Formulating and Evaluating Alternatives for Water Quality Improvement Projects

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1. INTRODUCTION

1.1. Background

In July 2001, the California Tahoe Conservancy (CTC) adopted new Guidelines for Erosion Control Projects (CTC, 2001) that describe a preferred design approach for CTC-funded projects. The new Guidelines establish priorities for the use of source control measures, hydrologic design of erosion control projects, and treatment facilities with the objective of improving overall water quality performance of projects. The Guidelines also recommend an analysis of project alternatives to consider potential benefits of alternative approaches. The U.S. Forest Service (USFS) subsequently adopted the CTC Guidelines for grant-funded projects, and the Nevada Division of State Lands (NDSL) further refined and adopted the Guidelines. In addition, the Regional Water Quality Control Board and Tahoe Regional Planning Agency have indicated their support for the priorities described in the Guidelines. The acceptance of the Guidelines by a number of grant funding agencies indicates that they may soon serve as a unifying theme for water quality improvement projects undertaken in the Lake Tahoe Basin, regardless of funding source.

The Guidelines describe a design approach that differs from the approach used on many projects in the past, but do not lay out specific technical procedures for implementing the preferred design approach or evaluating alternatives. CTC sponsored two workshops with implementing and review agencies after adopting the Guidelines to discuss their application to projects. Discussion at these workshops focused on the needs to 1) better understand the differences between the procedures in use for many years and those required under the new Guidelines; 2) develop technical guidance for formulating and evaluating alternative designs; 3) provide additional clarity and efficiency in the project review and project delivery process; and 4) provide changes or clarifications in the regulatory framework to be consistent with the objectives and methods described in the Guidelines. The Lake Tahoe Basin Storm Water Quality Improvement Committee (Committee) was formed in May 2002, with the objective of defining strategic project planning and delivery tools needed for water quality improvement projects basin-wide.

1.2. Purpose of Document

This document is intended to supplement the adopted Guidelines by describing methods applicable to the initial stages of project design; specifically, formulating and evaluating project alternatives. It is intended to assist implementing agencies in defining a consistent and efficient process to deliver projects that meet the goals of the Guidelines and comply with engineering standards. The most current version of the Nevada or California guidelines should be referred to when using this document.

This document suggests recommended information collection, compilation, and analysis procedures to formulate and evaluate project alternatives and to select a preferred design alternative. These procedures are suggested methods rather than

mandates or adopted requirements that apply to each project. An effort should be made to integrate the alternatives analysis process with existing agency design procedures at project initiation. The approach described here expands the planning and analysis work that has typically been completed for water quality improvement projects.

The level of detail and extent of analysis for each project may vary according to project complexity, water quality implications, and project planning and implementation constraints. Water quality projects typically involve review by several regulatory and funding agencies, often in the form of a review committee referred to as a project advisory committee, technical advisory committee or project development team. At the initiation of individual projects and at the beginning of each major step in the planning and design process, it is recommended that the checklists provided in this document be used by project designers and reviewers to establish the appropriate level and complexity of analysis.

This document does not define the detailed review process that is a critical part of water quality improvement projects. However, suggested content and format of interim work products at successive stages of the alternatives analysis process are described. It is anticipated that these products would be reviewed at each stage of the process, and consensus reached among project implementers and reviewers prior to proceeding to the next stage. The Committee is presently preparing a detailed project delivery outline and is defining the elements of a recommended review process.

The need for technical guidance to implement the approach described in the Guidelines is recognized by the Committee, as are the constraints in developing guidance that is both scientifically based and grounded in experience in the Tahoe Basin. This first version of the procedures is intended primarily as a starting point for further work.

The Committee fully expects and hopes that the document will be modified and expanded as time allows, and as the base of scientific knowledge and practical experience grows. Further, it is not the intent of this document to unduly constrain the creative design process needed to implement innovative solutions to water quality problems in the Tahoe Basins. It has been written to allow for flexibility, and to encourage design professionals to exercise discretion and judgment in project design. The application of professional judgment to modify or expand the procedures described here, and their documentation in the design process, may be one of the best sources of improved procedures to be incorporated in future versions.

1.3. Overview of Document

The sections below begin with an overview of the alternatives analysis process and then describe steps in the process in chronological order, as they would occur for a typical project. The text in the body of the document has been kept to a minimum to allow a reader to easily review the entire process. Suggested data compilation and

analysis procedures and sources of technical information have been included in a set of appendices. This approach allows updates to be made relatively easily to technical procedures as new information becomes available without editing large portions of the document. The procedures outlined in the appendices are intended to provide guidance in formulating alternatives, but do not represent absolute requirements.

Section 2 provides an overview of the alternatives analysis process, including its purpose and a brief description of the recommended steps. Section 3 describes recommended data collection and analysis procedures for existing project area conditions, and Section 4 provides suggestions on the formulation of alternatives to meet the intent of the Guidelines. Section 5 provides recommended procedures for comparison of alternatives, and Section 6 describes the selection and development of a recommended alternative.

All sections make reference to Appendices, which provide more detailed descriptions of specific procedures for formulating and evaluating alternatives.

2. ALTERNATIVES ANALYSIS PROCESS

2.1. Purpose of Alternatives Analysis

The alternatives analysis process, as described in the Guidelines, is intended to investigate a range of possibilities for water quality improvement in a project area. The alternatives analysis process described here is intended to ensure that a broad range of potential solutions, based on water quality goals and objectives, are investigated at an early stage of design. It also provides a process for documenting the basis of design decisions. This process is intended to increase the level of consensus in preliminary designs, thereby reducing the level of review and revision during the preparation of contract documents.

Figure 2.1 illustrates the relationship of the alternatives analysis process (formulating and evaluating alternatives) to other elements of project development and implementation for a typical water quality improvement project in the Lake Tahoe Basin. The process shown in Figure 2.1 is also generally consistent with a process outlined for planning and permitting Environmental Improvement Program (EIP) projects in *Assistance in Planning and Permitting White Paper* (TRPA, 2003). TRPA's EIP process includes a step for alternatives analysis and selection of a preferred alternative. The environmental compliance and permitting elements should be strongly linked to the alternatives analysis process, but are not described in detail in this document.

The alternatives evaluation process provides a means to illustrate and compare the potential benefits and impacts of different approaches. Presentation of this analysis to review agencies provides an open exchange of information, a framework for decision-making, and a means to identify constraints early in the design process that might otherwise lead to costly re-design or design delays.

The alternatives formulation and evaluation process described here concludes with the selection of a preferred alternative. The preferred alternative should be developed at sufficient detail to have confidence in its feasibility and expected performance. Nomenclature may vary from agency to agency, but this stage is described here as approximately the 30% design level, and is defined as the point at which detailed development of contract documents (plans and specifications) can begin to dominate the design process. Until completion of the alternatives analysis process described here, little or no work may occur on construction contract plans and specifications (contract documents), although substantial design information may be developed for later use in their preparation. At the completion of the Alternatives Analysis, major design issues and design criteria should be resolved, so that in the next phase of project design the focus can shift to the production of contract documents that implement the selected alternative.

Lake Tahoe Water Quality Improvement Projects

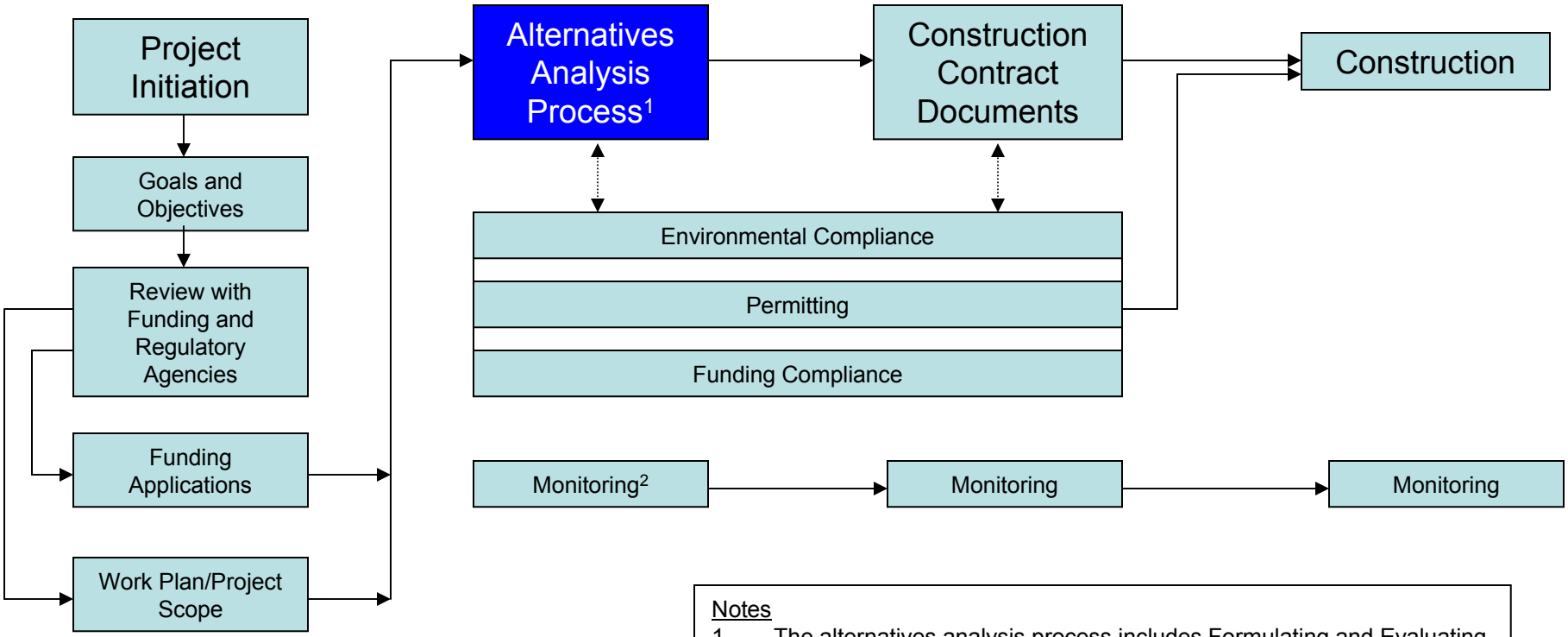


Figure 2.1 Overview of Project Delivery Process

The alternatives analysis process is described in a series of phases in this document – a successful alternatives analysis process would reach consensus on each phase prior to proceeding with subsequent phases. To prevent delay of projects when consensus is not reached in normal project review, the Storm Water Quality Improvement Committee is preparing recommendations for timely conflict resolution as part of the project review process.

It is recognized that not all projects require the same level of analysis, and that some of the data and analysis described in the Appendices may not be appropriate or necessary for some projects. However, the same framework for formulating and evaluating alternatives may be utilized, but simplified (with consensus in the review process) to include a lower level of detail in the data collection and analysis, or in the number and complexity of alternatives.

The alternatives analysis process described here is not unique; similar processes are used in drainage master planning, transportation planning and design, and other traditional public works endeavors. However, the water quality objectives and environment in the Lake Tahoe Basin are both unique and challenging. Therefore, the procedures described here are intended to assist implementing agencies in applying a generally accepted alternatives analysis process to these unique problems.

2.2. Elements of the Alternatives Analysis Process

The primary steps in the alternatives evaluation process include**:**

- Analyzing Existing Conditions
- Formulating Alternatives
- Evaluating Alternatives
- Selecting and Developing a Recommended Alternative

Figure 2.2 illustrates the major steps of the Alternatives Analysis process.

The Existing Conditions Analysis investigates and describes the physical and environmental characteristics of the project area and project vicinity that are relevant to the design of the storm water quality improvement project. Because many factors may influence the design, it is not feasible or efficient to define a single standard set of characteristics or the level of detail of these investigations. However, the hydrologic characteristics of the area and sources of potential pollutants are of primary importance in all watersheds. In addition to describing relevant project area characteristics, the Existing Conditions Analysis should develop opportunities and constraints for water quality improvement based on an understanding of processes and conditions that generate and transport pollutants.

Alternatives Formulation builds on the opportunities and constraints identified in the Existing Conditions Analysis to identify a range of alternatives for water quality improvement. This step should consider the priorities identified in the Guidelines for

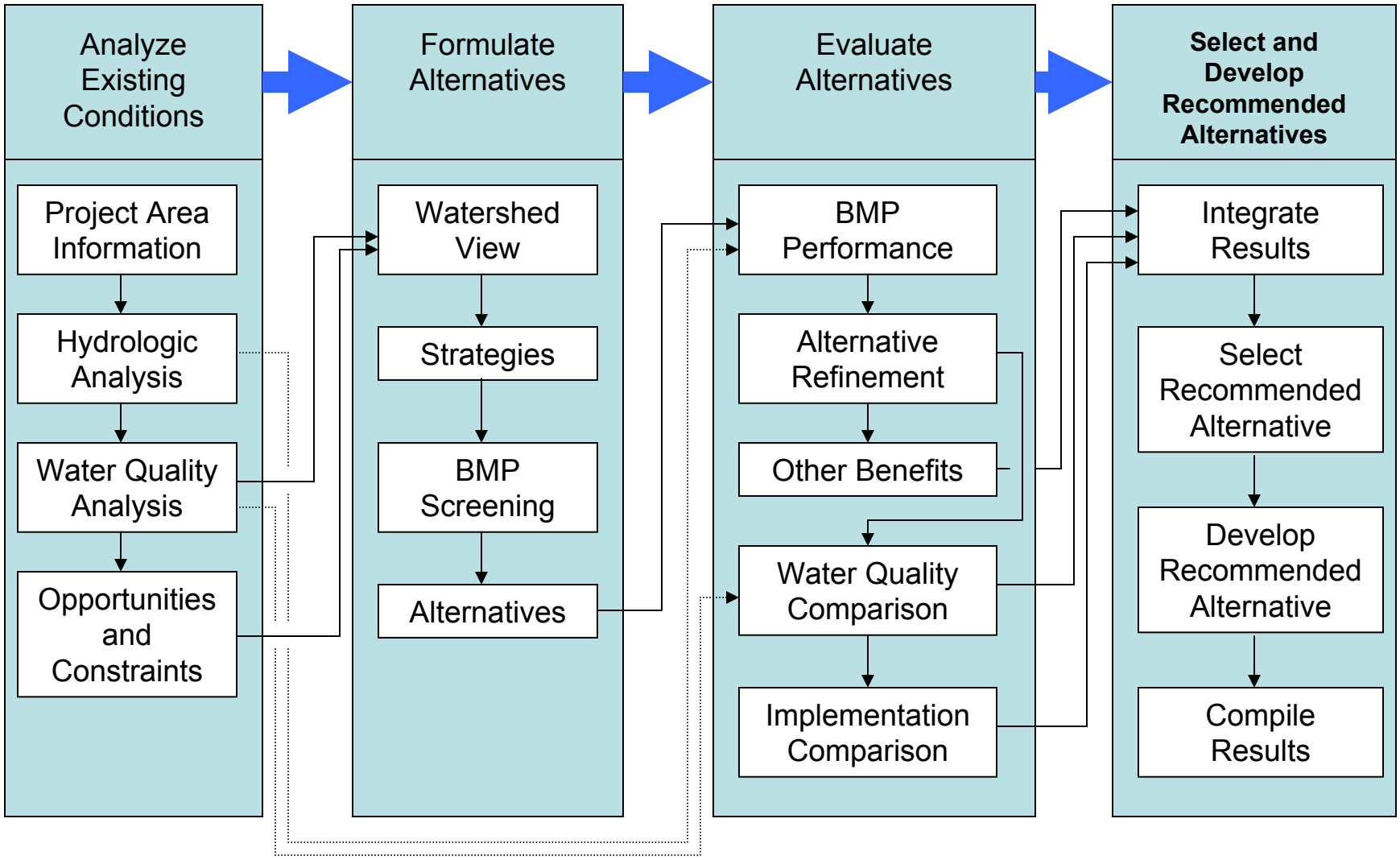


Figure 2.2 Alternatives Analysis Process

source control, hydrologic design, and treatment. Each alternative should be based on a defined strategy for water quality improvement, with sufficient differences between alternatives to identify a range of benefits and costs. In the context of this document, alternatives are intended to be project design approaches with fundamentally different water quality strategies, not similar strategies with different materials or design treatments that achieve the same results on a site-specific scale.

Alternatives Evaluation compares alternatives based on quantitative or qualitative procedures. In addition to comparing water quality benefits and performance, alternatives should be compared based on other expected benefits and their feasibility for implementation. These comparisons involve factors such as right-of-way acquisition, utility conflicts, liability, permitting, and maintenance considerations.

The current scientific basis for comparing water quality performance of alternatives is limited. This document provides an outline of a methodology for comparison of alternatives and suggestions for quantitative analysis of some aspects of water quality improvement projects. Where quantitative analysis is not feasible, or confidence in the results is low, qualitative analysis or simplified quantitative procedures can still provide a basis for comparisons and for discussion of alternatives.

A Recommended Alternative should be selected based on the Alternatives Evaluation, and may be one of the originally formulated alternatives or a combination of alternatives. The design criteria, benefits, costs, and implementation constraints for the recommended alternative should be well defined at this stage. However, investigation of all potential implementation constraints for each alternative is generally not feasible. Therefore, the Recommended Alternative will typically require substantial further development following its selection.

The preliminary design of the Recommended Alternative should be sufficiently complete to ensure that major constraints are identified, and that the project is feasible to permit and construct. This may require relatively detailed design work on selected aspects of the alternative. However, preparation of construction contract documents (e.g., plans and specifications) may be at a low level of completion, or may not have begun. The goal is to have a truly feasible preliminary design, but there is no procedure that can guarantee that obstacles will not be encountered later in the contract document development process. The Alternatives Analysis process is designed to reduce the possibility that unforeseen obstacles will be discovered later in the process, leading to delays, redesign, or permitting difficulties.

2.3. Technical Guidance and References

A framework for the methodology to be used in the alternatives analysis process and limited technical references and guidance are provided in this document. In general, the methodology is briefly described in Sections 3,4, and 5; suggested procedures, technical guidance, and references are more fully described in the appendices. This format allows the procedures to be updated periodically as additional scientific

information becomes available, and the performance of various water quality improvement strategies and designs are monitored and tested. The gaps in our technical knowledge of water quality processes in the Lake Tahoe Basin and their impact on the lake and other resources are considerable. This document cannot fill all of these gaps, and therefore does not specify a single set of computations or procedures for analysis of projects. Instead, it lays out a process and defines suggested procedures, with flexibility, for project designers and reviewers to consider a range of alternatives based on best available information. As the level of knowledge increases, it is anticipated that the technical procedures will be greatly expanded and revised.

2.4 Work Products

The alternatives analysis process illustrated in Figure 2.2 will typically result in work products at the completion of each major stage. For some smaller or less complex projects, two or more of these work products and review stages may be combined. It is suggested that the Work Plan or other project planning document clearly lay out the anticipated work products and review stages for each project. The alternatives analysis work products envisioned for a typical project include:

- Existing Conditions Analysis Memorandum
- Alternatives Formulation Memorandum
- Alternatives Evaluation Memorandum
- Recommended Alternative Memorandum
- Recommended Alternative Project Report

In general, memoranda will include a minimum amount of text to present data and results from each stage. The memoranda provide a consistent format for distribution of information, data, and analysis. These results would typically be reviewed in a project advisory group meeting following their distribution in electronic or hard copy form. The suggested content and format of each memorandum are more fully described in the appendices. The Project Report provides a compilation of preliminary design information for the selected alternative, with sufficient detail to use as the basis for development of contract documents.

2.5 Project Review

This document does not explicitly address the project review and approval process, although it is clearly linked to the steps of the alternatives analysis process described here. Logical points for funding and regulatory agency review occur at the completion of each stage in the process. Project committees, comprised of members from the implementing, funding, and regulatory agencies in the Tahoe basin, are commonly formed to assist in the project development and review process. Various names and acronyms are used for these committees depending on jurisdiction and project type; in this document, these committees are referred to as project advisory committees. The Storm Water Quality Improvement Committee is currently preparing

recommendations for project review procedures, consistent with the steps of the alternatives analysis process described here.

3. ANALYZING EXISTING CONDITIONS

This section describes the methodology for analyzing conditions in a project area that are relevant to the design of storm water quality improvement projects. The methodology draws upon the experience of agencies that have implemented projects in the Tahoe Basin over the past decade. However, the procedures for identifying pollutant sources and defining project area hydrologic characteristics are expanded. These topics are directly related to priorities identified in the Guidelines.

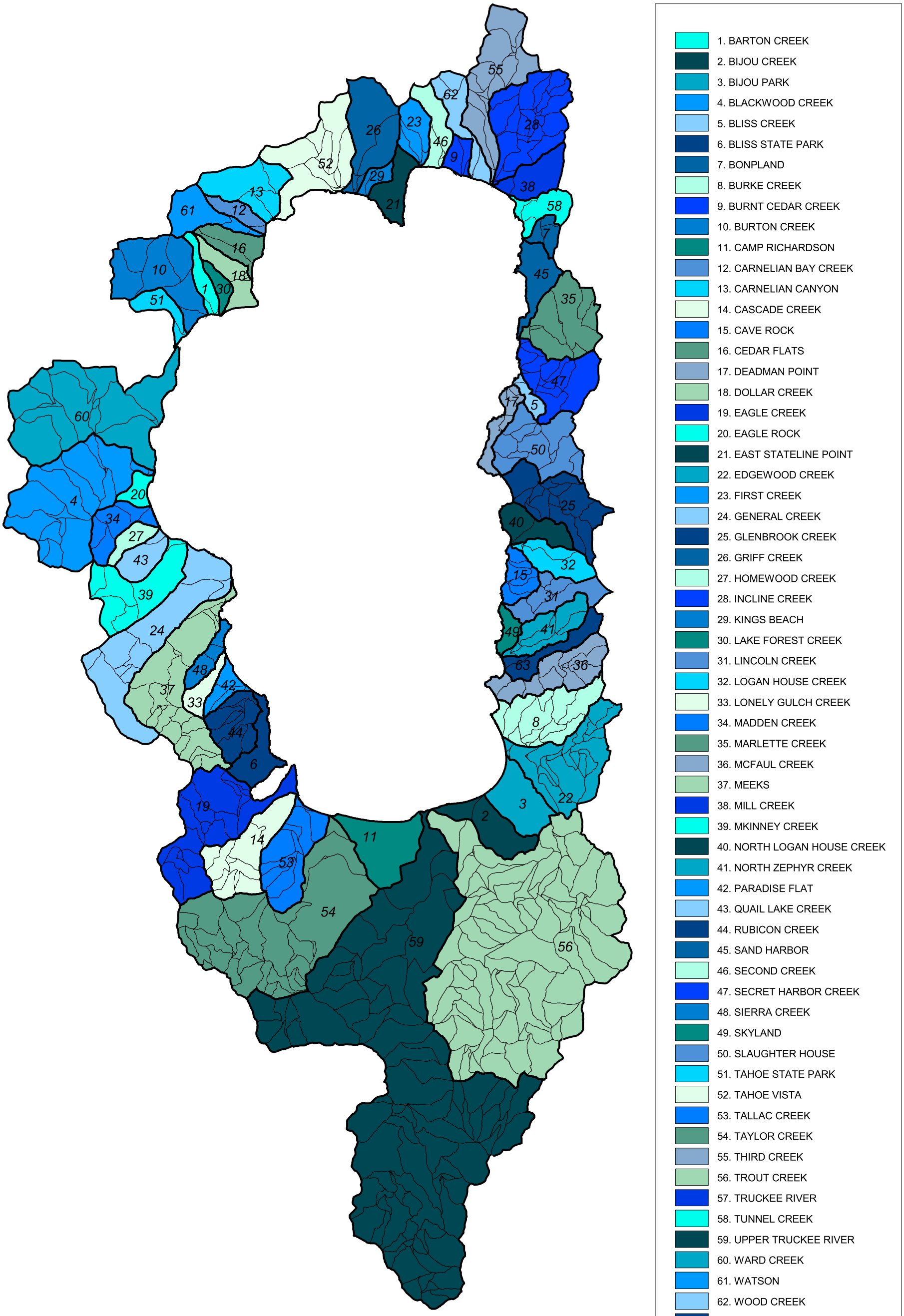
3.1. Watershed Approach

The preferred design approach described in the Guidelines suggests development of alternatives using a watershed approach. In general, the intent of the Guidelines is to consider potential project improvements in the context of watershed processes (e.g., hydrology, sediment and pollutant transport, stream stability, infiltration and groundwater) and resources (e.g., water quality, ecological resources, cultural resources, and infrastructure). To the extent feasible, project area boundaries that are coincident with watershed or major drainage area boundaries will facilitate this approach. However, where project area boundaries and watershed boundaries do not coincide, project planning and design will need to consider the area outside the project area boundary but inside the watershed boundary. A total of 63 major watersheds are identified in the Tahoe Basin, as shown in Figure 3.1.

For the purposes of this document, "watershed" refers to one of the areas shown in Figure 3.1. The "project catchment" refers to all area tributary to the project area. Note that this frequently includes substantial area upstream of the project area. The "project area" refers to the area where water quality improvements are being considered for implementation. The project area may comprise only a small portion of the watershed, especially in watersheds with a large proportion of undeveloped land.

If a project area drains directly to Lake Tahoe without entering one of the major streams (sometimes referred to as intervening areas or zones), the project catchment should again be defined as the entire area tributary to the outlets of the project area.

Selection of an appropriate scale and level of detail for analysis outside the project area requires application of judgment. In some cases, it may be prudent to include larger areas for planning purposes, while in others, the project area may be too small to justify an analysis of the entire watershed. An effort should be made to coordinate project analyses on very small projects with other on-going or future projects in the watershed.



Source: Tahoe Regional Planning Agency

Figure 3.1 Lake Tahoe Basins Watershed

The concept of a 'watershed approach' is subject to interpretation for individual projects, but the following suggested elements help to define the intent of the Guidelines in the Analysis of Existing Conditions:

1. Definition of major drainage area boundaries in the watershed, and more detailed definition of drainage areas and sub-areas in the project catchment and project area
2. Estimation of hydrologic and water quality characteristics for the project catchment
3. Estimation of the relative importance of pollutant sources in the project area and project catchment to water quality in the watershed
4. Identification of priority pollutants and problems in the project area and project catchment based on watershed conditions and trends

3.2. Analyzing Project Area, Catchment, and Watershed Conditions

Existing conditions in the project area and catchment will be analyzed as a step in the design process, and conditions in the watershed may also be analyzed to develop an appropriate context for water quality improvements in the project area. A large amount of information may be collected in this phase of the project and it will likely not be practical to compile all the information into the Existing Conditions Analysis Memorandum. The project advisory committee may provide input on the level of detail required for data collection and analysis in the project area, project catchment, and watershed.

Suggestions for general categories of information to be collected and the types of analyses to be performed for existing conditions are listed below. More detailed guidance is provided in the appendices. Appendix A-1 includes checklists for information to be compiled, and outlines the suggested content and format of the Existing Conditions Analysis Memorandum. Appendix A-2 provides sources for information, cross-referenced to Appendix A-1. Appendices A-3 and A-4 provide guidance on analysis of hydrologic and water quality conditions.

3.2.1. Project Area Information (Appendix A-1, Checklist; and Appendix A-2, Sources of Information)

1. General Information – identify location of project area, geographic setting, base map
2. Site Topography and Aerial Photography – compile topographic mapping and planimetrics, ortho-rectified aerial photography
3. Watershed and Drainage Characteristics – define major watershed boundaries, watershed plans and studies, project catchment, drainage areas and sub-areas, surface drainage features and watercourses, and drainage infrastructure

4. Soils and Geology – compile soils mapping and characteristics, characterize geology and identify geologic features as they relate to runoff and erosion control
5. Vegetation – identify project area vegetation characteristics, compile mapping of sensitive and special status species, compile mapping of wetland and riparian vegetation, compile mapping or reporting of noxious and invasive weeds
6. Land Use and Land Capabilities – land use mapping and categories; land capability mapping, including SEZs
7. Land Ownership – compile mapping showing public owners, private parcels and easements
8. Utilities – define locations, sizes, and depths (where practicable) of major utilities; determine depths or elevations of sanitary sewers at manholes; define utility constraints
9. Environmental Resources – identify special resource considerations (e.g., wetlands, SEZs, wildlife habitat for sensitive or special status species, cultural resources, visual resources, aquatic habitat in streams)
10. Pre-Project Monitoring Data – compile available monitoring data in project area and vicinity

3.2.2. Analysis of Existing Hydrologic Conditions (See Appendix A-1, Checklist; and A-3, Hydrologic Procedures)

1. Project Areas – where practical, define project areas to coincide with major watershed or drainage area boundaries
2. Watershed, Project Catchment, and Drainage Area/Sub-area Boundaries – delineate on a project base map within the project area; on USGS quadrangle, in GIS coverage, or other available mapping if needed for project catchment and watershed
3. Hydrologic Data – compile hydrologic monitoring information available in the area, and identify need for any pre-project monitoring; compile precipitation and runoff characteristics from available references
4. Hydrologic Setting – characterize the physical hydrologic setting (e.g., topography, geology, soils, vegetation, precipitation) in a watershed context; characterize inflows to the project area and outflows from the project area; identify potential sensitivity of water quality and stream stability in the project area and downstream of the project area to changes in inflows and outflows
5. Vegetation, Soils and Cover Characteristics – compile vegetation, soils, and cover or land use information in the project catchment
6. Impervious Areas and Connectivity – estimate impervious areas and their connectivity to the public drainage system and ephemeral or perennial streams; identify level of BMP retrofits implemented on private property

7. Peak Design Flows – compute peak discharges and hydrographs for design storm events; prepare hydrologic computations based on precipitation, soils, vegetation, slope, and other physical characteristics of sub-areas
8. Flow-Duration and Annual Runoff Characteristics – estimate flow-duration characteristics and annual runoff volumes
9. Groundwater Hydrology – characterize groundwater hydrology and information regarding seasonal groundwater levels
10. Drainage Problems – identify flooding and drainage problems; compile maintenance concerns and observations
11. Stream Stability – perform initial geomorphic characterization of stream channels and sensitivity to project changes (e.g., bed and bank material types, sediment loads, peak discharges, flow-duration characteristics)

3.2.3. Analysis of Existing Water Quality Conditions (See Appendix A-4, Water Quality Procedures)

1. Water Quality Information – compile water quality monitoring information available in the area, and identify need for any pre-project monitoring; compile water quality characteristics from available references and data analysis
2. Priority Pollutants – identify sources of fine sediment and nutrients for all project areas; identify other priority pollutants based on project area characteristics
3. Sediment Sources
   a. Qualitative identification – locate and estimate the severity of sheet and rill erosion, runoff collection system erosion and sediment supply (e.g., road shoulders, ditches, traction abrasives), streambank erosion, and other specialized problems (e.g., drainage system development or mass wasting)
   b. Quantitative estimates – where appropriate information and project budget is available, perform quantitative estimates of sediment yield and estimates by particle size class; simplified methods may be appropriate in most project areas
4. Nutrient Sources
   a. Qualitative identification – locate and estimate the severity of sources of nitrogen and phosphorous; including consideration of probable differences, if any, in sources of total and dissolved loads
   b. Quantitative estimates – where appropriate information and project budget is available, perform quantitative estimates of nutrient sources; simplified methods may be appropriate in most project areas
5. Other Pollutants – may be identified as priority pollutants in some project areas (e.g., hydrocarbons, heavy metals, organics)

a. Qualitative identification – locate and estimate the severity of sources of nitrogen and phosphorous; including consideration of probable differences, if any, in sources of total and dissolved loads
b. Quantitative estimates – where appropriate information and project budget is available, perform quantitative estimates of nutrient sources; qualitative identification is probably appropriate in most project areas

6. Key Pollutant Transport Processes
   a. Relationship to hydrology – identify storm types and runoff mechanisms that mobilize and transport pollutants
   b. Human/institutional influences – identify human influences on transport (e.g., maintenance, road abrasives, fertilizers, transportation, recreation)

3.3. Opportunities and Constraints for Water Quality Improvement

Opportunities and constraints should be identified based on project area characteristics and the priorities and preferred design approach identified in the Guidelines. The preferred design approach emphasizes pollutant source control and the control of runoff that delivers sediment, nutrients, and other pollutants to streams and Lake Tahoe. These approaches are to be considered prior to approaches that emphasize treatment. Therefore, in identifying opportunities and constraints, source control and hydrologic design should be considered higher priorities than treatment. At this stage of the project, opportunities and constraints can probably only be identified at a reconnaissance level.

3.3.1 Identifying Opportunities and Constraints

Opportunities should be identified based on the existing conditions analysis. Opportunities may include:

- physical characteristics that could provide water quality benefits (e.g., areas with suitable soil and moisture conditions for revegetation; available land for distribution of flows or for construction of treatment facilities, highly permeable soils for infiltration of runoff, etc.);
- potential elimination of significant sources or changes in hydrologic characteristics (e.g., stabilization of a stream course or specific problem that contributes a large fraction of the sediment load, reduction of impervious areas, flow routing through SEZs, etc.);
- potential cooperative or collaborative benefits (e.g., changes in land use that have water quality benefits, restoration of a stream segment for habitat and water quality benefits, participation in multi-agency public education or other programs with water quality benefits, cooperation with projects by other agencies, etc.); or
- other possibilities identified during the existing conditions analysis.

The opportunities identified need not be a comprehensive list of potential project features, but should instead identify specific features or characteristics that provide especially significant influences on potential project design or strategies for water quality improvement. Opportunities should be defined in the context of the preferred design approach described in the Guidelines, with highest priority on source control and hydrologic design, followed by treatment.

Major constraints that are likely to apply to the design and implementation of any project alternative should be identified. Examples may include physical characteristics of the project area (e.g., high ground slopes, rocky terrain, groundwater conditions, major utility crossings); institutional, legal, or social considerations (e.g., funding amounts, funding agency objectives, property owner agreements, incompatible land uses), and construction considerations (e.g., construction access, sensitivity to noise, dust and traffic during construction). In addition to identifying constraints that are likely to apply to all alternatives, constraints that apply to implementation of the preferred design approach should be identified. These constraints should be identified in a format that assists review agencies to assess the level of potential difficulty in resolving constraints that may have a substantial effect on the design.

Liability issues are of special concern to implementing agencies. These concerns should be identified as constraints, specifically as they relate to implementing the preferred design approach for source control and hydrologic control. For example, vegetated channels may be an option to meet source control or hydrologic design objectives, but in some areas may raise maintenance (e.g., access, debris accumulation, damage by human activities, etc.) or liability (e.g., public safety, flooding, non-standard or untested methods, etc.) concerns. Project designers are encouraged to identify both opportunities and constraints associated with these types of design issues, so that they can be resolved with the assistance of the project advisory committee.

Appendix A-5 provides a suggested format for summarizing opportunities and constraints. The summary format provided is intended as an example, with suggested categories and subjects, but is not intended as a comprehensive checklist. The project designer is encouraged to expand the example provided or develop other formats to meet the needs of specific projects.

3.4 Using Appendix A

Appendix A includes an information checklist, a list of sources of information, technical procedures for hydrologic and water quality analyses, a recommended format for opportunities and constraints analyses, and technical references in Appendices A-1, A-2, A-3 and A-4, A-5, and A-6, respectively. The appendix provides additional background information and suggested procedures for each step of the Existing Conditions Analysis described above.

3.5 Work Products

An Existing Conditions Analysis Memorandum is recommended to compile information and present the results of hydrologic and water quality analyses. The memorandum should describe opportunities and constraints as they pertain to formulation of potential alternatives in the next step of the process. The memorandum will not include all compiled project area information, but will summarize key information to be used in formulating alternatives. A suggested list of information to be presented in the Existing Conditions Analysis Memorandum is provided in Appendix A-1.

4. FORMULATING ALTERNATIVES

This section describes recommended procedures for formulating water quality improvement strategies and alternatives to implement the strategies. Figure 4.1 illustrates the overall process.

4.1 Watershed Approach

The watershed approach, as described in Section 3, applies to the process of formulating alternatives. In this step of the process, the following suggested elements help to define the intent of the Guidelines:

1. Identification of future land use and other changes in the watershed that may affect hydrology or water quality (e.g., planned development, channel restoration, surface water diversion or abandonment of existing diversion, etc.).
2. Development of alternatives that address highest priority water quality problems in the watershed, and avoid amplification of identified problems outside of the project area (e.g., priority pollutants for fisheries or other aquatic resources, stream stability downstream of project area, etc.).
3. Identification of potential effects within the project area due to runoff from the project drainage area upstream, and formulation of alternatives that maximize water quality benefits in a watershed or project catchment context (e.g., separation of flows from urban and undeveloped areas to reduce hydraulic loading of BMPs and improve performance)
4. Identification of potential impacts of alternatives on downstream receiving waters in the watershed (e.g., stream stability impacts due to increased peak flows or increased flow-duration)

Information and analysis of the watershed and project catchment can be at a lower level of detail than for the project area, unless specific questions are identified that require more detailed or quantitative investigation. Appendix A-3 provides additional suggestions on appropriate levels of detail in the hydrologic analyses for the watershed, project catchment, and project area.

4.2 Water Quality Strategies

The Existing Conditions Analysis is intended to identify and prioritize pollutant sources, identify opportunities for hydrologic design to reduce pollutant loads, identify appropriate treatment methods, and identify constraints on particular design approaches. The formulation of alternatives should follow directly from the Existing Conditions Analysis that estimates pollutant sources and the important transport processes in the project area, and from the intent of the Guidelines.

In formulating alternatives, designers are encouraged to include a range of creative options rather than focus on a single alternative that appears to be the best, most

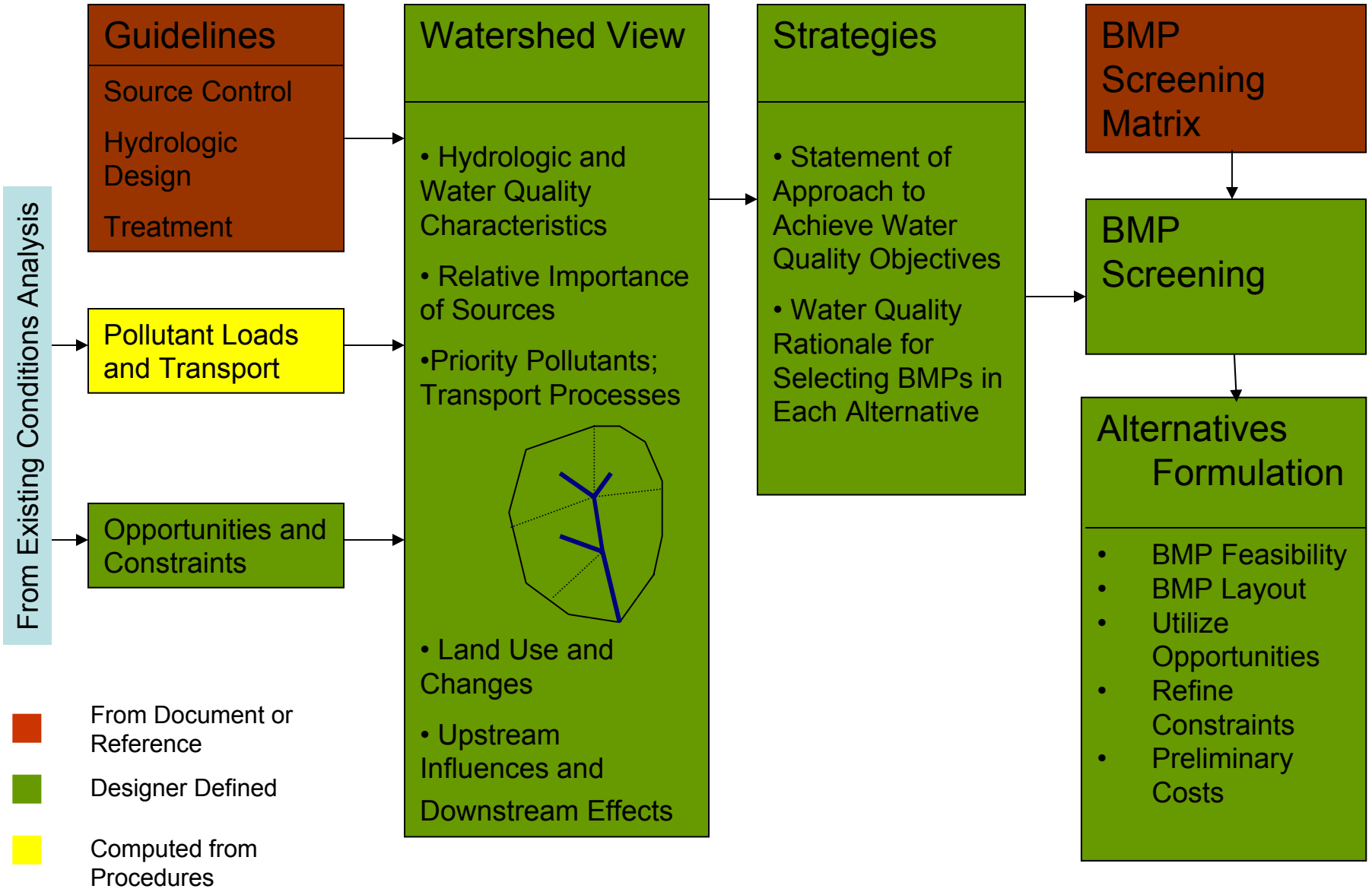


Figure 4.1 Formulating Alternatives

practical, or least expensive solution at the outset. The intent of this step in the process is to identify potential water quality benefits from a wide range of approaches, and assess their constraints (which may be considerable) and costs in this light. Alternatives that represent a fairly wide range of costs may be presented at this stage, including those that exceed preliminary project or grant-funding budgets, if established. This approach provides an opportunity for funding agencies to consider funding increases where a suggested strategy may provide substantially higher benefits.

It is suggested that alternatives be formulated based on defined water quality improvement "strategies" for a project area. In the context of this document, a "strategy" is simply a statement of the approach that an alternative takes in achieving water quality and other goals at a project area scale.

The strategy provides a rationale for selection of the types and extent of improvements to be included in a particular alternative. Strategies should be linked to the water quality goals and objectives defined for the project, and should consider the priorities and intent of the Guidelines.

In addition, strategies should consider the project area in the context of the watershed. Soils, slopes, vegetation, stream conditions and other watershed characteristics both upstream and downstream of the project area may be relevant to defining strategies that are most effective in a watershed context. For example, stream flows from relatively undisturbed areas upstream of a project area may contribute to flows, but not contribute substantially to pollutant loads in a project area. In this case, separation or bypass of these flows around project BMPs may improve BMP performance by reducing hydraulic loading rates. Conversely, the project may affect downstream areas. Changes in flows or sediment loads caused by a project may destabilize a downstream stream channel and result in net higher pollutant loads. These are only examples – each project area is likely to have specific factors that should be considered in this context.

Note that in the examples that follow, a simply-stated strategy is used to define alternatives for explanation purposes. This need not be the case for a real project – a strategy might be a logical combination of water quality techniques in a project area. However, the concept of defining a strategy avoids a random mix of BMPs to form an alternative, without a clear water quality design objective. Potential elements that might be considered to create a strategy include:

- Maximizing local source control (e.g., revegetation, slope stabilization, road closures, vegetated conveyance, distributed flows, local traction abrasive capture) to reduce required centralized treatment facilities
- Minimizing annual runoff volume (e.g., reduction of impervious surfaces, reduction of impervious surface connectivity to the drainage system, routing of flows through local storage or infiltration facilities, retention, etc.)

- Maximizing treatment of major pollutant sources with a lower level of treatment for the remainder (e.g., intensive treatment for commercial or high-volume roadway areas)
- Controlling peak flows or flow-duration characteristics to specific thresholds to avoid erosion or improve BMP performance (e.g., controlling peak flows to minimize channel erosion, controlling hydraulic loading of water quality basins or wetlands to ensure removal of fine sediment or other target pollutants)
- Re-establishing natural flow paths, floodplains, and wetlands to maximize SEZ treatment
- Applying advanced treatment or application of new treatment technology, especially in portions of the project area with high pollutant concentrations
- Constructing treatment facilities in sequences or trains, with each step focused on a specific process or pollutant
- Constructing treatment facilities with an stronger emphasis on a particular pollutant (e.g., phosphorous) based on priority in a particular watershed or in the Lake Tahoe Basin
- Constructing more complex drainage systems to isolate flows of differing quality, to control hydraulic loading of water quality BMPs, or to maximize treated volume (e.g., separation of flows from urban and undeveloped areas, peak flow bypasses, storage/infiltration, storage/treatment systems, etc.)

The concept of defining a strategy recognizes that budgetary and other constraints limit the extent or intensity of water quality solutions at a project scale. It also recognizes that, within the range of current Lake Tahoe storm water management practices, there are differences in opinion on the effectiveness of various techniques and approaches. Definition of a strategy allows the designer to state the basis of design for a particular alternative, and to then choose improvements to implement that strategy.

4.3 Formulating Alternatives

An "Alternative", in the context of this document, is a set of improvements that is designed to implement a water quality strategy in a particular project area. The strategy can be used in conjunction with project area characteristics identified in the Existing Conditions Analysis to screen potential BMPs for an alternative. Appendix B-3 provides simple screening matrices for BMPs based on site feasibility and pollutant treatment capabilities.

As a simple hypothetical example of the development and application of strategies, the sources of dissolved nutrients in a particular project area might be determined to be more concentrated in an area of commercial land use that makes up only a small percentage of the total project area. A strategy might be defined to focus the project resources on intensive treatment in this area to obtain the greatest benefit in dissolved load reduction. This strategy might then be implemented by defining an alternative

that would convey flows from a particular area to advanced treatment facilities that are designed and operated to make a significant reduction in dissolved nutrient loads.

Note that this strategy will have both constraints and disadvantages. For example, it may be difficult to acquire land to locate the treatment facilities, while initial capital and long-term maintenance expenses might reduce the available budget for other areas of the project.

Formulation of several alternatives based on different, defined strategies allows the benefits, constraints, and disadvantages of various approaches to be considered in a structured way. The strategy described above, for example, might be compared with a strategy of capturing nutrients primarily by removing sediment from runoff. This strategy might be conceived as a way to construct facilities distributed throughout the project area and capture a larger fraction of the total runoff. The subsequent evaluation of these two alternatives might then determine that one is likely to be more effective at reducing total nutrient loads, and one more effective at reducing dissolved loads.

Alternatively, assuming that budget is not a major constraint, a strategy with intensive treatment in the commercial area and distributed, smaller scale facilities in the remainder of the project area, might be compared with a strategy of smaller scale facilities for the entire project area. In this case, the two strategies might differ substantially in both cost and effectiveness in removing pollutants.

An infinite number of possibilities exist for defining strategies that are the basis for alternatives, and creative design teams are likely to generate a large number of possibilities. In practice, strategies are likely to include several elements for different portions of complex project areas, and more than one alternative might be defined for the same or very similar strategies (e.g., in the example above, wetland treatment or physical treatment or a combination might be considered).

In complex project areas, a screening process will likely be necessary at this stage to consider a relatively large number of possibilities, and then refine the list to a few alternatives to be evaluated in detail. A relatively large fraction of initial alternatives may be screened from further evaluation as constraints are identified. Designers are encouraged, however, not to eliminate a desirable strategy where a significant, but potentially resolvable, constraint is identified. One objective of the formulation process is to identify and resolve constraints, with the assistance of the project advisory committee, which may lead to improved project performance. The Alternatives Formulation stage provides a means to identify a reasonable number of alternatives that appear to warrant further study, identify their potential benefits, disadvantages and constraints, and then carry them forward to the next phase for further analysis.

This procedure increases the attention given to different approaches and potential design solutions at an early stage in the project, and thus will likely increase both the

cost and time required to complete this phase of projects. However, the benefits of this approach are a greater range of creative possibilities, a more structured and transparent process for communication between designers and reviewers, and a wider range of possibilities for adjustment of the project design should a particular facility or approach later be determined to be infeasible.

The objectives for formulating alternatives should be similar in most project areas. These include:

- Formulating alternatives based on a defined water quality strategies
- Identifying a sufficient range of approaches, potential benefits, costs, and other constraints to develop consensus on the design approach
- Ensuring that alternatives represent fundamentally different approaches rather than minor variations or design options
- Providing a basis for creative design by identifying a desirable water quality strategy, then developing potential improvements to achieve the desired results
- Identifying constraints and the steps needed to resolve constraints for particular approaches

This stage should utilize opportunities identified in the Existing Conditions Analysis to the extent possible, and further define constraints based on the alternatives.

4.4 Using Appendix B

Appendix B includes an information checklist, an alternatives formulation example, and screening matrices for BMPs in Appendices B-1, B-2, and B-3, respectively.

4.5 Work Products

An important result of developing strategies and formulating alternatives is the information provided for the exchange of ideas and concerns between designers and review agencies. The steps needed to resolve constraints for a desirable alternative can then be defined based on consensus that the strategy and its associated alternative are valuable to pursue.

The number of alternatives to be formulated may be agreed upon by the project advisory committee at the initiation of this stage, or left to the project designer to develop based on project site opportunities and constraints. For most projects, it is recommended that at least three alternatives be formulated at this preliminary stage to provide a suitable range for review. The decision of how many alternatives to carry forward should be made carefully – a large number will increase flexibility later in the design process, but will also substantially add to the time and cost of the evaluation.

An Alternatives Formulation Memorandum is recommended to describe the strategies and rationale for development of alternatives, estimate their probable benefits and costs, and identify constraints applicable to particular design approaches. Design and cost information should be at a sufficient level of detail to estimate probable benefits, identify constraints, and compare planning level costs for various alternatives. The memorandum provides a product for review by funding and regulatory agencies to develop consensus on alternatives to be evaluated further, but is not intended to rank alternatives or select a preferred alternative. Based on review of the alternatives, they may be modified prior to evaluation and comparison. A suggested list of information to be presented in the Alternatives Formulation Memorandum is provided in Appendix B-1.

5. EVALUATING ALTERNATIVES

5.1 Comparing Alternatives

Alternatives should be compared based on expected water quality performance, other benefits, and implementation considerations. Evaluation of alternatives should also be linked to the environmental review and permitting process.

5.1.1 Water Quality Comparisons

The Lahontan Regional Water Quality Control Board (Lahontan) is implementing a program to define Total Maximum Daily Loads (TMDLs) for pollutants of concern to Lake Tahoe. Consistent with this emphasis on reducing pollutant loads, monitoring programs in the basin are providing increased information on pollutant loads and transport processes for a full range of hydrologic conditions.

In the past, simple standards have been applied to the evaluation and permitting of water quality improvement projects that are based on synthetic or hypothetical storm events (e.g., 20-year, 1-hour storm; 6-hour, 10-year storm, etc.). To some extent, references in the literature for sizing water quality BMPs also follow this methodology, although often in more sophisticated form than has been typically used in the Lake Tahoe Basin. This method of evaluating and sizing project facilities may not result in optimum reduction of pollutant loads on an annual average basis, and may bias the selection of project features toward BMPs that can be sized for large storm events.

The focus on storm event volumes typically has placed a large reliance on water quality basins, after collection and conveyance of runoff to a location where a suitably large site is available.

An evaluation procedure is needed to compare the benefits of alternatives developed using the preferred design approach described in the Guidelines. Because the Guidelines emphasize source control, distributed flow patterns, and hydrologic design, procedures are needed that compare hydrologic characteristics of alternatives and their related transport of pollutant loads and treatment performance. A broader temporal view of the hydrologic response of a project area is needed to assess the performance of alternatives on an annual load or other cumulative basis rather than solely based on synthetic events.

The data available for developing such procedures is limited, but will increase as monitoring efforts are expanded and results compiled. Appendix C-3 describes recommended procedures based on the currently available information. Both qualitative and quantitative procedures are described for the purpose of providing a range of methods that can be applied to project areas with varying levels of complexity and available information. The procedures included in Appendix C-3 are designed to make comparisons of alternatives based on expected reductions in

sediment and nutrient loads, runoff rates and volumes, and treatment effectiveness.

Due to uncertainty in many of the estimates required to compute pollutant loads, and due to limitations in currently available data and knowledge, numeric results should be regarded as a relative basis for comparison rather than a prediction of actual performance. Although qualitative or semi-quantitative methods may be necessary in most areas, even these methods should assist designers and reviewers in making comparisons based on an estimation of overall performance. Where direct quantitative comparisons cannot be made, qualitative methods are intended to inform the review process, and provide a basis for discussion to build consensus on a preferred alternative. As additional data become available and scientific knowledge increases, the procedures can be updated and modified.

5.1.2 Other Benefits

Stormwater quality improvement projects typically provide benefits in addition to water quality. These may include:

- Improved drainage system performance or flood damage reduction
- Improved maintenance conditions
- Improved aesthetics
- Increased open space and recreational values
- Improved public safety

Although the primary purpose of the projects to be developed using the procedures described in this document is water quality improvement, a comparison of these secondary benefits may be useful when comparing alternatives. Appendix C-3 suggests a simple format for comparing these types of benefits.

5.1.3 Implementation Considerations

The feasibility of alternatives depends on their ability to be funded, permitted, and constructed. In addition, their conformance with standard public works policies and practices, acceptance by the public, and long-term maintenance requirements are key considerations in evaluating their feasibility and desirability. At a minimum, the following areas should be used as the basis for comparison of alternatives:

1. Right-of-way and land requirements
2. Utility locations and potential conflicts
3. Conformance with drainage and public liability laws
4. Construction feasibility/methods/schedule
5. Maintenance requirements
6. Permitting requirements

7. Funding availability and agency requirements
8. Compatibility with existing and future land use
9. Compatibility with other programs and planning efforts
10. Environmental compliance
11. Capital improvement, right-of-way, and maintenance costs

Appendix C-4 provides suggested procedures for comparing alternatives based on implementation considerations.

5.2 Using Appendix C

Appendix C includes an information checklist, procedures for comparison of water quality benefits, a sample format for comparison of Other Benefits, and a sample format for comparison of Implementation Considerations.

5.3 Work Products

The checklist in Appendix C-1 includes suggested information to be submitted in the Alternatives Evaluation Memorandum. This memorandum provides the basis for comparison of alternatives on water quality and other benefits, as well as a complex set of implementation considerations. The level of detail at this stage of analysis may be preliminary for components of the alternatives with few implementation constraints. However, some elements may require detailed design work to adequately identify constraints and design criteria. Design and cost information should be at a sufficient level of detail to provide a basis for comparison of water quality benefits, define other benefits, evaluate implementation constraints and the probable costs and time required to resolve them, and compare capital and maintenance costs for the alternatives.

6. SELECTING AND DEVELOPING A RECOMMENDED ALTERNATIVE

6.1 Selecting the Recommended Alternative

The recommended alternative should be selected based on the comparison of alternatives, and on the review comments from funding and regulatory agencies. The preferred design approach should be considered in selecting a recommended alternative, but it is not possible to define fixed standards or methods for selection. In the absence of implementation or regulatory constraints, the alternative or combination of alternatives that provides the best anticipated water quality performance should be selected. However, in practice other benefits and implementation constraints play a role in selecting a recommended alternative. Examples of such constraints include capital costs, maintenance costs, safety and liability concerns, right-of-way and land acquisition limitations, and environmental or permitting considerations.

The Alternatives Formulation process is specifically designed to provide a range of possibilities and approaches; at this stage the focus of the design team should shift somewhat to providing the best water quality project that is feasible to implement, based on the results of the alternatives evaluation. To this end, components of more than one alternative might be combined to form the recommended alternative.

Significant implementation constraints identified in the evaluation of alternatives should be fully investigated prior to selecting a recommended alternative, or the uncertainty clearly stated in the memorandum. In some cases, additional time or funding may be required to investigate the constraints that are identified, and coordination with the funding and regulatory agencies may be required for this purpose.

6.2 Developing the Recommended Alternative

It is anticipated that selection of a recommended alternative may occur at a stage where major constraints have been identified, but not all have been fully resolved. In most cases, this is necessary to avoid excessive commitment of time and resources to alternatives that will eventually be dropped. Given the need to further develop the recommended alternative, additional effort is recommended to resolve identified design questions and constraints, and compile a design report. These steps are shown in Figure 2.2.

Nomenclature varies between agencies and designers, but the intended level of design is referred to here as approximately 30 percent. At this stage, major design issues have been identified and addressed, the components of the project have been located

and sized, and key details and typical sections have been developed. The design may be prepared on conventional engineering drawing sheets, but may be presented at reduced scale. Designers are encouraged to focus on design issues rather than construction contract document preparation at this stage. The Recommended Alternative Project Report can generally be regarded as the end of the alternatives evaluation and preliminary design process, and the beginning of the contract document preparation phase.

6.3 Using Appendix D

Appendix D-1 includes an information checklist for information to be compiled and submitted in the Recommended Alternative Memorandum and recommended Alternative Project Report.

6.4 Work Products

The Recommended Alternative Project Report should describe the alternatives formulation and evaluation process, and describe the recommended alternative. Memoranda and work products produced as described in Sections 3, 4, and 5 can be updated and combined to produce a substantial portion of the document, or can be referenced if the results of previous analyses have not changed. The Project Report should fully describe the recommended alternative and the steps required for its implementation. The following elements are recommended to be included in the report:

1. Summary of Existing Conditions
2. Description of the Alternatives Formulation and Evaluation Process
3. Selection of the Recommended Alternative – Rationale and Design Criteria
4. Detailed Description of Recommended Alternative (including Tables, Plans, Typical Sections, Description of Treatments)
5. Implementation Steps and Schedule
6. Preliminary Design Cost Estimate
7. Recommended Post-Project Monitoring Program (if applicable)

Additional detail on suggested formats is provided in Appendix D-1.

References

CTC, 2001. *California Tahoe Conservancy Soil Erosion Control Grants Program, Program Announcement and Guidelines*. California Tahoe Conservancy, State of California. July 2002. South Lake Tahoe, California.

TRPA, 2003. *Assistance in Planning and Permitting White Paper*. Tahoe Regional Planning Agency. January 2003. Zephyr Cove, Nevada.