the same day each month at a minimum of four locations in the watershed (North Fork near confluence, Middle Fork near confluence, South Fork near confluence, and Main Stem near Highway 49). This data collection will allow changes in baseline water quality to be tracked over time, although if degradation of water quality occurs, it is often too difficult and expensive to correct the cause.. Water quality monitoring data should be housed and maintained in accordance with the implementation plan. The monitoring results should be reviewed every two to three years to identify new data trends. At that time, the parameters themselves should be reviewed as well to determine whether parameters should be removed from the list. Conversely, additional parameters may be recommended at that time based on new regulatory requirements and/or emerging contaminants of concern.

Identify Sources of Water Quality Contamination

Several potential contaminating activities have been identified throughout the watershed. Timber harvesting, grazing and other activities that result in reductions in natural land cover are suspected to contribute to elevated concentrations of particulate matter in runoff. Similarly, formal and informal recreational activities can increase erosion, and may contribute to particulate loading. Grazing and recreational uses are also suspected of contributing microbial contaminants to watershed water bodies. Illegal dumping may contribute to a variety of contaminants in the watershed. However, while the potential for these activities to contribute contaminants to water bodies in the watershed is known, the magnitude of the impact of these activities on current watershed conditions is not known.

In order to understand the relative impact of these or any other suspected contaminating activities on the water quality of the watershed, tailored monitoring programs should be developed and implemented. These monitoring programs should be designed to monitor concentrations of specific parameters suspected to be contributed by the contaminating activity. Monitoring should be conducted upstream and downstream of the suspected activity to compare the potential impact on observed water quality. Results of tailored monitoring programs are necessary to demonstrate the impact of these activities.

Where parameters have been identified as being of potential interest, particularly pathogens, it is recommended that water quality monitoring programs be implemented to identify the contaminant source(s). A monitoring program at several locations in areas of high septic system concentrations, known failing systems, or older systems could provide documentation of source locations. The method used to identify the contaminant source will vary depending on the parameter of interest being addressed. For example, if it is suspected that elevated turbidity is being caused by runoff from an eroded area adjacent to a stream segment, a monitoring program may be developed to measure turbidity upstream and downstream of the suspected contributing location. Similarly, if stormwater is suspected of contributing to elevated metals concentrations, a monitoring program may be implemented to measure the concentrations of metals in stormwater runoff.

A monitoring program would particularly help identify sources of microbial contamination from leaking septic systems. To determine the origin of fecal coliform and other microbes, an additional step may be required. Because fecal coliform, *Cryptosporidium*, *E. coli*, and other pathogens can be contributed by both human and animal sources, various methods may be employed to identify the species of origin, including the following.[8]

- **Ratio of fecal coliform to fecal streptococci.** The ratio of fecal coliform concentration to fecal streptococci concentration can be used to infer contamination from human sources. A ratio of 4 or greater is considered to indicate human contamination, and a ratio of less than 0.7 suggests non-human contamination.
- **Species-specific indicators.** Many bacterial strains are specific to particular animal species. For example, streptococcus bovis is associated primarily with ruminants, though it occurs in low numbers in humans. *Clostridium perfringens Bifidobacteria longum*, and *Bifidobacteria adolescentis* can be used as an indicator of human point or nonpoint pollution. *Rhodococcus coprophilus* is primarily contributed from domestic farm animal grazing.
  Coliphages. Coliphages are viruses that infect *E. coli.* One category of coliphages, male-specific phages, while not common in humans or other animals are common in sewage, and can be an indicator of fecal contamination. Various categories of coliphages have been linked to specific host organisms (i.e., group I is only found in zoo animals, pigs contain types I and II, and humans contain types II and III, with group III phages exclusively human).
  Bacteriodes fragilis phage. The *Bacteriodes fragilis* phage is specific to humans and can be an indicator of human fecal contamination.
- **Multiple antibiotic resistance (MAR).** Due to limited exposure, bacteria found in wildlife are generally not resistant to antibiotics. By challenging with varying types and strengths of antibiotics and observing resistance characteristics, bacteria can be loosely classified as likely or unlikely to be of human origin.
- **Genotyping.** In this method, the DNA of pathogens found in the waterbody is compared to DNA from the same pathogen in various animal species to identify the closest match.
- **Presence of chemical indicators.** The presence of various chemical indicators in a sample can be used to infer human contamination. For example, the presence of detergents,

[8] A Washington State Department of Ecology Report: Fecal Contamination Source Identification Methods in Surface Water (http://www.ecy.wa.gov/pubs/99345.pdf).

caffeine, or coprostanol (a fecal sterol found in feces of humans and other higher mammals) would suggest contamination is of human origin.

Quantify Load Reductions from Management Measure Implementation

As load-reducing management measures are implemented throughout the watershed, water quality monitoring programs should be implemented to quantify the resulting load reductions. The parameter(s) to be monitored should correspond to the parameters for which load reductions are expected, and the location and timing of monitoring should be established on a case-by-case basis. Water quality monitoring data collected for this purpose should be housed in accordance with the management measure: House, maintain, and update assessment tools.

Characterize and Evaluate Temperature Variations

Temperature varies significantly throughout the watershed on both a daily and seasonal basis. Temperature on the North Fork is also influenced by hydropower operations which can increase instream temperatures by reducing flow volumes downstream of diversions, and can decrease instream water temperatures by discharging relatively cold water downstream of powerhouses. Due to the relatively limited set of temperature monitoring data available at this time, temperature was not able to be evaluated with respect to its benchmark: the Basin Plan Water Quality Objective. Temperature throughout the watershed should be monitored to confirm consistency with Basin Plan Water Quality Objectives for temperature and to identify potential impacts to aquatic life posed by temperature fluctuations caused by natural conditions and human influences in the watershed.

Track Copper Concentrations Downstream of Lower Bear Reservoir

Lower Bear Dam is currently suspected of leaching copper into the reservoir as well as the river downstream of the dam. The stream segment immediately downstream of the dam is currently classified as impaired for copper based on the California Toxics Rule ambient water quality criteria. Because of the potential negative effect elevated copper concentrations may have on aquatic life downstream of the dam, copper concentrations within Lower Bear Reservoir and downstream of Lower Bear Dam should continue to be monitored to confirm the source, identify trends associated with copper loading in that reach, assess the degree of the potential copper problem, and support identification of a solution.

OPPORTUNITIES AND CONSTRAINTS:

There is no additional funding for water quality monitoring available through this project. However, there are many potential funding sources for implementing monitoring programs. In particular, funding for citizen monitoring may be available for this purpose, and should be explored as a potential alternative.

In addition, some UMRWA members continue to implement water quality monitoring in the watershed. To the extent possible, the data collected by these agencies should be compiled, and new monitoring programs should be implemented to supplement rather than duplicate these existing programs. New monitoring programs implemented in the watershed should be reviewed for comparability with existing monitoring programs prior to implementation.

SHORT AND/OR LONG-TERM OUTCOMES:

To be able to track changing water quality conditions throughout the watershed using sustainable assessment tools is one of the lasting benefits established by the UMRWAP. This measure will provide the following short term outcomes.

- Continue to collect watershed water quality data to be used in conjunction with the assessment tools in tracking changing water quality conditions.
- Collect data on the effectiveness of management measure implementation.
- Collect data to be used to identify potential contaminant sources in the watershed.

The long term outcomes of the water quality monitoring data collection are as follows.

- Track ongoing water quality conditions in the Upper Mokelumne River watershed.
- Quantify load reduction benefits associated with management measure implementation.
- Locate contaminant sources in the watershed.

R2. Pollution Prevention Public Education

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:

Alpine County: Department of Health and Human Services – Environmental Health Services, Unified School District; Amador County: Environmental Health Department, Unified School District, Agriculture Department, Farm Advisor – UC Cooperative Extension, Public Works Department, Waste Management Department; Calaveras County: Department of Environmental Health, Unified School Districts, Environmental Management Agency – Agriculture Weights and Measures, Environmental Management Agency – Environmental Health, Public Works Department; Eldorado and Stanislaus National Forests; UC Agriculture and Natural resources (UC ANR); Local NGOs if funding can be obtained; EBMUD

Subwatershed	Management Measure R2: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

PAC ADVOCATE: UMRWC

DESCRIPTION:

As the Upper Mokelumne River watershed continues to become more developed, increases in population and changes in land use/management are likely to also increase the presence and expedite the transport of pollutants to local waterbodies. Public education on where common pollutants originate, how they impact water quality and how easily such impacts can be prevented will be critical to ensuring that the health of the watershed is maintained. By educating existing residents on how they can reduce water pollution, new residents will be greeted by an informed community and are more likely to follow suit. Pollution prevention education can include messaging and programs geared toward both source reduction and transport reduction in several areas. Below are a few of the areas that could be targeted. Public education of septic systems is described in management measure S1.

Upper Mokelumne Integrated Pest Management Program (IPM)

Establishing an Upper Mokelumne Integrated Pest Management Program would serve to educate local residents, farmers, vineyard growers and gentleman farmers on ways to reduce pesticide use by providing pest management alternatives that have lesser impacts on water quality.

- Partner with Amador County and Calaveras County UC ANR Cooperative Extension to assist farmers and landowners in adopting existing IPM program measures.
- Encourage local farmers to enter into research partnerships to receive grant funding for local IPM research through UC IPM Grant Program.

- Provide a certification for farms as well as landowner landscaping that uses IPM program measures.

Hazardous and Recyclable Materials Programs

Items such as fluorescent lights, thermometers, amalgam fillings, batteries, pharmaceuticals, and unused household and automotive fluids should never be dumped down drains or into trash cans. These materials should be brought to waste facilities capable of properly handling such items. However, it is often time consuming, inconvenient and expensive for residents or businesses to make this happen. Local sponsored collection and incentive/education programs provide real reductions in the amount of materials that make it to dumps and end up at wastewater treatment plants. Ideas such as hardware store recycling bins, dental office certifications for amalgam separators have been successfully implemented in rural areas thus reducing the amount of pollutants that enter the watershed.

A fluorescent light bulb recycling at hardware store pilot program was conducted by the North Bay Watershed Association in 2005. The program increased awareness of pollution prevention and also collected and recycled full boxes of bulbs every two weeks at three north San Francisco Bay hardware stores.

Stormwater Awareness Program

Whether required by the state or not, implementing a strong public awareness campaign on how water quality can be preserved and even improved by implementing basic pollutant transport prevention measures will reap near and longer term rewards. Such a program may be comprised of the items below.

- Multi-agency MOU to allow for resource and cost sharing while providing a consistent and unified message
- Coordination with local media to disseminate educational messages
- Coordination with local watershed council to bring up topics at local meetings or other gatherings
- Coordination with group to host homeowner and construction management measure information sessions
- Prepare materials and copy for newsletters, newspaper articles, press releases, hand-outs or other public outreach materials
- Coordinate with local school districts to incorporate stormwater pollution prevention into class curriculums and other educational formats, expanding on the Authority's current program
- Provide pet waste bags and trash cans at trail heads

An example of a progressive program is provided by the Russian River Watershed Association which has sponsored a Stormwater Awareness program for over four years. The program provides a regional program to assist its 11 member agencies in not only meeting NPDES permit requirements, but also provide community support of pollution prevention. Elements of the program include a student video contest, environmental articles in local papers, billboards, storm drain decals, coordination of local events and regional surveys for program effectiveness measurement.

OPPORTUNITIES AND CONSTRAINTS:

Given that there is little to no funding available to agencies to implement programs (especially without an NPDES permit requirement), funding these programs will be the biggest constraint. Coordination on a regional level will provide a better case for groups of agencies to apply for funding from state money geared toward watershed and regional level projects. Also coordinating with the UC ANR extension services may be another funding option. With coordination comes challenges on reaching agreement on goals, objectives, methodologies and implementation. Effectiveness monitoring of programs will also be a challenge – but coordination with local watershed groups can be key toward implementation

SHORT AND/OR LONG-TERM OUTCOMES:

Short-term reductions anticipated in pollutant loadings from stormwater runoff due to pollution prevention public education efforts. Long-term preservation of water quality anticipated.

R3. Items to Include in General Plan Update

Subwatershed	Management Measure R3: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Amador County Board of Supervisors; Calaveras County Board of Supervisors; Alpine County Board of Supervisors

PAC ADVOCATE: Foothill Conservancy

DESCRIPTION:
Every city and county in the state must have an adopted general plan. A general plan establishes the overall policy framework for land use and development. All land use and development regulations must conform with the general plan. For example, zoning regulations and zoning districts must conform with and implement the goals and policies of the general plan. Subdivision regulations and all other discretionary land use approvals, including variances, and use permits, must also conform with the general plan, or they may not be legally approved. Seven elements are required by the state: land use, transportation, housing, resource conservation, open space, health and safety, and noise. Water resources related information is typically fragmented throughout the various elements

The general plans should analyze the sources and quality of water resources and establish policies and programs to preserve its quality. It is recommended that a separate water element be developed for the Amador and Calaveras general plans which could compile and address water resources issues into one location instead of throughout the various elements. The water element is an optional element of the general plan as permitted by Section 65303 of the California Government Code. The general principles described here can be incorporated into a separate water element or the various other elements of the updated general plans.

General Plan Content

The general plan should contain an assessment of the following issues to support the development of goals, objectives, policies, and actions related to maintaining and improving source water quality.

- Delineate the boundaries of the watersheds within each county, aquifer recharge areas, groundwater basins, and floodplains
- Delineate boundaries of unique water resources such as marshes and wetlands, riparian corridors, and wild rivers.

- Assess the existing water quality of existing waterbodies. Extend the water quality assessment conducted for the Upper Mokelumne River to adjacent watersheds.
- Identify known and potential contaminants associated with specific sources such as grading or know areas of failing septic systems and from generalized sources such as stormwater runoff and abandoned mines.
- Inventory existing and planned wastewater treatment and disposal facilities, and on-site septic or related disposal systems.
- Correlate projected wastewater flows with existing land uses and draft general plan update land uses of undeveloped lands.
- Identify key waterbodies and subwatersheds that must be protected or rehabilitated to promote fisheries and other aquatic life.
- Identify groundwater recharge zones and floodplains.
- Identify open space areas vital for the preservation of key natural resources and for public health and safety
- Identify areas of unstable soils and landslide hazards if a water quality vulnerability zone map is not available.
- Assess the cumulative changes to river water quality associated with the draft general plan update proposed land use decisions.

Watershed Water Quality Related Policies

An interdisciplinary approach to watershed water quality related policies addressed in the general plans is encouraged. For example, policies and analyses related to fire hazards may be described in the public safety element with the implications of fire impacts on water quality linked to the water element or resource conservation element. Likewise, the linkage between land use decisions in the land use element and water quality impacts in other elements should be presented. The following policy topics are recommended for inclusion in the general plan updates.

- Develop a watershed overlay to the land use map. This overlay would reflect areas needing special policies and development standards for water quality protection. For example, the water quality vulnerability zones identified for the project identify key areas requiring land use controls to reduce the risk of water quality degradation. Restrict use and storage of potential water quality contaminants in these areas. Development restrictions or conditions would be enacted through zoning and subdivision ordinances.
- Establish setbacks or an overlay zone from riparian corridors, wetlands, and reservoirs for no or limited development.
- Establish open space areas reflecting key natural resources and public health and safety that require special management or regulation because they are in floodplains, high fire risk areas, areas of impact to fisheries and other aquatic life, groundwater recharge zones, and/or are areas highly vulnerability to contributing water quality impacts.
- Require runoff performance standards to not allow a net increase in peak storm drainage, and minimize the impacts of stormwater runoff water quality.
- Encourage existing property owners to reduce impermeable surfaces and eliminate or control sources of contamination.
- Require inspection and repair, if necessary, of septic systems prior to home or business sale.

- Establish an urban services boundary for the short and long term expansion of wastewater collection and treatment facilities.
- Pursue opportunities for enhanced water conservation programs and use of recycled water.

The Santa Clara County General Plan provides good examples of general plan policies related to many of the above items (www.sccplanning.org).

OPPORTUNITIES AND CONSTRAINTS:

Both Amador and Calaveras general plans updates are in-progress. Alpine County is not updating its general plan. Alpine County could incorporate recommended changes in its next update, and by adopting policies and revising current development requirements to reflect the policies.

SHORT AND/OR LONG-TERM OUTCOMES:

Change County policies, adopt ordinances, and revise permit requirements to reduce risk of water quality contamination associated with existing and future land uses.

R4. Encourage Compact Development in General Plan Updates for Water Quality Protection

Subwatershed	Management Measure R4: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Amador County Board of Supervisors; Calaveras County Board of Supervisors; Alpine County Board of Supervisors

PAC ADVOCATE: Foothill Conservancy

DESCRIPTION:
Clustering development accommodates more people in less space with the intent of preserving natural areas. Compact growth consumes less land and reduces infrastructure costs. Sprawl contributes more impervious surfaces. Paved surfaces increase stormwater runoff in areas that once absorbed rainfall. Discontinuous, low-density, auto-dependent growth patterns that result in increased impervious surfaces can lead to the following impacts.[9]

- Disturbance of forests, soils, and wetlands that once served as buffers and filters
- Destruction of habitat for fish and wildlife and impaired aquatic health
- Increased nutrient pollution in waterways, causing algal blooms and eutrophication
- Thermal flashes and damaging temperature ranges in streams and creeks
- Contamination of drinking water sources
- Increases in polluted runoff from human and household sources
- Decreased groundwater recharge

The term "new urbanism" can be adapted to the Upper Mokelumne River watershed as "new ruralism" (Local Government Commission Organization, 2007). New urbanism refers to community design concepts that promote the creation of walkable, compact, mixed use communities containing the same components as conventional development but assembled in a more integrated fashion.

The general principles can be applied to the rural nature of the Upper Mokelumne River watershed.

- **Walkability**. Locate commonly accessed uses within a 10 minute walk from home or work. Make walking pleasurable. Encourage walking and biking through pedestrian-friendly design.

[9] http://www.epa.gov/watertrain/smartgrowth

- **Traditional neighborhood structure**. Designate mixed land uses and a range of uses and densities within walking distance. The highest densities should occur at the town or village center, becoming progressively less dense towards the edge.
- **Environmental impacts**. Planning for compact growth rather than sprawled development minimizes environmental impacts of development by encouraging less driving. Specifically important to this project, compact development reduces impervious surfaces overall by concentrating development, allows for better management of urban/rural runoff pollutants, and provides enough concentration to support sewage collection and treatment systems instead of septic systems.

It is a particular concern within the Upper Mokelumne River watershed that microorganisms associated with leaking septic systems be eliminated (see measure S1). Compact development in already developed areas of the watershed can encourage the extension or construction of sewage collection and treatment systems for new development and provide more cost effective connections for existing homes currently on septic systems.

Compact development not only encourages walking and less automobile use, but also reduces the automobile-generated pollutants that are washed away in stormwater. With compact development, less impervious surfaces are created and there are opportunities to manage the stormwater runoff through the use of streetscape design features. The green streets concepts discussed in Management Measure F1 provides for the recommendation to reduce hydrologic impacts and stormwater pollutants through design features such as bioretention using native vegetation to slow down and clean stormwater before it reaches a stream and paving using pervious materials. The public education Management Measure R2 includes resident support within the watershed for this concept of community design. More information on compact development concepts can be found at www.lcg.org, www.newurbanism.org, and many other websites.

Another form of this measure is for the counties to encourage compact development on individual large lots. Siting homes on a lot to reduce water quality impacts may be a simple as building a two story home with a smaller footprint, or locating homes far from waterbodies to allow for stormwater runoff to filter through vegetation before reaching the stream.

Encouraging compact development as the three counties grow, will aid in minimizing watershed water quality impacts associated with growth. Amador and Calaveras counties can incorporate compact development in community design through the General Plan update process of developing policies and ordinances. Most zoning ordinances do not allow for compact development; adopting form-based codes in combination with more traditional use-based zoning codes can overcome this problem. Form-based codes place a primary emphasis on building type, dimensions, parking location, and façade features and less emphasis on uses. They stress the appearance of the streetscape over long lists of different use types and densities. (Source: Local Government Commission, 2007, www.lcg.org.)

OPPORTUNITIES AND CONSTRAINTS:

Higher densities of development within the Upper Mokelumne River watershed would alter the general rural nature, which may not have public support. However, this is an opportunity to avoid

the current practice of large lot developments spread throughout the watershed which bring a host of traffic, water quality, and other related quality of life issues.

SHORT AND/OR LONG-TERM OUTCOMES:

Incorporate compact development concepts in the General Plan updates through policies, land use changes, zoning ordinances, and design standards.

R5. Purchase Lands, Development Rights, and/or Conservation Easements

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Water purveyors, County agencies, non-governmental agencies, individual landowners

PAC ADVOCATE: UMRWC

DESCRIPTION:

Subwatershed	Management Measure R5: Targeted Objectives & Parameters	
	Maintain Concentration	Improve Concentration
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

Development control over lands within the Upper Mokelumne River watershed, and specifically within the high water quality vulnerability zones, could have a significant impact on maintaining watershed water quality. This type of development control may be in the form of outright purchasing of lands by a governmental or non-profit entity, purchasing development rights to lands without having to purchase the property itself, and/or encouraging landowners to file conservation easements on their own property.

Land Purchase
Purchasing of watershed lands allows for complete control of the purchased site. The City of New York's Department of Environmental Protection has spent over $1 billion acquiring land and conservation easements in their extensive drinking water watershed to protect water quality.

Purchase of Development Rights
Purchasing of development rights is not as costly as a land purchase; it provides the potential for keeping property on the tax rolls, and it allows for controlling future development on the land. The property owner voluntarily sells, versus donates, the development rights of its property to a state or local government or organization. The development rights may be retired permanently or for a predetermined number of years. The property rights forfeited typically include the right to construct man-made features on the property. These rights may be sold while other rights may be retained.

An easement is put on the property providing for protection of the property from development. The easement is a legal mechanism that places a restriction on the property deed or title of ownership. The local government must follow up on the enforcement of the agreement. The Nature Conservancy, The Trust for Public Land, and other land trusts are active in acquiring

development rights. Unlike conservation easements, the property owner must pay taxes on the sale of development rights.

A variation is the transfer of development rights (TDR) which compensates owners of sensitive lands by transferring the right to develop a different property. Amendments would be required to the zoning ordinance to establish transfer (sending and receiving) districts. Although there are no acquisition costs, the TDR concept may not be attractive to some communities. Rights are generally transferred from a rural area to an urbanizing area with infrastructure support. One advantage with TDRs is that the private sector is paying to preserve these sensitive lands.

Conservation Easements

Conservation easements are similar to purchasing development rights in that a property owner relinquishes some property rights but can still use the property for its current use. A conservation easement is a legal agreement between a landowner and a land trust or government agency that permanently limits uses of the land in order to protect its conservation values. It allows the property owner to continue to own and use its land and to sell it or pass it on to heirs. Conservation easements can be purchased, but are usually donated by property owners to realize significant tax benefits and have assurance that future landowners do not build on the land.

OPPORTUNITIES AND CONSTRAINTS:

Higher densities of development within the Upper Mokelumne River watershed would alter the general rural nature, which may not have public support. However, this is an opportunity to avoid the current practice of large lot developments spread throughout the watershed which bring a host of traffic, water quality, and other related quality of life issues.

SHORT AND/OR LONG-TERM OUTCOMES:

Incorporate compact development concepts in the General Plan updates through policies, land use changes, zoning ordinances, and design standards.

R6. Supplemental Watershed Assessments for Non-Water Quality Conditions

POTENTIAL PARTNERS/AGENCY TO IMPLEMENT:
Water purveyors, County agencies, non-governmental agencies, individual landowners

PAC ADVOCATE: Foothill Conservancy

DESCRIPTION:

The Upper Mokelumne River Watershed Assessment and Planning Project has been conducted with a specific, targeted objective: Maintain and Improve Source Water Quality. Management measures have been designed to achieve this goal by maintaining water quality conditions for parameters present at concentrations below the benchmarks and improving water quality for parameters present at concentrations in exceedance of the benchmarks.

Subwatershed	Management Measure R6: Targeted Objectives & Parameters	
	Maintain Concentration	**Improve Concentration**
North Fork	▪ Microorganisms ▪ Particulates ▪ Nutrients ▪ Metals ▪ SOCs, VOCs, and Pesticides	▪ General Physical
Middle Fork	▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ Particulates ▪ General Physical ▪ Nutrients ▪ Metals
South Fork	▪ Microorganisms ▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ General Physical ▪ Nutrients ▪ Metals
Main Stem	▪ Particulates ▪ SOCs, VOCs, and Pesticides	▪ Microorganisms ▪ General Physical ▪ Nutrients ▪ Metals

The watershed assessment performed as part of this project established and assessed baseline water quality conditions throughout the watershed. What the assessment did not address was fluvial processes, terrestrial and aquatic species and habitat conditions, etc. in the watershed. Implementing alternative approaches to assessing and addressing specific issues or concerns associated with the watershed could generate supplemental information supporting a broader understanding of watershed conditions. Complementary watershed assessments could provide valuable information on issues such as stream function and condition, condition of terrestrial and aquatic habitats, species present, wildlife corridors. A few examples, but certainly not an exclusive list, of watershed assessments that could provide additional information on the condition of the Upper Mokelumne River watershed, are described below.

Native and Sensitive Species Habitat Assessments. Native and/or Sensitive Species habitat assessments can provide important information on species present in the watershed that should be protected and/or supported.

Meadow and Riparian Corridor Assessments. These assessments provide information on the condition of existing meadows and riparian corridors, and can serve as a basis for prioritizing restoration projects.

Aquatic Species Habitat Assessments. This type of assessment involves evaluating the health of aquatic species habitat in the watershed to identify focus areas for aquatic habitat improvements.

Stream Function and Condition Assessment. The goal of a stream function and conditions assessment is to assess whether a riparian or wetland area is functioning properly. The identification of stream function and condition can be used to develop targeted environmental enhancement and restoration projects.

PRIORITIZATION OF MANAGEMENT MEASURES

The highest priority management measure is S1. Eliminate Leakage from Septic Systems. This is due to the risks to human health associated with microorganisms found in septic system effluent; the risk to human health from microorganism exposure through the use of the Upper Mokelumne River for body-contact recreation, such as swimming; , and the difficulty in treating microorganisms in the water treatment process.

There is difficulty in prioritizing the remaining management measures. Management measures aimed at reducing concentrations of parameters of interest in fork) where the benchmarks are exceeded could be generally considered higher priorities for implementation than management measures aimed at maintaining existing water quality concentrations. However, since the benefits associated with most of the measures are applicable to many water quality parameters, the opportunities for implementation of any of the measures must be pursued when funding can be made available, and the difficulty associated with corrective actions after a parameter exceeds a benchmark in the future, all remaining measures are considered a high priority.

IMPLEMENTATION

Implementation of the management plan is focused on the housing and maintaining the project tools and periodically evaluating progress toward management measure implementation.

House, Maintain, and Update Assessment Tools

The following tools were developed for the project:

- Baseline water quality;
- Watershed simulation of water quality (WARMF);
- Water Quality Vulnerability Zones (WQVZ); and
- Fire Models (FlamMap and FARSITE).

One of the primary purposes for developing assessment tools is to enable the Authority to track changing water quality conditions throughout the watershed. The WARMF tool provides a method for tracking long-term water quality conditions in the Upper Mokelumne River watershed, and can be utilized to simulate source water quality conditions under various land use and land management scenarios. Similarly, the WQVZ results are a tool for land use planning entities to prioritize and protect those watershed lands that are most vulnerable to transporting water quality constituents of concern to the waterbodies on a long-term basis. The fire model tools generate information that can be used on a long-term basis to allow optimization of fuels management and assessment of future fuels management efforts.

Housing of these tools requires the identification of an entity to serve as the steward of these tools. The PAC considers EBMUD to be the most appropriate steward because of its in-house modeling resources. If EBMUD is not available to serve in this capacity in the future, a potential alternate steward could be identified. Potential alternate stewards may include another Authority member agency, a local water district, a county agency, a local non-governmental organization, or a federal or state agency. If, in the future, another stakeholder would like to take responsibility for stewardship of the project tools, the project implementation strategy must be flexible to accommodate this change. Similarly, if the WARMF model is expanded to include other watersheds besides the Upper Mokelumne River, a decision will be made at that time if a change in stewardship is needed. This flexibility in implementation will be accommodated through continual review and update of project progress and changes, allowing key decisions such as a change of stewardship of project tools to be made over time on a case-by-case basis.

Regardless of who the steward is, all project tools will be made available from the steward upon request. If the tool is modified by someone other than the steward, the modifications made and the use of the tools should be documented. If the changes made included updates to the data or addition of new, more detailed data, the updated model could provide increased value to future users. In this case, it is expected that the user modifying the model would provide the updated version to the steward to be housed. The steward would determine whether the revised model is suitable to replace the former version. Otherwise, it is anticipated that the steward would perform the updated model runs, as requested, within a reasonable number of requests per year and as staff has availability, and results would be provided to the entity requesting the model run. This would allow the steward to retain staff skills in model operation. Monitoring data and other types of information developed by various entities should be contributed to the steward and maintained in a central database or clearinghouse for future updates.

Updates to the tools, particularly the WARMF model, may occur on a regular schedule if not needed sooner than the scheduled date. A schedule for updates is identified.

- **Baseline water quality**. It would be expensive to rerun the analyses of all variables assessed in baseline water quality. It is recommended that baseline water quality reflecting average monthly conditions be updated once per year for the parameters of interest, and once every 2 to 3 years for all other parameters. This will ensure that any preexisting or new benchmark exceedences can be tracked.
- **WARMF**. The WARMF land use layer should be updated annually. The model should be updated with new hydrology, water quality, and GIS watershed characteristic data at least once every two years to ensure that changing water quality conditions will be captured, and benchmark exceedences by subwatershed may be observed. Updates may occur more frequently than once every two years as needed for specific uses. Calibration with new data should occur every 5 to 10 years.
- **Water Quality Vulnerability Zones** (WQVZ): Updates are needed to the WQVZ data only if natural characteristics of the watershed are altered.
- **Fire Models**: Updates to FlamMap and FARSITE are needed when the models are to be used for analyses.

The tools are of great value to stakeholders in the watershed. They reflect a significant level of effort on the Authority and PAC's part, and will serve as useful and sustainable assessment tools for various uses.

Schedule for Implementing Measures (Interim, Measurable Milestones)

Maintaining and using the project tools is of utmost importance for realizing the value of this project. Implementing the developed management measures will ensure that water quality in the Upper Mokelumne River watershed is maintained and improved. Annual reporting and the evaluation of progress on the status of the tools and implementation of management measures provides for a system for keeping the activities and tools current and useful.

An annual report to the Authority and other stakeholders by the owner, with contributions from stakeholders, will provide the following information.

- Requests by others for use of project tools, purpose of use, modifications made by others, etc.
- Data obtained during the year for updates to the tools.
- Updates, modifications, recalibration for specific areas of study, if any, made to any of the tools during the year.
- Notification of any changes to water quality conditions, particularly parameters of interest and any new benchmark exceedences.
- Status of the management measures.
- Progress toward achieving target load reductions.

As the use of the tools and implementation of the management measures progresses in the future, periodic review is recommended to identify whether the tools and measures continue to provide value. The measures and tools may need to be adapted (through an adaptive management process) to better accommodate changing conditions.

Revisit Parameters of Interest and Benchmarks

If a water quality parameter of interest or a parameter concentration being maintained exhibits signs of water quality degradation, the entity noting the changing conditions should bring this observation to the attention of the Authority and other stakeholders, and a correction strategy should be developed cooperatively. However, by the time water quality degradation is indicated in monitoring data, it is difficult to correct the cause. Proactive implementation of the management measures is strongly encouraged.

Technical and Financial Assistance Needed

Grants and other sources of outside funds are likely to be necessary to implement and evaluate the effectiveness of the recommended management measures. The project tools, data, and technical memoranda were developed with the intent of supporting grant applications and targeting other sources of funds.

APPENDIX A: CALCULATION OF TARGETED CHANGES IN LOADING

As described in TM No. 10, the following parameters of interest exhibited observed or simulated benchmark violations during one or more months on one or more major tributaries of the Upper Mokelumne River.

- Fecal coliform
- Cryptosporidium
- E. coli
- Turbidity
- Nitrate
- Alkalinity
- Aluminum

For each of these parameters, the change in loading to achieve the benchmark was calculated. It should be noted that, depending upon the parameter, loading may be more or less important than concentration in determining potential impacts to human and aquatic health. For example, metal toxicity is largely a function of concentration, whereas impacts associated with nutrients may be more effectively managed by controlling loading rather than reducing concentrations. In general, if it is feasible to reduce or increase the concentrations of parameters of interest to remedy the observed or simulated benchmark exceedance(s), management measures have been developed to facilitate this change in loading.

In addition, these are not all load ***reductions***; the alkalinity benchmark is a minimum benchmark; as such, the target load change represents an ***increase*** in alkalinity loading. Because low alkalinity is the result of natural, pristine conditions in the watershed, management measures have not been recommended to increase alkalinity in the watershed. This appendix presents the methodology for calculating the targeted change in loading.

Methodology

For each parameter of interest, the target load change was calculated by subtracting the estimated load during the month and location of the exceedance if the parameter was present at the benchmark concentration from the estimated parameter loading causing the violation. Target change in loading was calculated as follows.

$$\Delta_L = L_V - L_B \qquad (1)$$

Where:

Δ_L =Target change in loading

L_V = Loading causing the violation at the specified location

L_B = Loading at benchmark concentration at the specified location

The loading causing the violation can be calculated as shown in Equation 2.

$$L_V = C_V * Q_V \qquad (2)$$

Where:

L_V = Loading at time and location of violation at observed or simulated concentration

C_V = Observed or simulated concentration during violation

Q_V = Average streamflow for the violation month over the period of record at the violation location

Because violations are determined by comparing an average monthly concentration over the period of record to the benchmark concentration, the streamflow used to calculate the loading was similarly taken as the average monthly streamflow during the month of violation over the period of record.

Similarly, the estimated loading that would have occurred at the same time and location at the benchmark concentration can be calculated as shown in Equation 3.

$$L_B = C_B * Q_V \qquad (3)$$

L_B = Loading at time and location of violation at observed or simulated concentration

C_B = Observed or simulated concentration during violation

Q_V = Average streamflow for the violation month over the period of record at the violation location

Substituting Equations (2) and (3) into Equation (1), Equation 4 can be derived to calculate the target change in loading.

$$\Delta_L = C_V * Q_V - C_B * Q_V \qquad (4)$$

Rearranging, we find:

$$\Delta_L = Q_V * (C_V - C_B) \quad (4)$$

Streamflow values are commonly reported in cubic feet per second (cfs). To facilitate loading calculations, it is desired to convert streamflow units to Liters per month (L/mo). This conversion can be achieved as presented in Equation 5.

$$Q_{V,L/mo} = Q_{V,cfs} * CF_{L/cf} * CF_{s/mo} \qquad (5)$$

Where:

$Q_{V,cfs}$ = Average streamflow for the violation month over the period of record at the violation location in cfs

$CF_{L/cf}$ = 28.3 L/cf

$CF_{s/mo}$ = 2,629,743.8 sec/mo

Table A-1 presents the month, location, C_V, Q_V, and C_B for each parameter of interest for the month and location of the violation. If multiple monthly violations were observed or simulated, the month and concentration of the maximum violation were used to determine C_V and Q_V.

Table A-1: Streamflow, Violation Concentration and Benchmark Concentration for Parameters of Interest

Parameter of Interest	Location of Violation	Month of Violation	Q_V (cfs)	Q_V[1] (L/mo)	C_V	C_B	Difference in Concentration ($C_v - C_B$)	Concentration Units
	North Fork	-	-	-	-	-	-	-
	Middle Fork[2]	Sept	9.9	7.4 E08	240	200	40	#/L
	South Fork	-	-	-	-	-	-	-
Fecal coliform	Main Stem	-	-	-	-	-	-	-
	North Fork	-	-	-	-	-	-	-
	Middle Fork	-	-	-	-	-	-	-
	South Fork	-	-	-	-	-		-
Cryptosporidium	Main Stem	July	871	6.5 E10	0.10	0.075	0.03	oocysts/L
	North Fork	-	-	-	-	-	-	-
	Middle Fork	Nov	18	1.3 E09	300	235	65	#/L
E. coli - single	South Fork	-	-	-	-	-	-	-
sample	Main Stem	Nov	512	3.8 E10	500	235	265	#/L
	North Fork	-	-	-	-	-	-	-
	Middle Fork	Dec	39	2.9 E09	8	6	2	NTU
	South Fork	-	-	-	-	-	-	-
Turbidity	Main Stem	-	-	-	-	-	-	-
	North Fork	-	-	-	-	-	-	-
	Middle Fork[2]	Apr	138	1.0 E10	0.04	0.04	0.001	mg/L as N
	South Fork[2]	Feb	193	1.4 E10	0.05	0.04	0.012	mg/L as N
Nitrate	Main Stem	Mar	1,101	8.2 E10	0.04	0.04	0.003	mg/L as N
	North Fork[2]	May	1,137	8.5 E10	7	20	13.0	mg/L as $CaCO_3$
	Middle Fork[2]	Mar	181	1.4 E10	14	20	5.8	mg/L as $CaCO_3$
	South Fork[2]	Apr	172	1.3 E10	17	20	2.8	mg/L as $CaCO_3$
Alkalinity[3]	Main Stem	Aug	653	4.9 E10	9	20	10.8	mg/L as $CaCO_3$
	North Fork	-	-	-	-	-	-	-
	Middle Fork[2]	Jan	110	8.2 E09	0.10	0.09	0.015	mg/L
	South Fork[2]	Apr	172	1.3 E10	0.09	0.09	0.005	mg/L
Aluminum	Main Stem	Jan	1,101	8.2 E10	0.22	0.09	0.133	mg/L

1. Q_v in Liters per month calculated by converting Q_v in cfs as shown in Equation 5.
2. Simulated value from WARMF model
3. Because alkalinity is a minimum benchmark, difference in concentration is calculated as $C_B - C_v$

To calculate the desired change in loading for the North Fork, Middle Fork, and South Fork, streamflow at the North Fork, Middle Fork, and South Fork are multiplied by the difference in respective concentrations (violation and benchmark). For Location A, where Location A is the North Fork, Middle Fork, or South Fork, loading is calculated as shown in Equation 4.

Applying Equation 4 to the Main Stem data results in a calculation of the necessary change for the entire watershed. Desired change for the Main stem subwatershed is calculated by subtracting the sum of the individual changes for each subwatershed from the change for the entire watershed. If this difference was found to be less than zero, no change to Main Stem loading is required. If the entire watershed does not require a reduction in loading, no reduction was determined for the Main Stem subwatershed. Table A-2 presents target changes in loading. Change in loading for turbidity could not be calculated because no clear, accepted relationship between NTU and mass exists.

Table A-2: Change in Loading Needed to Achieve Benchmark during Month of Greatest Benchmark Violation

Parameter	Location	Target Load Reduction	Units
	North Fork	-	-
	Middle Fork	2.9 E10	#/month
	South Fork	-	-
	Entire watershed	-	-
Fecal coliform	Main Stem	-	-
	North Fork	-	-
	Middle Fork	-	-
	South Fork	-	-
	Entire watershed	1.8 E09	oocysts/month
Cryptosporidium	Main Stem	-	-
	North Fork	-	-
	Middle Fork	8.6 E10	#/month
	South Fork	-	-
	Entire watershed	1.0 E13	#/month
E. coli - single sample	Main Stem	1.0 E13	#/month
	North Fork	-	-
	Middle Fork	-	NTU
	South Fork	-	-
	Entire watershed	-	-
Turbidity[1]	Main Stem	-	-
	North Fork	-	-
	Middle Fork	1.3 E07	mg/month as N
	South Fork	1.7 E08	mg/month as N
	Entire watershed	2.8 E08	mg/month as N
Nitrate	Main Stem	9.6 E07	mg/month as N
	North Fork	(1.1 E12)	tons /month as $CaCO_3$
	Middle Fork	(7.8 E10)	tons /month as $CaCO_3$
	South Fork	(3.6 E10)	tons /month as $CaCO_3$
	Entire watershed	(5.3 E11)	tons /month as $CaCO_3$
Alkalinity[2]	Main Stem	-	-
	North Fork	-	-
	Middle Fork	1.2 E08	tons /month
	South Fork	6.4 E07	tons /month
	Entire watershed	1.1 E10	tons /month
Aluminum	Main Stem	1.1 E10	tons /month

1. Due to lack of relationship between NTU and mass, change in turbidity loading could not be calculated.
2. Since Alkalinity has a minimum benchmark, the reported values represent a load *increase*.

Table A-3 presents the same information, with change in loading for nitrate, alkalinity, and aluminum converted to short tons per month. This conversion is accomplished by multiplying the change in loading in mg/month by multiplying by 1.1 E-9 short tons/mg.

Table A-3: Targeted Change in Loading during Month of Greatest Benchmark Violation

Parameter	Location	Target Load Reduction	Units
Fecal coliform	North Fork	-	-
	Middle Fork	2.9E+10	#/month
	South Fork	-	-
	Entire watershed	-	-
	Main Stem	-	-
Cryptosporidium	North Fork	-	-
	Middle Fork	-	-
	South Fork	-	-
	Entire watershed	1.8E+09	Oocysts/month
	Main Stem	-	-
E. coli - single sample	North Fork	-	-
	Middle Fork	8.6E+10	#/month
	South Fork	-	-
	Entire watershed	1.0E+13	#/month
	Main Stem	1.0E+13	#/month
Turbidity[1]	North Fork	-	-
	Middle Fork	-	NTU
	South Fork	-	-
	Entire watershed	-	-
	Main Stem	-	-
Nitrate	North Fork	-	-
	Middle Fork	0.01	tons/month as N
	South Fork	0.18	tons /month as N
	Entire watershed	0.31	tons /month as N
	Main Stem	0.11	tons /month as N
Alkalinity[2]	North Fork	(1213)	tons /month as $CaCO_3$
	Middle Fork	(86)	tons /month as $CaCO_3$
	South Fork	(40)	tons /month as $CaCO_3$
	Entire watershed	(579)	tons /month as $CaCO_3$
	Main Stem	-	-
Aluminum	North Fork	-	-
	Middle Fork	0.1	tons /month
	South Fork	0.1	tons /month
	Entire watershed	12.0	tons /month
	Main Stem	11.8	tons /month

1. Due to lack of relationship between NTU and mass, change in turbidity loading could not be calculated.
2. Since Alkalinity has a minimum benchmark, the reported values represent a target load *increase*.