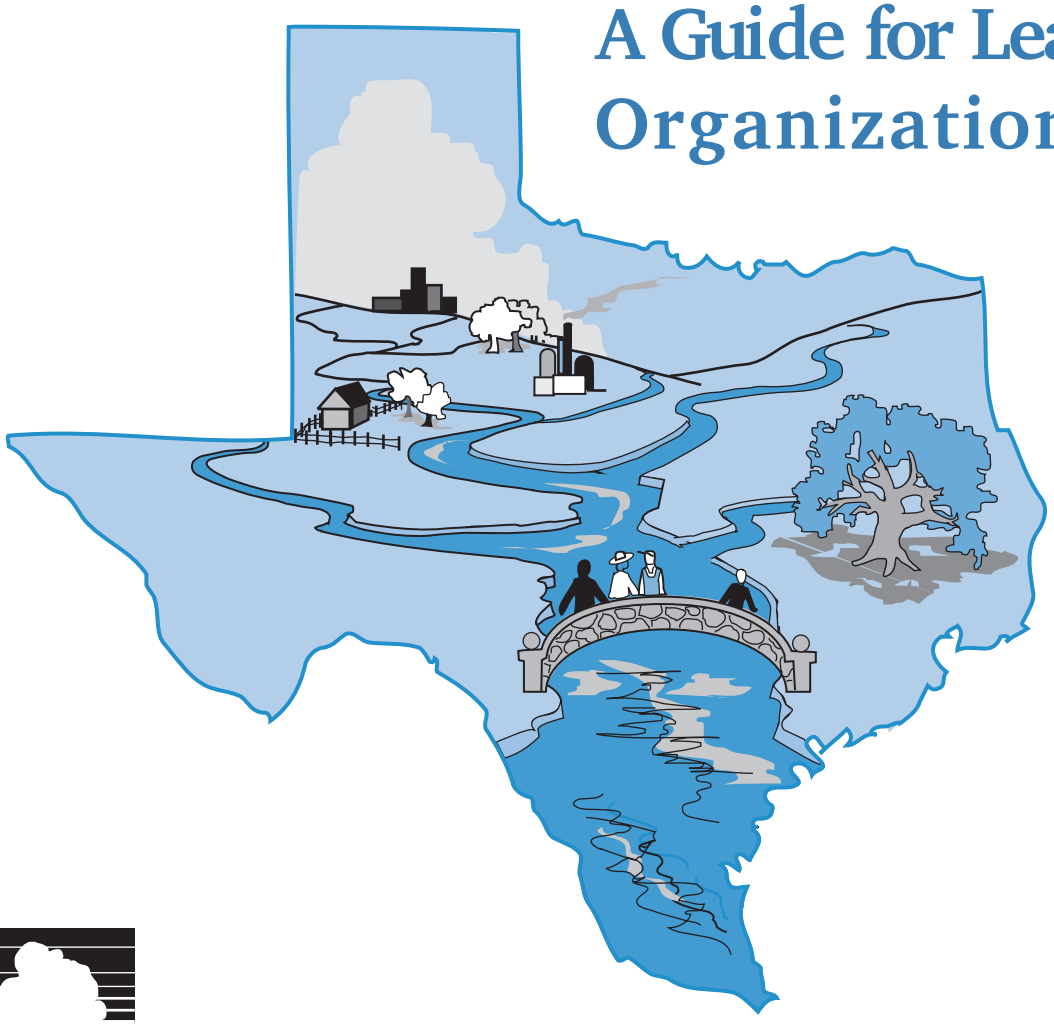
Developing Total Maximum Daily Load Projects in Texas: A Guide for Lead Organizations



TNRCC

A Cooperative Project of
the Texas Natural Resource Conservation Commission,
the Texas Institute for Applied Environmental Research,
and the Texas A&M University System

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TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
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Preface

The Statewide Watershed Management Approach

The Texas Natural Resource Conservation Commission (TNRCC) implements the statewide approach for watershed management in Texas to improve the efficiency, effectiveness, and continuity of water quality management programs. The approach, which is summarized in *The Statewide Watershed Management Approach for Texas: The TNRCC's Framework for Implementing Water Quality Management* (TNRCC 1997a), establishes the state's process for managing water quality. It focuses on assessing watershed conditions for all waters of the state and implementing solutions where improvement is necessary. The primary goal of the approach is to ensure that management efforts provide a safe, clean, affordable water supply and healthy aquatic ecosystems for Texas.

The Total Maximum Daily Load (TMDL) Program, a major component of the approach, addresses impaired or threatened streams, lakes, and estuaries (water bodies). The primary objective of the TMDL Program is to restore and maintain the beneficial uses (for example, drinking water, recreation, aquatic life) of impaired or threatened water bodies. This publication serves as supplemental guidance for TNRCC's watershed management approach.

The development and implementation of total maximum daily loads (TMDLs) has one ultimate objective—to restore and maintain the water quality in certain water bodies in Texas that are too polluted to support their beneficial uses. Achieving this objective through the TMDL process will be a major component of the state's watershed management efforts over the next 10 to 20 years.

Chapter 1
Introduction

Purpose of This Publication

This publication serves as a "how to" guide for consultants, universities, governmental agencies, river authorities, industries, communities, and others to use in conducting TMDL projects.

Important Web sites:
TNRCC: http://www.tnrcc.state.tx.us/
EPA: http://www.epa.gov/owow

This publication describes the process for completing a TMDL project for water bodies in Texas listed on the federal Clean Water Act (CWA) Section 303(d) list. Each chapter guides the reader through the steps and tasks necessary to prepare TMDLs which comply with current legal and technical requirements set forth by the U.S. Environmental Protection Agency (EPA) and the TNRCC. To make this publication clearer and easier to read, the TNRCC has often used personal pronouns—"we," "us," or "you." In this publication, "we" or "us" means the TNRCC. The pronoun "you" refers to our main audience—the lead organization.

Although lead organizations are our principal audience, any person who participates in a TMDL project will find this publication useful. If you represent a stakeholder group, you may be particularly interested in these chapters:

- Overview (Chapter 2)
- Public Participation in TMDL Projects (Chapter 5)
- The Quality Assurance Project Plan (Chapter 6)
- Finalizing a TMDL Project (Chapter 8)

This document does not address the process and rationale for including water bodies on the 303(d) list. Those topics are detailed in the methodology and guidance documents that accompany the 303(d) list. To find these documents and other information about the TMDL process in Texas, go to the TNRCC Web

site, http://www. tnrcc.state.tx.us/ and look for "Total Maximum Daily Load" under "Watersheds" in the index. For information about TMDL projects around the nation, go to the EPA Web site, http://www.epa.gov/owow.

Who Leads a TMDL Project?

An organization that accepts responsibility for conducting a TMDL project is referred to throughout this document as the **lead organization**. For some 303(d) listed water bodies, the TNRCC will serve as the lead organization to complete TMDL projects. Other TMDL projects will be initiated using state or federal funds through contracts between the TNRCC and an interested lead organization. In addition, a third party may initiate a TMDL project and assume the role of lead organization without invitation or funding support from the TNRCC. Regardless of the type of organization that undertakes a TMDL project, the TNRCC and the Texas State Soil and Water Conservation Board (TSSWCB) strongly suggest that the lead organization adhere to the guidance in this publication. The TNRCC has established a statewide schedule for determining when and where TMDL projects will be initiated. The TNRCC will assign a coordinator to each TMDL project to ensure that project components meet TNRCC and EPA requirements.

All TMDL reports must be reviewed and approved by the TNRCC.

The TNRCC and the TSSWCB are the state agencies primarily responsible for ensuring that TMDL projects are initiated and implemented. The TNRCC is the state's lead agency for urban nonpoint source pollution abatement and for point source discharge permitting [through the Texas Pollutant Discharge Elimination System (TPDES)]. The TSSWCB is the lead agency for agricultural and silvicultural nonpoint source pollution abatement. As a result, any organization considering undertaking a TMDL project for a listed water body in the state must coordinate efforts with the TNRCC (and with the TSSWCB where agricultural and silvicultural nonpoint source pollution are involved).

All TMDL reports must be reviewed and approved by the TNRCC. In addition, all TMDL reports must be submitted by the TNRCC to the EPA for approval. Any TMDL project initiated on a listed water body that shares a boundary with another state, tribe, or country will also require review and approval by the appropriate environmental agency representing that government.

By adhering to the tasks and outcomes outlined in this publication, a lead organization can improve the chance that its TMDL project will be approved by the TNRCC and EPA. For practical and legal reasons, some items associated with contractual agreements outlined in this publication may not apply to third-party lead organizations since they are not under contract with the TNRCC.

An Evolving Program

It is widely accepted that local, regional, state, and federal efforts to develop and implement TMDLs are still new and evolving. Minimal federal guidance exists and given the complex nature of trying to estimate the cumulative impacts of point and nonpoint source pollutants on a water body, there is still disagreement

or confusion surrounding many issues associated with TMDL development and implementation. In addition, the EPA is currently in the process of revising federal regulations and guidance for TMDLs based on a federal advisory committee report (EPA 1998a). The results of numerous legal challenges associated with TMDL programs around the nation will also have a significant impact on how states execute their TMDL program. While these variables create a moving target at which states must aim when developing and implementing TMDLs, opportunities exist for Texas to pursue innovative, flexible approaches that are best suited to the available resources and water quality issues of our state.

Recognizing this, the TNRCC, in collaboration with the Texas Institute for Applied Environmental Research (TIAER), The Texas A&M University System, and the TSSWCB, considered it necessary to establish this TMDL guidance to define acceptable boundaries for conducting TMDL projects in Texas. This publication has been prepared to establish a Texas approach for complying with existing federal regulations and guidance for TMDLs. Furthermore, this publication will provide more predictability to stakeholders as they become involved in TMDL projects in their respective watersheds. This publication was reviewed by and reflects recommendations from various environmental interest groups, river authorities, environmental consulting firms, academia, state agencies, EPA, agricultural businesses, industry, and municipalities.

Given these variables, you should consider this publication a work in progress. TMDLs and the forces driving them will continue to evolve around the nation. As a result, the TNRCC will need to revise this publication over time as the methods, procedures, and policies associated with developing and implementing TMDLs change and improve. This publication and its updates will be posted on the TNRCC Web site, http://www.tnrcc.state.tx.us. In the index on the home page, look for "Total Maximum Daily Load" under "Watersheds." It is anticipated that changes will be made to this guidance sometime after proposed changes to federal regulations and guidance are adopted. The TNRCC requests that readers of this publication obtain future updates through the TNRCC Web site.

Flexibility in Project Approach

Although this publication was produced to promote consistency, predictability, and accountability, the TNRCC and TSSWCB recognize that a fundamental tenet of the TMDL program must be to allow flexible approaches to restoring and maintaining beneficial uses of polluted water bodies. However, defining the boundaries of "flexibility" is difficult at best. Still, many factors dictate that flexible, innovative approaches must be accepted if TMDL projects are to be completed in a timely and cost-effective manner. For example:

> TMDL projects must be legally and scientifically defensible.

- Different assessment methods (monitoring, modeling) will be needed to address different pollutants.

- Every watershed has unique physical characteristics which may warrant changes in assessment methods.
- TMDLs initiated by different organizations will most likely recommend different approaches.
- Within each watershed, stakeholders will influence a TMDL project in a different manner.
- Limited financial and staff resources will result in varying levels of effort for each TMDL project.
- Future changes or advances in scientific methods and analytical tools used to assess point and nonpoint source pollutants may provide new approaches.

In contrast to the concept of "flexibility," the TMDL process is also influenced significantly by another tenet—that is, TMDL projects must be legally and scientifically defensible. The TNRCC, the TSSWCB, the regulated community, and the public at large may have different thresholds they deem legally and scientifically defensible. The need for a flexible approach and for legally and scientifically defensible TMDL projects creates a dichotomy that will need to be resolved on a watershed-by-watershed basis. Only in this way can we ensure that we achieve the restoration and maintenance of beneficial uses of water bodies—the final measure of success in all TMDL projects.

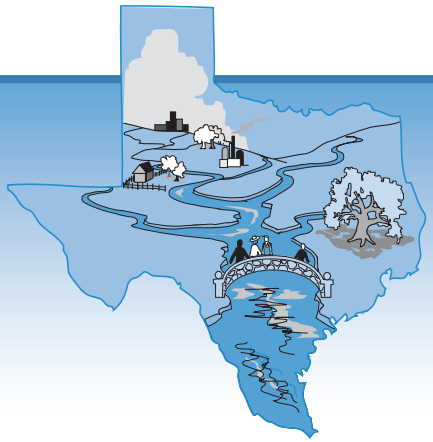
Removing a Water Body from the 303(d) List

Currently, EPA guidance allows a water body to be removed from the 303(d) list only if a TMDL is approved or if the original basis for listing the water body is no longer valid. The TNRCC has attempted to clarify this guidance in Table 1-1. Each TMDL project has the opportunity to identify a legally and scientifically valid rationale for delisting during the course of the TMDL project, perhaps even before the project is completed.

The acceptable rationale for removing a water body from the 303(d) list will be different for each constituent of concern and will vary depending on the type of listed water body—stream, lake, or estuary. The TNRCC will work closely with the lead organization, stakeholder groups, and the EPA to evaluate each rationale presented for delisting.

Table 1-1. Delisting Criteria for Clean Water Act Section 303(d) List

Criterion and Description	Examples	How Delisting Will Occur
New data. Additional monitoring data from this water body demonstrates that it meets applicable water quality standards and criteria.	• Data set screened for an ensuing 305(b)/303(d) listing cycle does not fail the screening criteria • Additional data collected in preparation for TMDL analyses reveals that there was no violation of water quality standards or criteria	TNRCC will consider water bodies for delisting on an annual basis in conjunction with its annual update of the state's 303(d) list.
Errors in listing. Errors in the data or procedures used to list the water body invalidate the basis for listing.	• Errors in computer-calculated screening criteria for particular constituents • Quality assurance failure by significant portion of the database used for listing	Errors noted in the data or procedures used by the TNRCC to assess water bodies for 303(d) listing will be coordinated with the EPA and communicated to the affected stakeholders during the course of each annual update to the 303(d) list.
New procedures or criteria. Procedures and criteria used by the state to assess water quality monitoring data for determining compliance with water quality standards are revised, and this revision results in a listed water body no longer meeting the criteria for listing.	• Changes in 305(b) screening procedures • Refinement of screening criteria for a specific water body or portions of a water body • May involve excluding certain monitoring stations from screening process, due to their locations not being representative	Changes to procedures and criteria used by the TNRCC to assess water bodies for 303(d) listing will be coordinated with the EPA and communicated to the affected stakeholders during the course of each annual update to the 303(d) list.
New standards. Water quality standards are revised, and a listed water body no longer meets the criteria for listing.	• May include changes in designated uses, numeric criteria, redefinition of segments, etc. • Standards revisions affecting waters statewide • Standards revisions affecting individual water bodies	Changes to state water quality standards will be coordinated with the EPA and communicated to the affected stakeholders during the course of each triennial update to the state's water quality standards and the annual update to the 303(d) list.
TMDL approval. The EPA has approved a TMDL designed to attain water quality standards for this water body.	• EPA approves TMDL submitted in accordance with 303(d)	The TNRCC will consider water bodies for delisting on an annual basis in conjunction with its annual update of the 303(d) list.



Chapter 2
Overview

What Is a TMDL? What Is a Watershed Action Plan?

In general, a TMDL is the total amount of a pollutant a water body can assimilate and still meet state water quality standards. The term also refers to the assessment necessary to establish an acceptable pollutant load for an impaired water body and to allocate the load between contributing point, nonpoint, and natural background sources of pollution in the watershed (i.e., loading allocation). The TMDL provides the foundation for establishing an implementation plan to restore and maintain beneficial uses.

You must include two components in every TMDL project:

- **A TMDL report**—a summary report of how the loading allocation for point, nonpoint, and background sources of a pollutant was derived.
- **An implementation plan**—a summary of the management strategies needed to restore the water quality.

The combination of these two components is a **watershed action plan** for 303(d) listed water bodies. This is prepared by the lead organization as the final outcome of the TMDL project. The flow chart in Figure 2-2 shows the steps for developing a TMDL. The following activities are a necessary part of a watershed action plan and are addressed in subsequent chapters.

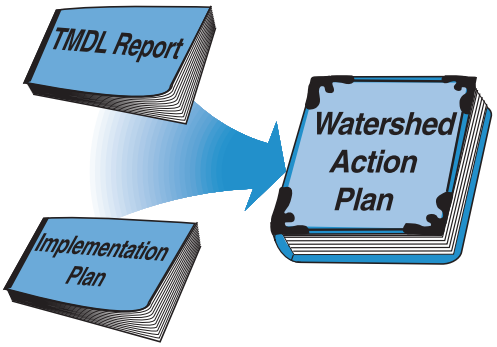


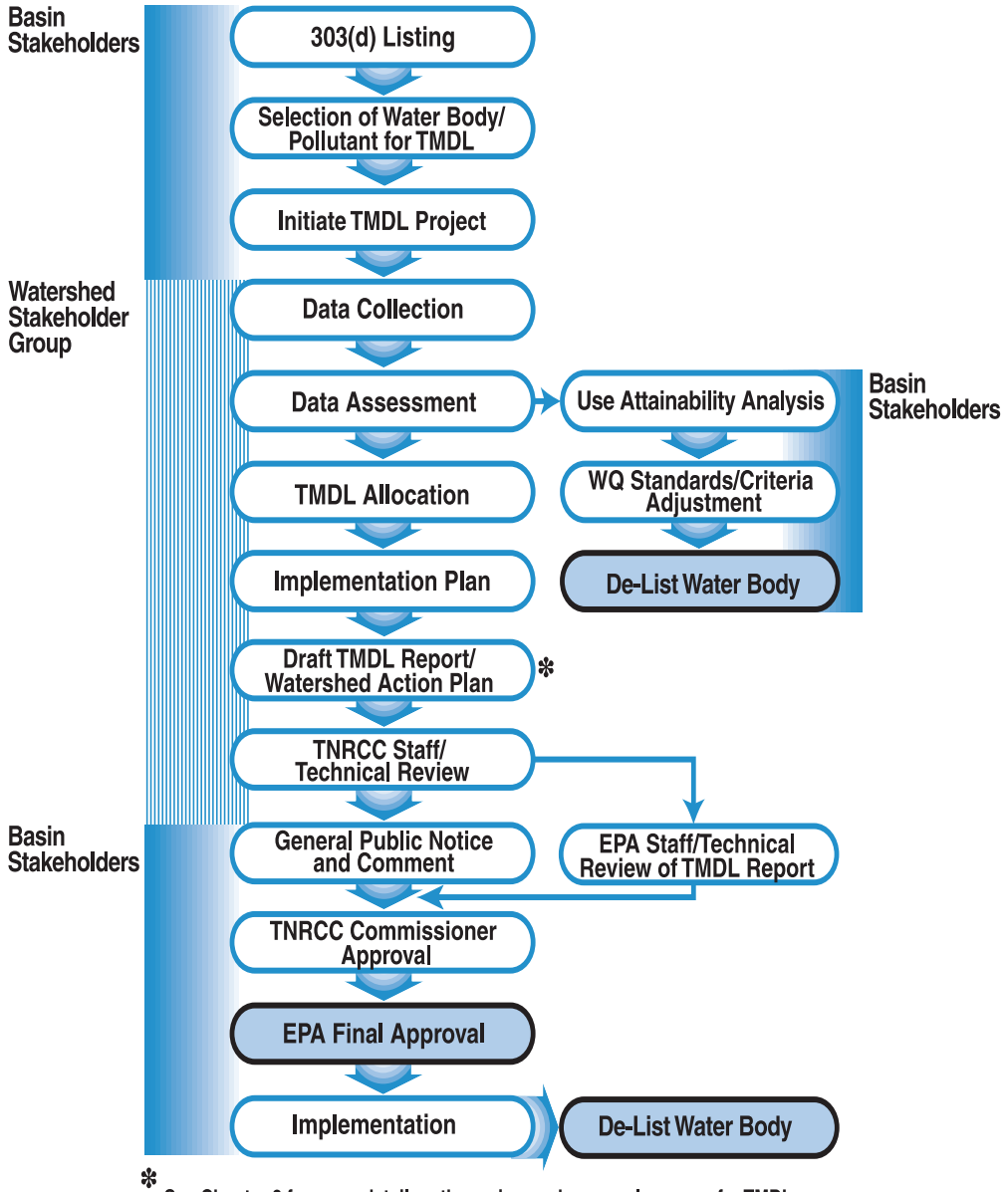
Figure 2-1. Building Comprehensive Watershed Approaches

- Establish a loading allocation.
- Select control actions and management measures.
- Ensure public participation.
- Conduct water quality monitoring and provide quality assurance.
- Utilize water quality models.

Federal Mandate

The federal mandate for state TMDL programs is contained in the 1972 CWA. Under Section 303(d) of the CWA, states are required to identify and list water bodies that do not meet, or are not expected to meet, applicable water quality standards for their designated uses [Title 40 Code of Federal Regulations (CFR) § 130.7]. States are required to prioritize all 303(d) listed water bodies for TMDL project initiation and submit the list to the EPA for approval. Federal regulations also require states to complete a TMDL for each water body as well as each pollutant listed on the 303(d) list. For example, if a stream is impaired as a result of elevated levels of metals and low dissolved oxygen levels, two individual loading allocations would be required: one for metals and another for dissolved oxygen.

Figure 2-2. General Process for TMDL Development



* See Chapter 8 for more detail on the review and approval process for TMDLs

The Basin Management Cycle

Through the basin management cycle, the TNRCC coordinates the water quality management activities of the watershed management approach. This cycle has five phases, which rotate in sequence over a five-year period.

- **Phase 1. Scoping and re-evaluation:** Conduct public outreach, identify watershed priorities, and develop monitoring plans.
- **Phase 2. Data collection:** Implement monitoring plan, and compile and maintain data.
- **Phase 3. Assessment and targeting:** Analyze data and quantify impacts and sources.
- **Phase 4. Strategy development:** Develop and document management strategies.
- **Phase 5. Implementation:** Finalize watershed action plans and implement management strategies.

The basin management cycle includes activities and actions that are directly involved with TMDL projects, such as data collection, assessment, and TPDES permit decisions; therefore, you should coordinate TMDL project activities with the cycle. For additional information on the basin management cycle, see the *Statewide Watershed Management Approach for Texas* (TNRCC publication GI-229; TNRCC 1997a) which can be found under "Publications" on the TNRCC Web site, http://www.tnrcc.state.tx.us/.

Guiding Principles

Follow these principles when undertaking a TMDL project.

- Coordinate with the TNRCC and the TSSWCB (if necessary) before beginning a TMDL project.
- Promote pollution prevention practices.
- Involve appropriate stakeholders throughout the TMDL project.
- Promote public education and awareness by cooperating with the TNRCC to publish project results on the TNRCC Web site.
- Use existing public participation forums, such as the Clean Rivers Program basin steering committees, Source Water Protection Program committees, and National Estuary Program committees, to initiate stakeholder participation in each TMDL project watershed.
- Seek to develop TMDL control measures that, whenever possible, use existing regulatory and voluntary programs to attain the load reduction.
- As much as possible, coordinate TMDL project activities with the TNRCC's basin management cycle.
- If the water body is impaired by multiple pollutants, structure the project to address as many pollutants as technically and financially practical.

The TNRCC and TSSWCB will work with the EPA to ensure that new approaches comply with federal regulations and guidance.

- Document and communicate the level of uncertainty in the scientific tools used.
- Implement strategies to reduce pollutants as close to the source as possible.
- To the greatest extent possible, verify and use existing water quality data. If additional data are necessary, collect data in accordance with a TNRCC-approved quality assurance project plan.
- Adopt and justify an appropriate modeling approach.
- Work with the stakeholder group to develop criteria for selecting the loading allocation and control measures.
- Consider the costs of recommended implementation strategies.
- Comply with federal and state regulations and guidance.

Unknown Factors

Over the course of any given TMDL project, technical, programmatic, policy, or legal issues may arise that have not been encountered before in the Texas water quality management program. As the state's TMDL program matures, the TNRCC and the TSSWCB will develop new policies, procedures, and approaches as necessary to respond to these types of issues. In some cases, lead organizations and stakeholders will have the opportunity to work with the TNRCC and the TSSWCB to shape new approaches for addressing these challenging matters. The TNRCC and the TSSWCB will work with the EPA to ensure that new approaches comply with federal regulations and guidance. Lead organizations and stakeholders should contact the TNRCC when new issues arise during the course of a TMDL project.

During TMDL projects, as additional data and information become available, monitoring strategies, water quality targets, loading allocations, or implementation strategies may need to be refined to more adequately respond to site specific conditions and project goals. For example, as additional monitoring occurs throughout the TMDL project, adjustments to the scope of work may be needed as knowledge of the problem increases and uncertainty decreases. The process for changing the scope of work for a TMDL project—for example, to accommodate a different assessment tool or to change the monitoring plan—where the lead organization is under contract to TNRCC would be outlined in the contract.

Planning a TMDL Project

The state's TMDL program requires a management approach that is driven by technical requirements and must integrate a wide range of information and activities. To shape an individual TMDL project, the lead organization and stakeholders must do significant decision making and project planning. The TNRCC recommends starting by preparing a scope of work which summarizes the tasks involved and how the project will adhere to the guidance outlined in this document. You will be given flexibility to establish an efficient and acceptable scope of work. However, the scope of work must result in the preparation of a watershed action plan, adhere to the guiding principles outlined above, and include project costs if state or federally funded. Appendix A of this document is an example of a scope of work created for a TMDL project. This example shows how the guidance in this publication translates to individual project tasks and deliverables.

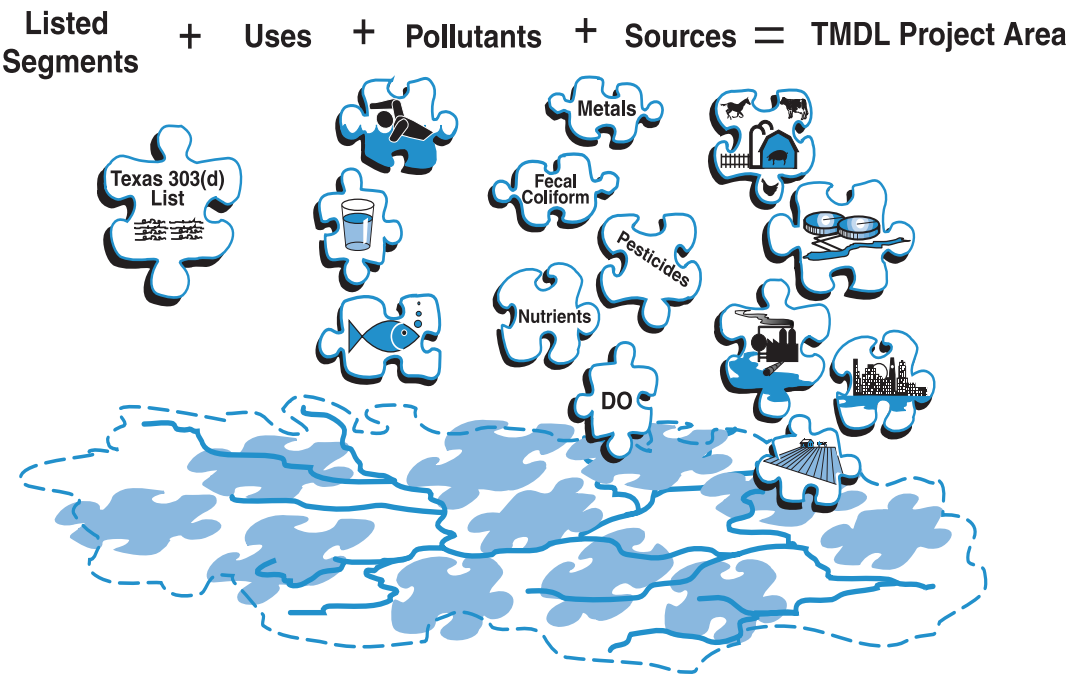


Figure 2-3. Geographic Scope of TMDLs

Other project planning activities you should initiate at the outset of a TMDL project are:

- **Create a watershed stakeholder group.** Establishing a watershed stakeholder group at the outset of the project and maintaining their participation throughout will increase the support for restoring water quality in 303(d) listed segments. Methods for strengthening the commitment from stakeholders to stay involved throughout the TMDL project should be established early in the planning process. See Chapter 5 for more information on stakeholder groups.

- **Consider broad-based and source-specific pollution prevention strategies.** Examples of broad-based pollution prevention strategies include educational materials and campaigns, newsletter columns, Web pages, and storm drain stenciling. Source-specific or constituent-specific pollution prevention includes reducing or eliminating waste generation at the source, reducing or eliminating releases of pollutants, and reducing environmental or human health hazards associated with wastes and pollutants.

- **Determine the geographic scope of the TMDL project.** The TNRCC and the lead organization should determine the geographic scope of a TMDL project early in the planning process. The geographic scope will affect decisions such as which stakeholders to recruit, monitoring plan design, acquisition of land use and land cover data, and modeling approaches. This scope should include the entire drainage area from which any pollutants affecting the water body originate. The drainage area will vary considerably from one water body to the next. For example, a drain-

age area may encompass several hundred acres of land surrounding a small stream or thousands of acres that drain into a large river basin. To determine the geographic scope of a particular project, some information about the location of significant sources of pollutants will be needed.

Alternative Outcomes of TMDL Projects

This publication describes the objectives, tasks, and deliverables necessary to complete a watershed action plan for a constituent of concern in a given water body on Texas' approved 303(d) list. Over the course of each TMDL project, one key aspect of water quality planning and management that will come into greater focus is the water body's present water quality standard. Stated another way, during the early stages of the TMDL project, the lead organization and the stakeholder group should collaborate with the TNRCC to determine options for conducting a more detailed analysis of the severity and geographic extent of the impairment as identified on the 303(d) list to determine the appropriate direction for the TMDL project. As a TMDL project is conducted, two alternative outcomes may materialize as existing and additional data are assessed to characterize the constituent of concern and watershed conditions:

1) the stakeholder group and the TNRCC may determine that it is appropriate and feasible to conduct a use attainability analysis (UAA) to have the designated use changed [40 CFR §§ 131.10(h) and 131.10(d)]; or
2) the water quality criterion that was exceeded, placing the water body on the 303(d) list, may not be appropriate and should be replaced by a site-specific criterion, which would result in a change to the water quality standards, screening criteria, or both for some parameters [40 CFR § 131.11(b)].

The TNRCC recognizes that, within the current regulatory framework, changes to designated uses may be feasible in very limited situations only. The TNRCC is interested in establishing more site-specific water quality criteria for a variety of technical, scientific, economic, and administrative reasons. Establishing the most appropriate site-specific water quality criteria is an important first step of every TMDL project.

Chapter 3
TMDL Allocation Components

This chapter presents the recommended process for developing a loading allocation. This process involves the following four components and culminates in allocating pollutant loads among various sources:

- Identify the water quality target.
- Assess current watershed and water quality conditions.
- Analyze pollutant sources (point, nonpoint, natural background, atmospheric deposition).
- Allocate pollutant loads.

Lead organizations, working with watershed stakeholder groups, will be required to summarize these components in the TMDL reports which they submit to the TNRCC and EPA for review and approval. For EPA guidance on these components, see Appendix B.

Identify the Water Quality Target

TMDL projects must identify a quantifiable water quality target for each constituent that causes a body of water to appear on the 303(d) list. Identifying a water quality target for a specific water body will depend on the nature of the impairment and applicable water quality standards. For certain pollutants of concern, the primary water quality target has been established by the TNRCC through the Texas Surface Water Quality Standards [30 Texas Administrative Code (TAC) §§ 307.1–307.10]. These standards define goals for surface water quality and contain three components:

- designated uses
- water quality criteria
- an antidegradation policy

The four general categories of designated uses in Texas are recreation, domestic water supply, aquatic life, and other uses (navigation, agricultural water supply, and industrial water supply).

Water quality criteria establish maximum pollutant levels that allow designated uses to be maintained. Other measures of support for designated uses, including sediment toxicity and total toxicity, are also used. The criteria may be either numeric or narrative, for example:

Numeric: The chloride concentration in segment X should not exceed 30 mg/L.
Narrative: No foaming or frothing of a persistent nature.

The antidegradation policy in the Standards prohibits an increase in loading that would impair or further impair an existing use.

If a numeric water quality criterion exists for the identified pollutant of concern, it may be presumed to be adequate and used as a target. However, some TMDL projects may encounter one of these complications:

- Existing numeric criteria may need to be refined to adequately reflect watershed-specific conditions.
- Only narrative criteria may be at issue.
- Numeric criteria may not exist, but it may be possible to develop them.
- Numeric criteria may not exist, and it may be impossible to develop them.
- Multiple pollutants may exist, complicating the development of targets.

TMDL projects must identify a quantifiable water quality target for each constituent.

In developing a TMDL project, the lead organization and stakeholders may either develop additional water quality targets to aid in achieving the goal of restoring water quality, or find valid reasons for modifying existing designated uses or water quality criteria.

Three widely accepted methods can be used for characterizing or defining targets in situations when targets are not readily available:

- chemical-specific
- toxicity biomonitoring
- bioassessments

The chemical-specific approach evaluates water quality in terms of a chemical-based condition, such as dissolved oxygen or pollutant concentrations (for example, mercury measured in micrograms per liter). This is the approach that typically produces numeric water quality criteria.

Toxicity biomonitoring evaluates the cause-and-effect relationship between water quality and aquatic ecosystem health as characterized by the response of relevant indicator organisms. Toxicity is measured as statistically significant effects on growth, reproduction, and survival of the test organisms.

Bioassessments evaluate water quality in terms of biological criteria, or "biocriteria." A biocriterion is not itself a pollutant, but indicates the effects of pollution. One example is a determination of benthic macroinvertebrate diversity as an indicator of the health of a water body.

Targets should be set for locations in close proximity to the pollutant sources to aid in evaluation of source impacts on water quality. Targets may also need to be set in other areas in the zone of impact, which may not be near sources.

Narrative Criteria

A narrative water quality criterion expresses the acceptable level for a pollutant with words, instead of numbers; for example, "no toxics in toxic amounts." Existing narrative criteria are summarized in the Texas Surface Water Quality Standards. If the constituent of concern for a listed water body has only a narrative criterion, contact the TNRCC to determine whether a numeric criterion can be developed. A surrogate may be adopted for use as a target if a numeric criterion cannot be developed in a timely fashion.

Multiple Constituents

Some bodies of water may be on the 303(d) list for more than one constituent. For these water bodies, the lead organization should get input from the stakeholder group to decide how to address the constituents of concern: separately, or under a single project.

In making this decision, consider these possibilities for the interaction of multiple constituents:

- The impact of the combination of constituents may be greater than the sum of their individual impacts.
- A constituent or group of constituents may magnify the impact of another constituent.
- A constituent or group of constituents may suppress the impact of another constituent.
- The constituents may have little or no effect on or relationship with one another.

Also, bear in mind that combining separate constituents under one project will sometimes lead to an overall efficiency in meeting the water quality goal, but may also add new complications. For example, a combined project requires only one stakeholder group, and reduces the time and costs required to collect water quality samples. On the other hand, a combined project faces additional complexity since it must establish multiple water quality targets and will require more complex models. This is an important decision, and must be carefully considered.

Combining separate constituents under one project will sometimes lead to an overall efficiency in meeting the water quality goal, but may also add new complications.

Still, when a body of water contains multiple constituents of concern, we encourage you to address these constituents through a single project whenever possible. These are some of the methods available for addressing more than one constituent in a single TMDL project:

- using multiple targets
- using the limiting or constraining factor
- using bioassessment as an indicator

Assess Current Conditions

In most TMDL projects, you will have to collect additional water quality data and other information to adequately characterize the water body, its watershed, and the nature of impairment; however, in some cases, sufficient data may already be available. The stakeholder group and lead organization should work with the TNRCC to determine whether the available data are sufficient. Quantitative data and other information on hydrology, biology, chemistry, pollutant sources, land uses, and the concentration, fate, and transport[1] of pollutants may be needed to complete the TMDL project. Water quality data will support several tasks, including the assessment of current watershed conditions, determination of loading capacity, and allocation of pollutant loadings among contributing sources. Additional water quality data can also be used to evaluate the water quality criterion originally used to list the water body and determine whether a site-specific modification is appropriate. If a modification to the original water quality criterion is found to be appropriate, then the additional water quality data can be used to develop a scientifically defensible, site-specific water quality criterion for the pollutant of concern.

> The stakeholder group and lead organization should work with the TNRCC to determine whether available data are sufficient.

Assess Current Water Quality

The first step in assessing the current conditions is to gather available data and information on the water body. At a minimum, obtain the water quality data the TNRCC used for listing the water body. Other data sources include universities, businesses, municipalities, other state and federal agencies, other states, and citizen groups. Use these data to educate yourselves and the stakeholders about local issues and prior initiatives, communicate with other citizens or entities involved in local water quality issues, and guide new data-collection efforts.

Evaluate Existing Data

The lead organization and stakeholder group will be required to evaluate and describe the sufficiency and adequacy of existing data. The definition of "sufficient and adequate data" may vary among specific TMDL projects. The TNRCC will consider data to be sufficient and adequate when the data accurately characterize the conditions of the water body, watershed, pollutant, and pollutant sources throughout typical geographic and temporal conditions with reasonable certainty.

[1]Fate and transport define whether the pollutant is biochemically or physically altered by the water body or whether the pollutant passes through the water body unaltered.

To the extent practical, the lead organization and stakeholder group should identify and document any quality assurance and quality control procedures used in collecting the data to determine the appropriateness of using the data. Considerations include the source, quality, collection, and analytical methods associated with the data.

Collect Additional Data

Most TMDL projects will require additional watershed information relating to particular water quality conditions, as existing data alone may be insufficient to support the analytical needs of TMDL projects. Since data collection efforts by other organizations may already be in place, collection of new data should be coordinated with them. Data on low-flow conditions, storm-flow conditions, and seasonal variations should be gathered when appropriate to the situation.

If additional water quality data are needed, the lead organization and stakeholder group must provide a quality assurance project plan (QAPP), including a water quality monitoring plan. The QAPP process is outlined in Chapter 6, "The Quality Assurance Project Plan."

Determine the Water Body's Loading Capacity

A water body's loading capacity is an estimate of the maximum amount of pollutant loading the water body can receive over time without exceeding water quality standards. Hydrological, biological, chemical, and pollutant fate and transport data are required to calculate a water body's loading capacity. Loading capacity can be determined by modeling or empirical study.

Analyze Pollutant Sources

Before pollutant loads are allocated among sources, the lead organization and stakeholder group should identify the location and types of sources, and the current and projected pollutant load for each source. Examples of data needed for pollutant source analysis include:

- watershed and subwatershed boundaries;
- hydrologic interaction between surface water and groundwater;
- locations of stream segments;
- locations of pollutant sources;
- types of pollutant sources (for example, wastewater treatment plant, urban, forestry, or agricultural runoff, natural background, atmospheric deposition);
- TPDES[2] permit information;
- anticipated growth of discharges during the implementation period;
- rainfall data and rainfall runoff coefficients;
- land uses and land cover;
- soil types.

[2]Texas Water Code (§ 26.027) authorizes the state, with some exceptions, to issue permits for the discharge of waste or pollutants into or adjacent to waters of the state.

Incorporate Geographic Data

Use specific formats for geographic data collected in source analysis and other TMDL project elements. Vector data (point, arc, and polygon) that will be used in area analysis should be delivered in the Texas Statewide Mapping System (TSMS) format, based on the Lambert conformal conic projection. Grid data (digital elevation models, flow grids, and land-use data) that are used in area analyses, such as determination of watershed areas, should be delivered in an Albers projection format to ensure minimal areal distortion. This format should also be used for vector data associated with grid models. Both the TSMS and TSMS-Albers projections use the projection parameters listed below.

Units	meters	**1st Parallel**	34 55 00
Datum	NAD83	**2nd Parallel**	27 25 00
Spheroid	GRS 1980	**False Easting (m)**	1,000,000
Central Meridian	-100 00 00	**False Northing (m)**	1,000,000
Reference Latitude	31 10 00		

Identify Point and Nonpoint Sources

The lead organization and the stakeholder group must analyze point, nonpoint, and natural background pollutant sources. Point sources discharge pollutants into water from a defined outlet, such as a pipe, ditch, channel, tunnel, or container. Discharges from industrial plants, wastewater treatment plants, and most large concentrated animal feeding operations are included in the legal definition of a point source. Most point source dischargers are required to operate under permits with conditions that are designed to control pollution. Nonpoint sources discharge pollutants from diffuse, hard-to-define, and wide geographic areas. Examples of nonpoint sources include runoff from cultivated fields, waste application areas, and urban areas (such as streets and yards); deposition of airborne toxics into water bodies; and contaminated sediments. Federal TMDL guidance includes natural background sources (those not associated with human activities) in the nonpoint source definition. We prefer to differentiate between nonpoint sources and background levels.

Point sources discharge pollutants into water from a defined outlet, such as a pipe, ditch, channel, tunnel, or container.

Nonpoint sources discharge pollutants from diffuse, hard-to-define, and wide geographic areas.

The lead organization and stakeholder group should develop an inventory of all known factors in the watershed which influence water quality. These factors might include permitted industrial and municipal wastewater discharges, concentrated animal feeding operations (CAFOs), waste application sites, cropland, forestry operations, industrial stormwater, urban runoff, construction activities, and other sources such as natural background where possible. This information should be collected and maintained by subwatershed to enhance the identification of cause-and-effect relationships. The watershed inventory should be compiled from land-use data, special investigations, TNRCC complaint investigations, TNRCC permit databases, surface water monitoring data, and watershed stakeholder group input.

Determine Current Loading from Sources

A pollutant load is a mass per unit of time—for example, pounds of nitrogen per day, month, or year. Each point, nonpoint, and natural background source within the watershed contributes to the current pollutant load of the water body. The contribution of each source to the current load must be calculated or estimated to allocate pollutant loads. The lead organization and stakeholder group should determine source contributions by measuring pollutant loads directly, calculating or estimating loads from water quality and flow data, estimating loads with mathematical models, or using a combination of these methods.

Estimate Future Loading from Sources

Loading allocations that will be implemented to achieve water quality standards in the future must account for foreseeable increases in pollutant loading. Implementation of load allocations will occur over a period of years, with a projected date for meeting the water quality target(s) that may be far in the future. For example, normal population growth in cities should require some increase in wastewater discharge over the target period, and growth of industries or commercial activity may increase discharges from those sources. Other human sources may increase during the implementation period as part of normal economic growth.

Past planning efforts that were similar to TMDLs have typically used a projection horizon of fifteen to twenty years, beginning from the period when the analyses and plans are developed. The EPA has consistently required that domestic wastewater discharges be analyzed using the larger of either the maximum discharge allowed by the current permit, or the discharge that would be needed to serve predicted populations at the projection horizon. Consequently, municipal discharges are usually modeled at flows that are significantly larger than their current condition, and models may even exceed the capacity of existing facilities. This approach provides some allowance for future population growth in areas served by municipal wastewater treatment facilities.

All anticipated increases in loading should be included in models or other analyses that project water quality responses or conditions into the relatively distant future. This not only provides greater assurance that the water quality target(s) will be achieved; it also encourages explicit consideration of future growth allowances while load allocations and implementation plans are developed.

Allocate Pollutant Loads

The TMDL loading allocation process culminates in allocating pollutant loads among various point, nonpoint, and natural background sources in the watershed. Lead organizations and stakeholder groups should use the equation and recommendations listed below to develop and evaluate TMDL loading allocations. This allocation equation should be included in the TMDL report submitted to the TNRCC and EPA.

$$LC = WLA + LA + MOS$$

where: **loading capacity (LC)** is the maximum amount of pollutant loading a water body can receive without violating water quality standards

wasteload allocation (WLA) is the portion of a receiving water's loading capacity that is allocated to existing and future point sources

load allocation (LA) is the portion of a receiving water's loading capacity that is allocated to existing and future nonpoint sources and to natural background sources

margin of safety (MOS) is the prescribed mechanism to account for the uncertainty in determining the amount of pollutant load and its effect on water quality

The MOS should not be used to account for allocation to future sources or to natural background sources.

MOS is typically considered implicitly with conservative assumptions within calculations or models, explicitly during allocation of loads, or both. The MOS should not be used to account for allocation to future sources or to natural background sources. The MOS, and specifically uncertainty, are very important components of TMDL projects, and lead organizations need to communicate their implications to stakeholder groups and the TNRCC. See "Uncertainty in TMDL Projects and the Margin of Safety," in Chapter 7 for more information about the MOS and uncertainty.

Currently, neither the federal CWA nor EPA regulations specify methods for allocating pollutant loads among contributing sources; this decision has been left to the states (EPA 1991). In Texas, the TNRCC recommends that stakeholder groups be responsible for evaluating and recommending loading allocations to meet TMDL project goals—specifically, water quality standards. The TNRCC will examine loading allocations for technical sufficiency, focusing on whether the loading allocation is expected to achieve the water quality target. Loading allocations may affect many residents in TMDL watersheds; therefore, stakeholder groups should make allocation decisions based on sound science and principles of equity to the extent possible. To enhance TNRCC and stakeholder group acceptance of the loading allocation, obtain adequate data and information and communicate the loading allocation process used to the TNRCC and stakeholder groups.

Allocating to Both Point and Nonpoint Sources

TMDL projects for 303(d) listed water bodies may involve a combination of point, nonpoint, and natural background sources or may be dominated by one of the source types. The types of sources that dominate the watershed and the nature of the pollutant will strongly influence the allocation scheme selected. The loading allocation may also be influenced by the enforceability of control actions and management measures used to achieve pollutant reductions. Point sources must have permits; these permits can be modified and enforced. Nonpoint sources are not generally required to have a permit, but water quality management programs for nonpoint source management do exist—for example, on-site

wastewater treatment system regulations, agricultural waste management, Edwards Aquifer protection, and source water protection. For other criteria to consider in evaluating loading allocations, see "Selecting Control Actions and Management Measures" in Chapter 4.

The lead organization and stakeholder group should also assess how much individual sources can feasibly reduce their pollutant load contributions. This information can be acquired with a combination of empirical research methods (including monitoring data), spatial analysis tools, and predictive models. It is critical to involve the TNRCC and TSSWCB in this step to coordinate the permitting process for point sources and the implementation of management measures for nonpoint sources.

Loading Allocation Requirements

The lead organization and stakeholder group must consider and incorporate the following important factors when developing a loading, unless the lead organization can demonstrate to the TNRCC that one or more of these factors is not relevant to the particular load allocation:

- future growth allocations
- variations in flow and pollutant load
- temporal aspects
- antibacksliding requirements
- antidegradation requirements

Future Growth Allocations

As indicated in the allocation equation on page 3-8, future growth (such as new sources and source expansion) should be considered when allocating pollutant loads. If the pollutant loads are allocated without considering future growth, no pollutant loading is available for new sources and for the expansion of current sources. Therefore, the stakeholder groups should consider reserving a portion of the pollutant load for future growth. The MOS must not be used to account for future growth needs.

Variations in Flow and Pollutant Load

Variability in hydrology and effluent discharge need to be considered in allocating pollutant loads. The pollutant load and concentration can vary depending on a number of factors, including rainfall and normal seasonal variations. Federal regulations mandate that TMDL loading allocations take these variations into consideration. Addressing variable conditions may require a modified approach to loading allocation, such as different loading levels at different flow conditions or during certain times of the year.

> Future growth should be considered when allocating pollutant loads.

Temporal Aspects

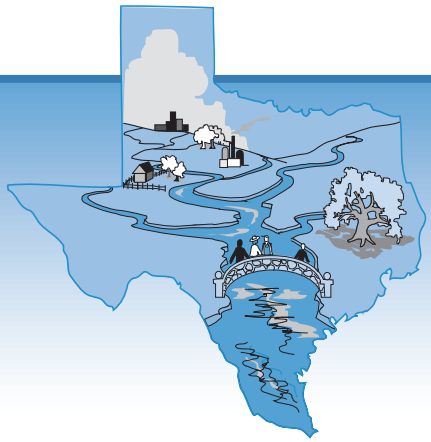
The pollutant load can be expressed in different time frames, but is usually expressed as a mass per day, as in "total maximum daily load." The period of time over which a total load will be evaluated for the purposes of TMDL loading allocation is a function of hydrologic and seasonal variations in pollutant loads. When determining the appropriate time frame, focus on watershed conditions, including water quality, hydrology, source locations, and climatic patterns. For example, in systems with significant nonpoint source load contributions, it may be appropriate to use an annual time frame. In watersheds with continuous flows from point sources, the pollutant load may not vary with time, but evaluation of critical conditions should occur during low-flow. The lead organization and stakeholder groups will need to consult with the TNRCC to establish an appropriate time frame for each constituent of concern.

Antibacksliding Requirements

When evaluating loading allocation alternatives, the lead organization and the stakeholder group must consider the constraint imposed by the CWA "antibacksliding" requirements. These requirements generally prohibit reissuing a TPDES permit with less-stringent technology-based effluent limits than those contained in an existing permit. Federal law provides exceptions in certain cases—for example, when new information justifies the relaxing of technology-based permit limits (CWA 1987). Exceptions to the overall prohibition against relaxing a water quality-based effluent limitation also exist. For example, when a water body is not attaining a standard, an effluent loading may be revised and made less stringent in one or more discharges into the water body only when the cumulative effect of these permit revisions will ensure attainment of the standard in the water body.

Antidegradation Requirements

The antidegradation policy in the Texas Water Quality Standards (30 TAC § 307.5 and Texas Water Code § 26.003), prohibits an increase in loading that would impair or further impair an existing use. In addition, the policy prohibits degradation of high-quality waters, even if designated uses would still be attained, unless the degradation is justified under an exception. Loading allocations must be consistent with these provisions. Further information on antidegradation is included in TNRCC publication RG-194, *Implementation of the TNRCC Standards via Permitting* (TNRCC 1995). This document is available from the TNRCC Web site, **http://www.tnrcc.state.tx.us/admin/topdoc/rg.html.**



Chapter 4
TMDL Implementation Plan

Implementing management measures and pollutant control actions[1] through watershed-scale approaches is essential to restoring water quality. Therefore, we expect the lead organization and the stakeholder group to formulate an implementation plan for each TMDL project. When complete, the TMDL report and implementation plan form a watershed action plan—a comprehensive strategy for restoring and maintaining the beneficial uses of the water body (TNRCC 1997a).

Implementation Plan Components

The recommended implementation plan components were adapted for Texas from the recommendations of the TMDL federal advisory committee (FAC) (EPA 1998a) and from a publication of the Ohio EPA (Ohio EPA 1997).

1. Describe control actions and management measures that will be implemented to achieve the water quality target. For point sources, describe discharge permits and permit revisions. For nonpoint sources, describe the parties responsible for implementation and summarize the anticipated effectiveness of the proposed management measures.
2. Develop a schedule for implementing specific activities determined necessary to achieve TMDL objectives. To allow for flexibility, we recommend a schedule based on time frames rather than specific dates—for example, "loading allocations will be evaluated and, if necessary, adjusted in the fall of 1999." This schedule should include time frames for:
    - issuing and revising TPDES permits, including schedules of compliance;
    - obtaining funds and in-kind services to support implementation;
    - implementing nonpoint source management measures;

[1]Control actions refer to point source pollutant reduction strategies, generally TPDES permits. Management measures refer to nonpoint source pollutant reduction strategies.

- conducting public education;
- performing follow-up water quality monitoring;
- adjusting TMDL loading allocations or implementation strategies; and
- reporting regularly to improve project coordination and communication with stakeholders.

The implementation schedule should identify entities responsible for accomplishing each step. It should also coordinate activities that involve all appropriate local, regional, state, and federal agencies—for example, permitting, monitoring, or nonpoint source management measures. Efforts to obtain funds and in-kind services should begin early and continue throughout the project. You should not wait until all funds have been secured to begin implementing control actions, management measures, and pollution prevention programs. By initiating strategies with available funds, you can demonstrate successes to the funding sources and possibly get more funding.

3. Provide reasonable assurances that the implementation of voluntary management measures will achieve the load allocations for nonpoint sources and that funds will be available to implement point source controls and nonpoint source management measures. This may include the use of backup enforcement authority, if necessary.
4. State the legal authority under which control actions and management measures will be carried out and indicate whether they are enforceable.
5. Formulate a follow-up surface water quality monitoring plan (see "Follow-up Monitoring Plan" in this chapter) to determine the effectiveness of the control actions and management measures and to determine whether loading allocations are achieved.
6. Set measurable outcomes for determining whether the implementation plan is being properly executed and water quality standards are being achieved.

Selecting Control Actions and Management Measures

In most cases a comprehensive restoration of water quality requires a combination of point source controls, nonpoint source management, public education and involvement, economic incentives, urban land use management, habitat restoration, and other measures (Ohio EPA 1997). The stakeholder group and lead organization should identify a set of solutions when considering control actions and management measures. Potential incentives and options include (ELI 1997; Ohio EPA 1997):

- **For point source pollutant reduction:** recognition awards; cost savings; improved public image; increased property values; permit requirements for industrial and municipal dischargers and concentrated ani-

mal feeding operations (including limits, effluent monitoring, and coordination with the basin management cycle); and training and technical assistance on pollution prevention for permittees and facilities discharging to publicly-owned treatment works (see Table 4-1).

Table 4-1. Examples of Pollution Prevention Activities

Good Operating Practices
Separate types of hazardous waste to make them more amenable to recycling
Separate hazardous waste from nonhazardous waste
Improve maintenance scheduling, record-keeping, or procedures
Change production schedule
Other changes in operating practices

Process Modifications
Institute recirculation within process
Modify equipment, layout, or piping
Use a different process catalyst
Institute better controls on operating bulk containers to minimize empty container disposal
Change from small containers to bulk containers to minimize empty container disposal
Other process modifications

Inventory Control
Institute procedures to reduce outdated material
Test outdated material
Eliminate shelf-life for stable materials
Use better labeling procedures
Institute clearinghouse to exchange materials
Other changes in inventory control

Surface Preparation and Finishing
Modify spray systems or equipment
Substitute coating materials used and/or improve application techniques
Change from spray to other system
Other surface preparation and finishing modifications

Spill and Leak Prevention
Improve storage and stacking procedures
Improve procedures for loading, unloading, and transfer operations
Install overflow alarms or automatic shut-off valves
Install vapor recovery systems
Implement inspection or monitoring program of potential spill and leak sources
Other spill and leak prevention activities

Cleaning and Degreasing
Modify stripping/cleaning equipment
Change to mechanical stripping/cleaning devices (from hazardous solvent to other materials)
Change to aqueous cleaners
Modify containment procedures for cleaning units
Improve draining procedures
Redesign parts racks to reduce drag out
Modify or install rinse systems
Improve rinse equipment design and/or operation

Raw Material Modifications
Increase purity of materials
Substitute nonhazardous for hazardous raw materials
Other raw material modifications

Product Modifications
Change product specifications
Modify design or composition of product
Modify packaging
Other product modifications

- **For nonpoint source pollutant reduction:** education; training and technical assistance; cost-share programs and other financial incentives; best management practices (see Table 4-2); nutrient and fertilizer regulations; mandatory best management practices for "bad actors[2];" use of best management practices to form exemption from a regulatory program or violation or to form a defense from nuisance actions; logger and forester licensing; best management practices in forestry plans; erosion and sediment control laws (especially on land development or land conversion projects); TSSWCB water quality management certification program in areas impacted or threatened by nonpoint source pollutants; and regulation of on-site sewage disposal systems and septic tanks in local building and health codes.

Table 4-2. Examples of Nonpoint Source Pollution Best Management Practices (BMPs)

Urban
flood storage
porous pavements
street cleaning
nutrient management*
pesticide management*
irrigation management*

Construction
disturbed area limits
nonvegetative soil stabilization
surface roughening
silt fences

Agriculture
animal waste management
conservation tillage
contour farming
terraces
field borders
strip cropping
cover crops
crop rotation
crop selection
nutrient management*
pesticide management*
integrated pest management
livestock exclusion or controlled access
range and pasture management
proper stocking rate
irrigation management*
conservation buffers

Silviculture
maintaining ground cover
limiting disturbed areas
log removal techniques
pesticide management*
proper handling of haul loads
removal of debris
road and skid trail management
limiting stream crossings

Mining
block-cut or haul back
underdrains
water diversions

General
wetland protection
restore wetland areas or construct artificial wetlands
riparian area management
buffer strips
runoff detention or retention
sedimentation ponds
mulching or vegetation to limit exposed soil
proper cleaning and disposal of pesticide containers
critical area planting
prevention of illegal dumping
automotive, agricultural, household waste collection
impervious cover limits
stormwater runoff requirements

*Nutrients, pesticides, and irrigation water should be applied when most effective and at the proper application rate to minimize loss in surface runoff.

[2]Bad actors are individuals who are aware of but fail to comply with the requirements of a program or permit. Such actors would include repeat offenders.

- **Pollutant trading:** an agreement that alters the allocation of pollutant reduction responsibilities between contributors of pollutant sources on the same water body may be an appropriate tool for implementing control actions and management measures. Trading, as well as other economic incentives, could speed progress toward and improve the cost-effectiveness of restoring water quality. In certain watersheds, opportunities for point source to point source trading, pretreatment, point source to nonpoint source trading, and nonpoint source to nonpoint source trading may exist (EPA 1996). Pollutant trading must follow EPA guidance, should result in net environmental benefit, must require partners to meet applicable technology-based requirements, be designed to ensure that pollutant reduction measures are implemented and effective, and must not lead to violations of water quality standards.

Pollutant trading: an agreement that alters the allocation of pollutant reduction responsibilities between contributors of pollutant sources on the same water body.

For a good example of a comprehensive implementation strategy, refer to Appendix C for a summary of the *Clark Fork-Pend Oreille Basin Water Quality Study: A Summary of Findings and a Management Plan* (EPA 1993). This document describes point and nonpoint source options to control excessive nutrient input and the resulting increased aquatic plant growth.

For pollution prevention assistance, contact the TNRCC's Pollution Prevention and Industry Assistance section at 512-239-3100.

Control Action Considerations

After potential control actions and management measures are identified, the lead organization and stakeholder group may need to develop criteria by which to choose a particular set of control measures. The lead organization and stakeholder group may decide to select from the criteria listed below or to develop additional criteria that reflect the particular conditions of the watershed and community.

The TNRCC has identified these criteria for choosing control measures:

- percentage reduction in pollutant loading
- associated environmental benefits (for example, enhanced water quality, fish and wildlife habitat, or air quality)
- associated environmental consequences (for example, loss of habitat or stream bank erosion)
- public support (ability to provide community benefits and to garner support from a high percentage of the community)
- political support
- current technology and technical feasibility
- past experience with similar approaches

- enforceability
- equity (environmental, economic, and other)
- feasibility of implementation and maintenance (considers capital and operating costs and difficulty in operating)

Selecting a Set of Control Measures

In contrast to the required factors listed for developing a loading allocation, the lead organization and stakeholder group have much greater latitude in selecting which criteria should be considered in choosing particular control measures. In some cases, these criteria may be useful at the earlier stage of evaluating and selecting among several different loading allocation scenarios.

The selection of pollutant control actions and management measures may be a point of contention among stakeholder groups. Methods to control and prevent water pollution benefit society and the environment but often do not provide economic benefit to the group that installs them. Some stakeholder groups may argue for the least costly methods, and others may argue for the most effective methods, regardless of cost. The most palatable actions may need to be selected first, with others used only if the water quality problem persists (Terrene 1993).

When financial resources are limited or mandatory pollution controls are resisted by stakeholder groups, the selection of pollutant reduction strategies may be restricted to those alternatives that are most environmentally productive, cost-effective, or locally acceptable. In this case, a limited number of alternatives and voluntary approaches can be implemented. If follow-up monitoring shows that the limited set of approaches is not successful, additional alternatives or mandatory controls may eventually be necessary (Ohio EPA 1997; EPA 1993).

The mix of criteria used to select the suite of control measures will vary from watershed to watershed and ideally will reflect local values and conditions. In most—if not all—cases, the costs of implementation will be a necessary criterion, but the lead organization and the stakeholder group should recognize that doing an economic analysis to assess these costs may require additional resources.

Performing an Economic Analysis

In most cases, the lead organization and stakeholder group will want to consider the costs of implementation. To do an economic analysis, you must have data similar to that used throughout the loading allocation process, including data on the environmental effectiveness of each control action or management measure for each pollutant of concern. Several types of economic analysis apply to TMDL projects, including:

- cost-effectiveness of individual control actions or management measures;
- cost-effectiveness of a combination of control actions or management measures;
- cost-effectiveness of loading allocation alternatives.

In most cases, the lead organization and stakeholder group will want to consider the costs of implementation.

Because a water quality target can be achieved through several loading allocation alternatives and resulting combinations of control actions or management measures, economic analysis could begin by estimating the least costly method of achieving the target. You should estimate the cost-effectiveness or cost-benefit ratio of these alternatives and compare this value to the least costly alternative or the alternative with the lowest cost-benefit ratio. Certain pollutant sources may be able to obtain equivalent pollutant reductions at lower costs; thus, each allocation alternative will yield unique implications for costs imposed on each sector and on the total cost for the watershed. With this information, stakeholder groups can make informed decisions on loading allocation alternatives and the resulting control actions and management measures.

Follow-up Monitoring Plan

As a component of the implementation plan, lead organizations must provide recommendations for follow-up monitoring, evaluation, and corrective mechanisms (feedback loops) after pollutant loads are allocated. These measures ensure that implementation strategies actually result in attainment of water quality standards (EPA 1998a). Although the lead organization may not be responsible for the actual monitoring, all TMDL implementation plans should contain explicit constituent-specific strategy provisions for follow-up monitoring.

Specifically, follow-up monitoring should:

- evaluate the effectiveness of point source controls and nonpoint source management measures;
- assist in reporting progress to the funding provider, stakeholders, regulatory agencies, and the legislature;
- evaluate the need for modification of the model or models;
- indicate whether water quality standards are attained;
- evaluate the need for adjustment of the loading allocation or implementation plan; and
- assist in verification of pollutant source allocations.

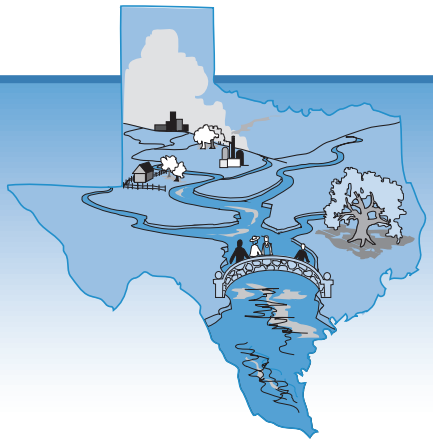
Refer to page R-3 for additional resources on “Tracking Effectiveness of BMPs.”

Some TMDL loading allocations can be developed with a high degree of confidence and scientific understanding. Still others may need to be developed when there is considerable uncertainty about pollutant sources, causes of impairments, or other relevant factors. Constituents of concern, pollutant source type, and other aspects of TMDL projects vary in the degree to which they can be rigorously quantified. Therefore, TMDL projects differ in the type and extent of follow-up monitoring and evaluation required.

The degree of quantitative rigor that is possible should not be viewed as an absolute (all-or-nothing) determination. If the highest level of quantitative rigor is not possible, an intermediate level of rigor should be considered (the “next-best” approach). At the same time, a logical relationship exists between the degree of confidence and specificity in the TMDL allocation components and the degree

of specificity required in the implementation and subsequent follow-up monitoring and revision phases. This relationship is described as a "hierarchy approach" for TMDL projects (EPA 1998a; EPA 1991).

When types of TMDL projects and TMDL allocation components are quantifiable with a high degree of certainty, the degree of specificity provided in the implementation plan is relatively low. By contrast, when types of TMDL projects and allocation components are not readily quantifiable, the degree of specificity and reasonable assurances associated with implementation measures should increase.



Chapter 5
Public Participation in TMDL Projects

Each watershed presents a unique and often complex set of problems. Consequently, solving these problems will require a different mix of regulatory and voluntary actions for each watershed. As a general rule, for this mix of actions to result in the restoration and maintenance of water quality standards, those individuals and organizations who actually use the water resource, or contribute or control pollution to the water body, should help to design and carry out a TMDL project. These individuals and organizations are the watershed stakeholders, and their participation constitutes the most important part of the public participation process for TMDLs. As the lead organization, you will be expected to encourage public participation in TMDL projects through close cooperation with a representative stakeholder group formed at the beginning of the project.

This chapter discusses the function of a watershed stakeholder group throughout a TMDL project and the recommended steps for establishing this group. Certain legal requirements for public hearings that are the TNRCC's responsibility are not discussed in this publication.

A successful public participation effort will:

- improve the quality and quantity of contributions to TMDL projects;
- promote government accountability;
- ensure that state government considers the local perspective in its decisions;
- lead to consensus-based solutions;
- help stakeholders gain insight into the nature of water quality problems and alternative solutions;
- educate stakeholders about pollution prevention techniques;
- encourage open dialogue on water quality issues;
- increase a stakeholder's understanding of the views of other interest groups;
- reduce the probability that a particular advocacy group will dominate the process;

- improve the probability of successful implementation of TMDL load allocations;
- lead to voluntary individual actions to curb pollution.

As mentioned in Chapter 2, "Guiding Principles," you should rely on existing public participation forums to initiate stakeholder participation. We encourage you to expand upon the ideas for involving the public presented in this chapter, to build on existing communication mechanisms and public participation forums whenever possible, and to cooperate with other water or natural resource planning groups in their basins. For example, the Texas Clean Rivers Program (CRP) basin steering committees are existing forums for public participation and should be involved in TMDL projects in their river basins. CRP planning agencies are likely candidates to lead a public participation process, and CRP priority watershed subcommittees may form the core of a stakeholder group for a TMDL project. Successful public participation requires both you and the stakeholders to commit significant amounts of resources and time. This commitment is as important to the success of your TMDL project as the technical aspects are.

Successful public participation requires both you and the stakeholders to commit significant amounts of resources and time.

Who Are Stakeholders?

Stakeholders include all individuals or organizations in the watershed who have one or more of these attributes:

- are significant contributors of pollutant loadings or other impacts to water quality;
- are significantly affected by water quality problems;
- may be required to undertake control measures because of statutory or regulatory requirements;
- have statutory or regulatory responsibilities closely linked to water quality—for example, flood control;
- can help develop or implement actions to fix water quality problems;
- are members of the general public who live in the watershed or use the water resource.

Although not an exhaustive list of possible stakeholders, these categories give some examples of who you should involve in your TMDL project:

- **Wastewater dischargers**–municipal and industrial.
- **Public**–individuals; civic groups such as those representing environmental, consumer, recreational, and community interests; schools, universities, and private landowners.
- **Agriculture and Aquaculture**–corporate and individual farmers and ranchers; subsistence and commercial harvesters of fish and shellfish; agricultural groups and organizations.

- **Business**–commercial, residential, and industrial firms; utilities, business groups, and trade associations.
- **Government**–city, county, regional, state, federal, and international government agencies, tribes, utility districts, and river authorities.

Refer to Appendix E for a list of agencies, governmental entities, businesses, and local organizations that stakeholders may need to communicate or coordinate with during the TMDL project.

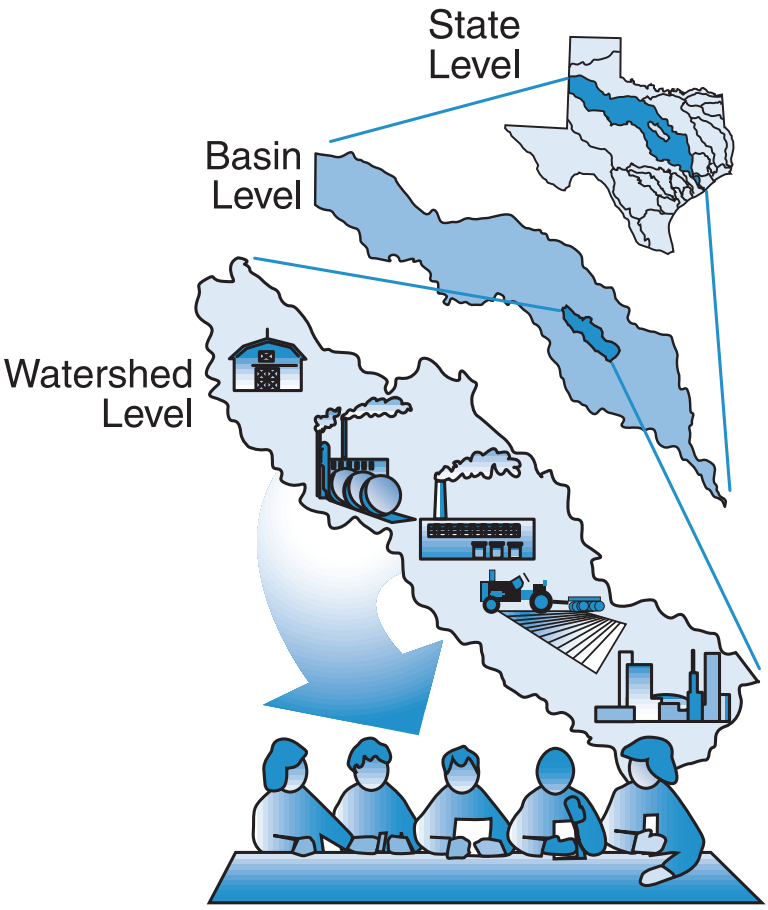


Figure 5-1. Watershed Stakeholder Group

Federal and State Public Participation Requirements

A federal regulation [40 CFR § 130.7 (a)] requires that the state's process for involving the public in identifying impaired segments, prioritizing load development, establishing the loading allocation, submitting lists and loading allocations to the EPA, and incorporating these loads into water quality management plans (WQMPs) and permits be described in a document called the state's continuing planning process. Also, TMDLs established must be included in the state WQMP, according to 40 CFR § 130.6(c)(1). In revising the WQMP, the TNRCC follows

the public participation requirements of 40 CFR Part 25 as well as applicable state law (Texas Water Code §§ 26.036 and 26.037). Moreover, it is a guiding principle of our agency to seek meaningful public participation in decision-making processes. Current EPA guidance states that a properly developed TMDL program will broaden the opportunities for public participation. This guidance requires states to provide for adequate public involvement throughout the program (EPA 1991). Since this guidance does not specify requirements for what constitutes "adequate participation," each state has the opportunity to develop one or more locally appropriate approaches.

Partnering for Success: Organizing and Operating a Watershed Stakeholder Group

Selecting Members

You should establish the watershed stakeholder group as early as possible in the project. When you select members of the stakeholder group, it is crucial to ensure that the group reflects the diversity of interests within the watershed and incorporates the viewpoints of those who will be affected by the TMDL. You should consider these steps when selecting stakeholder members:

Step 1: Using the categories from "Who Are Stakeholders?," systematically identify stakeholders in the watershed and develop a draft list.

Step 2: Revise this draft list to be watershed-specific by consulting with the CRP planning agencies and other organizers of existing public forums (for example, councils of government or estuary programs), other local and regional environmental efforts, local and regional governments, educational institutions, business and industry groups, legislators, state and federal agencies, and community and environmental groups.

Step 3: Refine the list to about 20 to 35 representatives. Maximize group effectiveness by selecting individuals who can represent several constituencies. Representatives should be empowered to speak and act for the groups they represent, and should be able to contribute a significant amount of time to the project.

Step 4: Identify and invite specific individuals. You can formalize the commitment of members of the stakeholder group by sending them letters of appointment, by getting signed letters of commitment from them, or both. Be sure the letters detail the time and resource requirements of membership in the group.

At one or more points in the process of developing the TMDL, you may need to add one or more members to represent a constituency that was originally overlooked or has requested the opportunity to participate in your TMDL project.

Addressing Specific Technical Issues

In some watersheds, you and members of the stakeholder group may recommend that a technical advisory group (TAG) be formed to address specific scientific and technical issues. The stakeholder group can rely on the TAG to develop the technical information needed for completing the TMDL project and to assist the stakeholder group with technical issues. The need for a TAG should be assessed at the beginning of the TMDL process. The TAG will assist in gathering the necessary information, developing a quality assurance project plan (QAPP) and monitoring or modeling plans, overseeing data collection, and evaluating loading allocation alternatives.

Many state and federal agencies may have regulatory responsibility, interests, expertise, and information that will be integral to the TMDL project. Representatives from these agencies may be members of the stakeholder group or, more likely, members of a TAG. The lead organization should identify and include these agencies when organizing the stakeholder group.

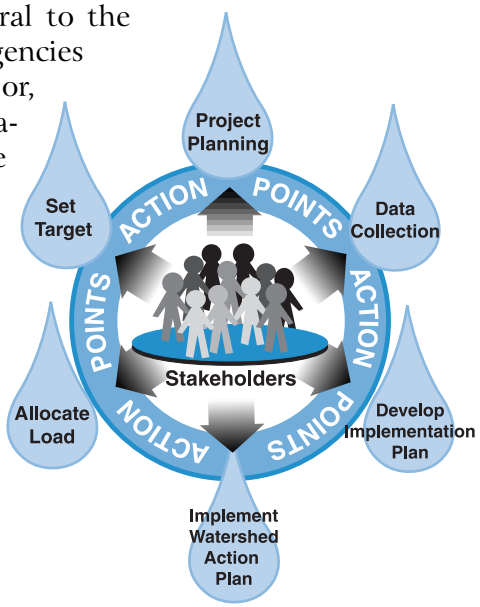


Figure 5-2. Stakeholder Roles and Responsibilities

Setting Roles and Responsibilities

You should expect stakeholder group members to work with you in these following areas:

- planning the project
- collecting data
- setting the water quality target
- allocating pollutant loads
- developing an implementation plan
- putting this plan into action

Project Planning

Although you will be primarily responsible for project planning, the stakeholder group should be involved early, both to influence and to understand the goals, schedules, work plan, responsibilities, and outcomes of the TMDL project.

Data Collection

Based on their knowledge of local water resource conditions and community activities, stakeholders can provide existing data or information on possible pollutant sources, land uses, water quality conditions, and local water quality protection efforts. Stakeholders may also suggest specific data collection or assessment activities to be conducted to ensure that all pollutant sources are identified. In some cases stakeholders may participate in new data collection efforts.

Setting the Water Quality Target

Selecting the water quality target may be relatively simple—you may rely on an existing water quality criterion set by the state for the specific constituent of concern. When there are no numeric water quality criteria set by the state or the project calls for the identification of an alternative target, the opportunity for stakeholder group involvement can increase significantly. The watershed stakeholder group may choose to be involved directly with you to make recommendations for a watershed-specific water quality target. The stakeholder group may instead delegate responsibility for specific tasks to a technical subcommittee or to a TAG to participate with you in determining a target.

Allocating Pollutant Loads

In collaboration with you and the TAG, the watershed stakeholder group will make recommendations for allocating loads among the identified pollutant sources. Work closely with the stakeholder group to develop criteria for the selection of the loading allocation, educate group members about the range of possible alternatives for loading allocation, and to reach a consensus on the chosen allocation. Fair decision making, reflecting the range of perspectives in the stakeholder group, should be a goal in all allocation decisions. By being involved throughout the entire TMDL project, the stakeholder group will have the knowledge necessary to review, comment, and support the TMDL report that summarizes the methods used to recommend the loading allocations.

Figure 5-3. TMDL Action Points

Developing the Implementation Plan

A TMDL project will require the preparation of a plan for implementing loading allocations. The stakeholder group will need to be extensively involved with you in developing this implementation plan. The stakeholder group can provide the information you need to customize implementation strategies, schedules, and local responsibilities most suitable to the water quality impairment and watershed of concern. While you will be required to prepare the watershed action plan, which combines the TMDL report with the implementation plan, the stakeholder group must work closely with you to finalize this plan.

Implementing the Plan

Depending on the components of the implementation plan, some or all members of the stakeholder group will lead the efforts to carry out the specific management strategies identified in the plan. For example, if the plan calls for implementation of agricultural best management practices, the members representing agricultural interests would be expected to promote and initiate their implementation.

Holding the Watershed Stakeholder Group Meeting

You should provide, or the stakeholder group should elect, a group leader who will set agendas, establish meeting dates, and take care of meeting logistics—that is, line up the place, set the time, and issue notice. Meetings of the watershed stakeholder group will, in most cases, benefit from having a facilitator present. A facilitator is a person who remains neutral on the issues and works with the group to focus its activities and discussions on achieving the tasks and goals it has identified.

Facilitators should:

- encourage team development
- help set and enforce ground rules
- ensure participation by all members
- allow the free flow of ideas
- coordinate with outside organizations as necessary
- keep meetings on track and focused
- coordinate outreach to help ensure all appropriate stakeholders are involved early in the process
- publicize meetings to help ensure consistent attendance
- facilitate distribution of meeting proceedings, group reports, and related materials

It is usually best to obtain the services of an independent, professional facilitator. You should determine, in consultation with the stakeholder group members and us, who will facilitate the stakeholder group early in your TMDL project. We also recommend that you explicitly define expectations for the facilitation of meetings as well as the responsibilities and costs of the facilitator.

Guidelines for Stakeholder Group Activities

There is no set of rules or guidelines for operating a watershed stakeholder group. However, we recommend that you develop draft guidelines and work closely with the stakeholder group to produce a final set of guidelines. Guidelines—or ground rules—provide a framework for structuring watershed stakeholder group activities, specifying goals, explaining member rights and responsibilities, and clarifying decision-making authority. Guidelines build structure and predictability into the participation process. To assure the effectiveness of stakeholder group activities, group members should participate in setting the guidelines and commit to following them, once agreed on. Depending on the group's needs, you may be well advised to request all members of the stakeholder group to sign a final written statement of the rules to reinforce their commitment. For an example of stakeholder group guidelines and key points to consider when developing them, see Appendix D.

Stakeholder groups play a vital role in communicating with the greater affected public.

Communicating and Tracking Results

In your TMDL project, you must have methods in place to ensure that you have ongoing communication with the watershed stakeholder group about the project status and deliverables. For example, you should consider using the Internet to disseminate project information not only to the stakeholder group, but to the general public throughout the watershed. You should also consider other methods to improve the stakeholder group's understanding of the project. For example, you could offer project notebooks for each member of the group, meeting minutes, progress reports, draft technical reports, and so forth.

You need effective communication because the members of the watershed stakeholder group will be called upon to represent their constituency and to bring the information they learn as the TMDL project develops back to the constituents they represent. In addition, stakeholder groups play a vital role in communicating with the greater affected public. Both you and the watershed stakeholder group should identify and pursue opportunities for promoting broad public involvement through community education and volunteer projects that support the restoration of water quality.

We expect you to be active in promoting public awareness throughout the watershed about programs related to TMDL development. Such activities may include volunteer water quality monitoring projects, environmental educational programs, pollution prevention strategies, and TMDL watershed meetings.

Documenting stakeholder group activities is another important part of your TMDL project. By maintaining a record of meetings, activities, and decisions made by the group, you can keep members on track regarding their progress, commitments, and accomplishments.

The products we describe in the remainder of this chapter are effective tools you can use to track the progress of your TMDL project and communicate with the

stakeholder group. Although the stakeholder group should play a strong role in developing these products, it is your responsibility to produce these products and distribute them as needed.

Project Notebook

You should develop a project notebook, such as a three-ring binder, and provide this notebook to stakeholder group members. This notebook should contain background materials (for example, water quality, regulatory information), meeting agendas, names and addresses of members, guidelines, budget, schedules, and other pertinent information.

Guidelines

You should develop draft guidelines, but the stakeholder group should agree to or amend these guidelines if necessary.

Meeting Summaries and Minutes

You and the stakeholders should determine whether you need summaries or minutes at the beginning of stakeholder group activities. These documents should be reviewed by all group members. When approved, they will become work products of the group.

TMDL Report

Stakeholder group members should participate in the preparation of the draft and final TMDL report. The draft report should be reviewed by the stakeholders, and the final report should be signed by all the group members.

Watershed Action Plan

Stakeholder groups will also help to develop a watershed action plan (WAP) through their activities in developing the TMDL report and writing a TMDL implementation plan. All stakeholders should sign the final WAP.

List or Database of Stakeholders

You should develop and maintain a list or database of the watershed stakeholder group members. You should also keep a much larger database of individuals and organizations in the watershed who are interested or involved in the project. You can use this database throughout the project as one tool to notify the public of activities either directly or indirectly related to the project or to mobilize participation in implementation.

A list of additional resources about organizing stakeholders and leading meetings is provided on page R-3.

Chapter 6
The Quality Assurance Project Plan

This chapter provides an overview of the quality assurance project plan (QAPP) that each lead organization must develop for its TMDL project. The development of a QAPP is a necessary step in producing a scientifically sound TMDL project.

TMDL projects require a very structured planning process that connects the development of the QAPP and the TMDL assessment with the implementation of the TMDL project.

TMDL projects require a very structured planning process that connects the development of the QAPP and the TMDL assessment with the implementation of the TMDL project. Even if you already have an approved QAPP in place with the TNRCC, a QAPP is still required for your TMDL project. Consult with your TNRCC project manager to determine whether an addendum to your existing QAPP is sufficient or if a separate QAPP is required.

This chapter does not tell you how to draft a QAPP. For that information, please see the current version of *Requirements for Quality Assurance Project Plans* (EPA Report No. QA/R-5; EPA 1998b). This publication is available from the EPA Quality System Documents Web page, **http://es.epa.gov/ncerqa/qa/qa_docs.html.** A list of selected resources for developing QAPPs can be found on page R-4.

This chapter will cover some aspects of QAPPs that are unique to TMDLs. Use this information with EPA QA/R-5 to tailor the QAPP to the needs of your watershed.

You can shorten the QAPP process by following these six steps:

1. Contact the TNRCC and the EPA about your TMDL project early in the planning stages.
2. Complete and sign a project contract if applicable.
3. Meet with one of our QA specialists about developing a QAPP.
4. Develop a QAPP and submit it to the TNRCC for review and comment.

5. Respond to comments from the TNRCC or the EPA and finalize the QAPP.
6. Begin collecting data when your QAPP is approved.

Quality Assurance specialists in the TNRCC's Data Management and Quality Assurance (DMQA) Team can advise you as you develop the QAPP. These specialists review the draft QAPP documents for completeness, consistency, and technical merit and track it through approval and sign-off.

What Benefits Does a QAPP Offer?

By developing an approved QAPP, you will:

- build stakeholder support for a scientifically sound process
- ensure that you collect data that are valid and necessary
- ensure that the TNRCC and the EPA can approve your TMDL project

Building Stakeholder Support

When properly carried out, the process of developing a QAPP allows everyone who has an interest in the watershed to have input into the planning process and produces a scientifically sound project plan. In developing the QAPP, you have the opportunity to build consensus that will benefit your project at every stage.

Use the QAPP as a communication tool to ensure that your approach is as open, inclusive, and objective as it can be. The benefits of this approach include:

- an accurate statement of the problems that exist in the watershed;
- an open discussion of the possible sources of those problems;
- modeling that is developed with a full awareness of the concerns that the stakeholders want to resolve;
- an understanding from all participants that limited resources, technical inabilities, and other practical limitations may prevent you from addressing all the questions you would like answered or from getting information that is accurate enough to give a definite answer;
- a dedication to collecting samples in a way that ensures the data derived from them will be valid and scientifically defensible;
- flexibility, as participants work throughout the project to respond to information gained during modeling, to changes in the availability of funding, or to other events that force changes to the original plan;
- pollutant loading limits that are established through the agreement of a broad community of stakeholders who, because they have participated in some way in the development of this project, will continue to support the project throughout its implementation.

Each of the stakeholders in the watershed should participate to some degree in the development of the QAPP—even if they do not choose an active role but merely remain informed about its progress.

Ensuring Valid Data

The process of developing QAPPs ensures that your project focuses on collecting data that are needed and valid. In completing the QAPP, you will also establish plans that will ensure that the data you collect are evaluated and stored in ways that ensure the integrity of the data, and that the data remain available to the public. The data quality objectives (DQOs), monitoring plan, and data management plan (DMP) each address separate aspects of this issue. For more information about these components of a QAPP, see "What Are the Essential Parts of a QAPP?" in this chapter.

Ensuring Approval of Your Project

Before field data can be collected for a TMDL project, the TNRCC must review and approve the QAPP, even if the project is privately funded. All projects funded by the EPA must be reviewed and approved by them. A properly completed QAPP tells the TNRCC and EPA that you have developed a sound, scientific approach for your TMDL project.

The TNRCC will work with the lead organization and the EPA to expedite the review and approval of your QAPP. The estimated total time frame for the review is 45 to 90 days for both TNRCC and EPA approval. This process may take longer if your QAPP is incomplete. The most common problems found with QAPPs are:

- The QAPP lacks appendices or organizational charts.
- The QAPP contains irrelevant language from an earlier QAPP.
- There is no documentation for references in the text.
- The signature page is incomplete.

The QA specialists on the TNRCC's DMQA Team can help you avoid these and other problems.

What Are the Essential Parts of a QAPP?

A QAPP includes these four essential components:

- a definition of organizational roles
- a statement of the data quality objectives
- a monitoring plan
- a data management plan

Work with a TMDL project manager as you follow EPA QA/R-5 to develop each of these components.

Defining Organizational Roles

Clearly define organizational roles and responsibilities for each aspect of your project. Be sure that it lets all participants know the expected lines of communi-

cation, the lines of authority, and the assessment and audit pathways that must be supported to ensure the success of the TMDL project. A QAPP must include an organizational chart and a statement that describes the roles and responsibilities of the personnel represented.

Stating Data Quality Objectives

An early stage of the QAPP process involves defining the project's data quality objectives (DQOs). In defining the DQOs, you and the stakeholders will answer these key questions:

- What data do you need to answer the questions involved in the TMDL project?
- For these answers to be meaningful, under what conditions must you collect the samples that produce the data?
- For these answers to be useful, what levels of precision and accuracy must your data have?
- Finally, to get from the collected data to the answers, how must you evaluate the data?

For a full explanation of how to define and apply DQOs, see *Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process* (EPA Report No. QA/G4 ; EPA 1994). This publication is also available from the EPA Quality System Documents Web page.

In the QAPP for a TMDL, consider your data quality objectives in the context of these and other factors:

- pollutants of concern
- multiple pollutants
- mathematical models

In the QAPP for a TMDL, consider your data quality objectives in the context of these and other factors:

- **Pollutant(s) of Concern.** The pollutant(s) of concern and the method used to characterize the nature of the impairment will affect data needs. The information needed to support analysis and characterization of individual pollutants may require different types of data. For example, the type of monitoring needed to assess an impairment due to dieldrin (an insecticide) will vary significantly from monitoring needed for characterizing impairments caused by nutrients or fecal coliform.
- **Multiple Pollutants.** Where multiple pollutants are involved with impairment of a water body, data needs will be affected. Impairment of a water body by multiple pollutants can produce synergistic or limiting effects. Monitoring goals and objectives should reflect the need to establish pollutant interaction.
- **Mathematical Models.** Mathematical models may be needed to support the technically complex aspects of TMDL projects. Models often require specific water quality and hydrologic data. These data must be identified prior to commencement of monitoring to ensure coordinated and efficient use of monitoring resources. For more information on the selection and potential usefulness of models and associated data needs in the TMDL process, see Chapter 7.

Drafting a Monitoring Plan

Your monitoring plan should outline the intended monitoring schedule, how you can draw on other organizations for assistance, and the field methods and procedures to be used in collecting samples.

Your Monitoring Schedule

Drawing from the information developed in your DQOs, you will determine where to sample, what to sample, and how often to sample to obtain the necessary information. State clearly how those gathering samples can recognize that conditions are right for the type of sampling you need.

Because the TMDL project may need to address one or more of a variety of situations—such as critical low-flow conditions, storm water flows, diurnal fluctuations, seasonal variability, point sources, nonpoint sources, natural background sources, tidal conditions—the TNRCC cannot give specific guidance here. Work with a TMDL project manager to make sure you draft a monitoring plan that addresses all the relevant temporal and geographic conditions in the watershed.

Drawing on Other Sources of Data

In part, the monitoring plan will depend on data that are already available. If available data meet the DQOs, you should include them in your monitoring plan. Consider sources of relevant historical water quality data as well as agencies and other organizations who support current water quality monitoring in the TMDL project watershed.

These sources may have relevant data on hydrology and water quality:

- Texas Parks and Wildlife Department
- Texas Water Development Board
- Railroad Commission of Texas
- Texas Department of Health
- river authorities (these data now available through the TNRCC)
- U.S. Geological Survey
- CWA § 305(b) water quality assessment reports for Texas
- EPA Region 6

In addition to businesses and other private organizations that may already monitor water quality, consider these potential collaborators as you develop your water quality monitoring plan:

- Texas Parks and Wildlife Department
- Texas Water Development Board
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- Natural Resource Conservation Service
- EPA Region 6
- river authorities
- Bureau of Reclamation
- state and private universities and colleges

When working with monitoring partners, be sure to clearly define the tasks and data quality you expect from each. Make sure each is aware of the standard monitoring procedures you have adopted to ensure that the data collected are valid.

Establishing Valid Data Collection Methods

A QAPP should address how water quality samples are collected in the field, how they are processed and analyzed, and how the data are recorded and stored. The TNRCC, in consultation with the EPA, has developed a set of standard sampling methods for assessing water quality. Use these methods unless you have specific reasons that justify an alternative. These methods are found in the *Surface Water Quality Monitoring Procedures Manual* (TNRCC 1997b).

It is possible that the TMDL project may require the use of other methods and techniques not contained in the Procedures Manual. To develop and support use of alternative sampling methods or constituents, you will have to further review the related literature and obtain appropriate technical expertise.

> In order to ensure efficient and reliable data storage and retrieval, you must establish a comprehensive data management plan (DMP).

As the lead organization, you will need to obtain the services of a laboratory that can conduct the required chemical analyses or toxicity tests on water and sediment samples. These analyses must follow TNRCC and EPA guidelines on collection, handling, and analytical procedures. The TNRCC can supply you with this information. Work conducted by an in-house laboratory must be defined in the QAPP and meet TNRCC requirements.

Developing a Data Management Plan

In order to ensure efficient and reliable data storage and retrieval, you must establish a comprehensive data management plan (DMP). If you currently have an approved QAPP and the data management plan applies to your project, you will simply need to reference that QAPP. A properly designed DMP calls for data to be reported in consistent units of measure, for data to be transmitted to the TNRCC, and for data management issues to be addressed in a manner that is consistent with the DQOs of your QAPP.

Your DMP must include:

- who handles the data, from generation in the field or laboratory to final use and storage;
- your data management system capabilities, including hardware and software;
- an explanation of how your system will operate, maintain security, and, in the event of system failure, ensure the recovery of the data;
- how public access to the data will be ensured.

Specific requirements for the contents of your DMP are explained in Appendix F, “Contents of Your Data Management Plan.”

Evaluating Project Performance

The TNRCC and the lead organization each have a role in evaluating and overseeing the completion of the TMDL project. In particular, the TNRCC will work with you to monitor whether the TMDL project follows the QAPP completely and correctly. This approach enables the TNRCC to identify any adjustments needed and see that the appropriate corrections are made. This process also serves to document that your completed project meets the quality standards needed for TMDL projects.

Lead Organization Responsibilities

As the lead organization, you must describe in detail the methods you will use to ensure that project activities consistently conform to project objectives. Through this commitment, you agree to provide the oversight necessary to remain informed of the project's progress and any failure to conform to the QAPP.

To enable the TNRCC to ensure that your project meets the requirements of the QAPP, you must also provide our staff with access to your project records. You must make available for review, inspection, or audit all books, records, documents, and other evidence that is reasonably pertinent to your performance on all work under the QAPP.

TNRCC Responsibilities

All TMDL projects will be included in the Water Quality Division's annual quality assurance risk analysis, which takes into account the level of funding and complexity of the project. Based on this analysis, the DMQA Team will schedule a quality assurance (QA) evaluation with a representative of the lead organization. This evaluation will focus on your project's conformance with the QAPP and provide a chance to discuss sampling methods and procedures and project progress.

In a typical QA assessment, a TNRCC QA specialist will contact you to arrange a date and time for the visit. Using the approved QAPP and a QAPP checklist, the specialist will review the program and discuss any changes, problems, or successes of the program. The QA specialist will report to TNRCC management and to you any items that do not conform to the QAPP. This report will identify corrective actions to be taken. You must respond to this report within 30 days.

Chapter 7
Mathematical Models

Completing a TMDL project may present several technically complex tasks, such as assessing current conditions, predicting future changes, and evaluating alternatives. Mathematical models can be valuable tools for addressing these complex aspects of TMDL projects. Specifically, you can use models to accomplish these tasks:

- assess present water body and watershed conditions;
- determine the water body's loading capacity;
- estimate current pollutant loads;
- evaluate loading allocation alternatives;
- estimate the water quality impacts of changes in pollutant loads;
- estimate the water quality impacts of changing conditions in the water body and watershed.

Various modeling issues are discussed in this chapter. Our mention of a particular model in this publication does not constitute an endorsement by the TNRCC. We will evaluate models to be used in TMDL projects on a case-by-case basis.

What are Models?

Mathematical models are analytical abstractions of the real world. In the context of TMDL projects, mathematical models are computer-based, simplified representations of water quality processes that govern the instream fate of one or more pollutants. In these models, "pollutant fate" considers the physical, chemical, and biological processes that affect pollutants in the environment—for example, transport, dilution, settling, biological transformations, sorption, and reduction/oxidation. Models attempt to mimic the movement and changes that pollutants undergo after they enter water bodies. In areas where nonpoint source pollution is a concern, models simulate the movement of pollutants *from* the landscape (for example, from urban areas or row-crop lands) *to* receiving waters as a result of rainfall runoff.

> Mathematical models are analytical abstractions of the real world.

Types of Models

Water quality models can typically be categorized as mechanistic or empirical. A mechanistic model or "process" model is based on theoretical principles and represents a simplified approximation of the actual system that is being modeled. Because current scientific understanding is inadequate to capture the complexity of natural terrestrial and aquatic systems, a mechanistic model is intended to provide a simplified, though appropriate, description of the system of interest (Reckow 1994). An example of a mechanistic model is QUAL-TX, which was developed by the state of Texas for use in waste load evaluations (WLEs) involving steady-state streamflow and dissolved oxygen issues. QUAL-TX contains numerous mathematical equations that collectively represent a variety of relevant processes within water systems, including advection, dispersion, nutrient cycles, oxygen demand, and reaeration.

A mechanistic model or "process" model is based on theoretical principles and represents a simplified approximation of the actual system that is being modeled.

Empirical or statistical models are based on a statistical summary of observational water quality data (Reckow 1994). Observational water quality data range from qualitative observations made in the field to highly specialized quantitative data that are collected from the environment under prescribed protocols and are analyzed in a laboratory. Empirical models often use observational data from similar water systems within a region or country, or from across the world, to develop descriptive statistical relationships between a desired output parameter and one or more input parameters.

Limits of Models

Models can only approximate the complexity of the water bodies, watersheds, pollutants, and pollutant sources under study. Complex conditions place greater challenges on model users and increase the uncertainty or potential error inherent in model results. For example, models that address TMDL issues associated with the fate of conservative pollutants (such as chlorides) under steady-flow conditions in a river are well understood and typically provide reliable results. However, models that address, for example, nonconservative pollutants (such as nutrients) generated from nonpoint source runoff into a highly dynamic, tidally-driven estuarine system are less understood and, in comparison, produce less reliable results.

Models can only approximate the complexity of the water bodies, watersheds, pollutants, and pollutant sources under study.

For certain TMDL projects, the pollutants of concern may be poorly understood or not readily amenable to model simulation due to the limited understanding of the pollutant behavior. For example, sedimentation, pH, and the presence of toxic substances in the sediment of receiving waters are receiving-water issues that a model may not be able to simulate well; however, models may still be important tools in these situations. In your TMDL project, you should communicate to the stakeholders the limitations and uncertainties inherent in models. You

should ensure that the necessary steps are taken to determine the predictive capabilities, limitations, and uncertainties associated with models.

What Level of Modeling is Needed in Your TMDL Project?

Since TMDL projects involve quantitative assessments and setting numeric water quality targets, many of the tools used for TMDL projects need to be quantitative. Mathematical models in combination with observational data from historical and current monitoring programs can provide the basis for TMDL loading allocations and implementation strategies. We expect you to evaluate what level of modeling—from simple calculations to dynamic, technically complex simulation—is necessary, and to communicate this to the stakeholder group and to us.

For TMDL projects presenting minimal technical complexity, simple computations will suffice for the necessary assessment and analytical steps. For example, a simple model would be appropriate for a TMDL project where the water body is impaired primarily by point source discharges and that involves low and steady streamflow conditions and a conservative pollutant. However, TMDL projects that involve highly dynamic environments and pollutants that undergo complex interactions may present technical challenges to model simulation and will require complex models. In these extreme cases, you will need to allocate significant financial and staff resources for additional model simulations, intensified model testing, and increased data requirements so you can get results that have an acceptable level of certainty.

You and the stakeholder group should recognize that there may be a situation where completing a complex analysis for a TMDL may be both prohibitively expensive and provide outcomes which offer no greater degree of certainty.

When complex constituents are the focus of a TMDL project, you may find that the available funding, data, and modeling tools may not provide the level of certainty desired by some stakeholders. In such cases, complex TMDL projects may require increased reliance on alternatives to the quantification provided by mathematical models. Because of limitations in the current technical tools available for modeling complex pollutants, such as contaminated sediments, it may be necessary to rely on other methods for making decisions even if those methods result in a higher level of uncertainty. For example, best professional judgement, statistical probabilities, or consensus approaches involving public participants, affected parties, and responsible agencies could be used to make decisions and move the project forward. You and the stakeholder group should recognize that there may be a situation where completing a complex analysis for a TMDL may be both prohibitively expensive and provide outcomes which offer no greater degree of certainty. In such cases, lead organizations, stakeholders, the TNRCC, and the TSSWCB will need to pursue other more cost-effective options for making decisions on establishing the loading allocation. When conditions are amenable to model quantification with a high degree of certainty, the degree of specificity required in the implementation plan to provide reasonable assurance of success is relatively low. By contrast, when conditions in TMDL projects are not amenable to model representation or

when model results are subject to considerable uncertainty, the degree of specificity and reasonable assurances associated with implementation measures and follow-up monitoring should increase. This method might ultimately result in a phased approach to implementing control actions. However, it will allow TMDL projects to move forward toward their goal to restore and maintain the beneficial uses of 303(d) listed water bodies in the absence of rigorously quantified analyses or models.

Quality Controls for TMDL Modeling

Mechanistic and empirical models require testing prior to application. To enhance model reliability, water quality and hydrological data are typically compared to model outputs. The model testing process consists of these three steps:

- calibration
- verification
- quantifying adequacy

The lead organization must document the methodologies used in testing and present the methods and results to the TNRCC and stakeholder group for review and approval.

Model Calibration

Models contain many input parameters which describe physical, biological, and chemical processes. Because the exact value of inputs is often unknown, input values are typically estimated during the calibration step and are bounded by numerical ranges of acceptability determined from previous research studies. During calibration, the model is run and the results are compared to a portion of the observational data. The value of each input parameter is refined within its range of acceptability until the model adequately reproduces the observational data.

Model Verification

In the verification process, the model is operated with input parameters held constant at the values determined during calibration, and the results are compared to the remaining observational data. The degree to which the model results replicate the observational data is a measure of the degree of robustness and reliability of the model for that system. To support the validity of model results, verification should involve data that are collected under varying conditions of rainfall, season, and flow and are different from the data used in the calibration process. Data that are gathered at a different time but represent conditions essentially identical to those used for calibration are less desirable.

Quantifying Model Adequacy

The lead organization should rely on statistical procedures such as comparison of means and medians, regression analysis, and relative error to quantify the adequacy of a model. These procedures involve comparing model output to the observational data used in the calibration and verification steps. Specifically, they are used to quantify the difference between the model's predictions and the data

actually observed and to quantify the uncertainty associated with modeling. Selected citations for statistical procedures are listed on page R-4 in the "References and Other Resources."

Uncertainty in TMDL Projects and the Margin of Safety

Uncertainty enters TMDL projects in many forms. These are three of the major sources of uncertainty:

- **Observational data.** Your data contain an uncertainty that is inherent to the measurement process used. They may not accurately or completely represent the project water body and watershed.
- **Mathematical models.** Because these models are simplified approximations of complex interactions, the model's output usually will not exactly predict actual conditions.
- **Pollutant load reduction.** The effectiveness and feasibility of efforts to reduce point and especially nonpoint source pollutant loads are often unknown.

Take these and other sources of uncertainty into account and communicate the implications of uncertainty to stakeholders. In addition, when high levels of uncertainty are present, provide reasonable assurance that the water body will reach the desired water quality target through the TMDL project.

Uncertainty Analysis with Models

While many sources of uncertainty may be difficult to quantify, procedures do exist to statistically quantify the uncertainty of mathematical models. When model uncertainty results from unknown input parameter values, you can address this uncertainty through sensitivity analysis, uncertainty propagation, or both (Morgan and Henrion 1990).

Quantifying uncertainty for some complex models may prove to be a formidable task, forcing you to rely on less rigorous, qualitative measures of uncertainty. Expert opinion and experience may be applied to reach a decision that less uncertainty is associated with one modeling approach compared to another.

Sensitivity Analysis

Sensitivity analysis provides a meaningful measure of the response induced in model output by changes in model input. Through calibration and verification, the model user will have determined input parameters that yield reasonable simulations of hydrology and water quality. While some of these parameters are directly measured and have reasonably high accuracy (for example, the surface area of a lake at its conservation pool elevation), other parameters may be determined from literature searches and iterative model simulations during model calibration.

Sensitivity is a measure of the magnitude of change in the output with respect to variation in an input. Commonly, sensitivity analysis involves changing one input parameter while others are held at a reference level. You then analyze the relative magnitude of changes in model output that result from changes to input factors. If the model you have chosen is highly sensitive to a particular input parameter, redirect monitoring efforts to produce more accurate, site-specific parameter determinations. Relevant references on sensitivity analysis are provided in the "References and Other Resources" on page R-5 at the end of this publication.

Sensitivity is a measure of the magnitude of change in the output with respect to variation in an input.

Uncertainty Propagation

You must quantify the uncertainty associated with applying the model's output and use this quantification in assessing the margin of safety. This procedure requires an understanding of statistics, the model application, and the degree of uncertainty associated with each input parameter. A few models, such as EUTROMOD and QUAL2E-UNCAS, are designed to allow uncertainty analysis, or have been applied in a mode to allow uncertainty analysis. For a limited reference list on uncertainty associated with mathematical models, see "Uncertainty of Mathematical Models" on page R-8.

Margin of Safety

The margin of safety (MOS) is the prescribed mechanism to account for the uncertainty associated with TMDL projects. The MOS can be included in more than one of the TMDL analytical steps. The rationale of the MOS should be clear, understood by all participants, agreed to by the stakeholder group, and be well-documented by the lead organization.

You may include the MOS implicitly or explicitly. To include the MOS *implicitly*, use conservative assumptions to complete one or more of these steps:

- derive numeric water quality targets
- determine pollutant sources
- represent pollutant fate and transport relationships
- determine the degree of pollutant reduction achievable through management measures and control actions

To include the MOS *explicitly*, you could, for example, set numeric water quality targets at more conservative levels than analytical results indicate.

Points to Consider in Selecting a Model

While many other factors could also enter into your selection of a model, be sure to consider the following factors:

- compatibility with TNRCC platforms
- receiving water type

- constituent type
- level of complexity
- level of concern
- funding resource availability

These factors are not independent. Collectively, they define the required modeling framework. Successful selection of a model results from matching these factors as closely as possible with model capabilities and financial and staff resource requirements. The lead organization must make a recommendation to stakeholders and to the TNRCC on which model or models are appropriate for each TMDL project.

Model Ownership and Compatibility

You must ensure that any model you use for TMDL analysis is provided to us for subsequent inspection, operation, and the potential modification or update of model input data files. Each model may continue to be used for subsequent analyses—for example, wastewater permit assessment—in the TMDL watershed and may be distributed, upon request, to watershed stakeholder groups. This effectively requires that any model selected for TMDL analysis be in the public domain.

Any proposed model must be compatible with existing TNRCC UNIX- or personal computer-based hardware platforms. When you deliver the model to us, we will verify its compatibility through installation and use. Installation of the model should require no modification of TNRCC system architecture and result in no system degradation. Model input data files should all be in a format that is compatible with existing TNRCC software. Verification of model compatibility must be achieved prior to TNRCC approval of the TMDL report.

Characterization of Receiving Water Body

Characterization of the receiving water body is an important step, since many mathematical models were developed to simulate a specific type of receiving water. These are the general types of receiving water in Texas:

- streams and rivers
- reservoirs and lakes
- tidal streams
- bays and estuaries
- the Gulf of Mexico

For situations involving nonpoint source loadings, the ability to model watershed loading processes is a highly pertinent consideration in selecting a model. Some models contain internally linked components that allow the user to simulate watershed loading and the receiving water body response. In other circumstances, separate models may be necessary for each of these components. Stipulation of watershed loading sources by land uses (for example: urban, grazing, intensive crop production, concentrated animal feeding operations, and forests) may be an important refinement for model selection.

Constituent Type

Because various models were developed to simulate specific pollutants, the constituent of concern is a second determining factor in model selection. While various groupings of constituents are possible, this is one convenient list:

- dissolved oxygen (DO) and organic loading
- nutrients (nitrogen, phosphorus) and aquatic plants (phytoplankton, periphyton, and macrophytes—often measured as biomass or chlorophyll *a*)
- dissolved solids (total dissolved solids, chlorides, and sulfates)
- suspended solids (total suspended solids, turbidity)
- temperature
- pH
- bacterial or microbial organisms
- toxic substances in water (metals, organic substances)
- toxic substances in sediments of receiving waters
- toxic substances in fish or shellfish tissue

The constituents listed are not necessarily mutually exclusive. For example, dissolved oxygen interacts with and responds to nutrients and temperature. As a result, model simulations will often include dissolved oxygen, oxygen-demanding organic matter, temperature, nutrients, and aquatic plants.

Level of Complexity

The level of complexity reflects the intricacy or sophistication required in the model to represent the water body and watershed with a degree of certainty that is acceptable to the stakeholder group. You should use the simplest modeling approach that produces a level of certainty that is acceptable to you and the stakeholder group. When selecting an appropriate model, you should consider the complexity involved in modeling pollutant source types, physical conditions, and chemical and biological interactions with the constituents of concern.

Pollutant Source Types

- Point source dominated. These sources may require optimization processes or stochastic approaches to establish loading allocations.
- Nonpoint source dominated. These sources may require quantification from watershed-scale pollutant loading models, in addition to the receiving-water model requirements.
- A combination of point and nonpoint sources.

Physical Conditions in Water Body and Watershed

- steady state (invariant with time)
- dynamic (variable with time)
- low, constant streamflow
- dynamic, tidally-driven flow in coastal areas
- storm-event streamflow
- variable streamflow due to varying discharge

- variation of salinity within a tidal cycle
- daily or seasonal fluctuations in temperature
- one-dimensional, with longitudinal (along the stream path) variation and little vertical or lateral (across the stream) variation (includes streams)
- two-dimensional, with vertical and longitudinal variations (includes reservoirs and tidal streams) or horizontal variations (includes most estuaries)
- three-dimensional, for some systems such as estuaries with deep ship channels

Chemical and Biological Interactions

- conservative substances such as certain dissolved solids, including chlorides
- conservative substances that bioaccumulate, such as mercury, dioxin, and some pesticides
- contaminants that interact mostly with the water column and sediments, such as many metals
- conconservative substances with limited interaction in the water column, such as bacteria and temperature
- conconservative substances that interact with other pollutants or substances in the water column or sediments—for example, dissolved oxygen, nutrients, and toxic organic substances

Level of Concern

While all TMDL projects are important to obtaining the desired objective of restoring and maintaining the beneficial uses of water bodies on the 303(d) list, not all TMDL projects are of equal environmental and socioeconomic importance. TMDL projects for water bodies with water quality that directly endangers human health or for water bodies with sensitive ecosystems may require special attention. Likewise, TMDL projects in which the implementation plan indicates high economic impact may have greater relative importance to the community. Under these circumstances, model selection and application have enhanced significance, the implications of uncertainty are more pronounced, and efforts to reduce uncertainty through directed monitoring programs require closer examination.

Resource Availability

The availability of resources is another factor to consider in selecting a model. Typically, the availability of data and funding resources will constrain the model selection process. You will need to adopt a simple modeling approach if the available data are inadequate for properly testing a sophisticated model or if there is inadequate funding to both gather the additional data and allow you to apply the model. At the same time, you should not select a model that is more complex than necessary merely because you have access to abundant data and funding.

Other Sources of Information on Model Selection

A list of relevant publications providing information on models and specific model applications is provided in the "References and Other Resources" at the end of this publication. *Compendium of Tools for Watershed Assessment and TMDL Development* (EPA 1997a) also provides information on a number of models.

Chapter 8
Finalizing a TMDL Project

The purpose of this chapter is to summarize the final steps associated with completing and adopting a TMDL project. It is important to note that the TNRCC will take the lead on most review steps after a lead organization has submitted a TMDL report. The TNRCC has the primary responsibility for tasks related to the review and approval of the TMDL report, the implementation plan, and the watershed action plan. However, while we conduct these activities, we will expect you to complete various tasks that are critical to finalizing your TMDL project. Figure 8-1 on the next page provides an overview of the steps and decision points of the approval process for a TMDL project.

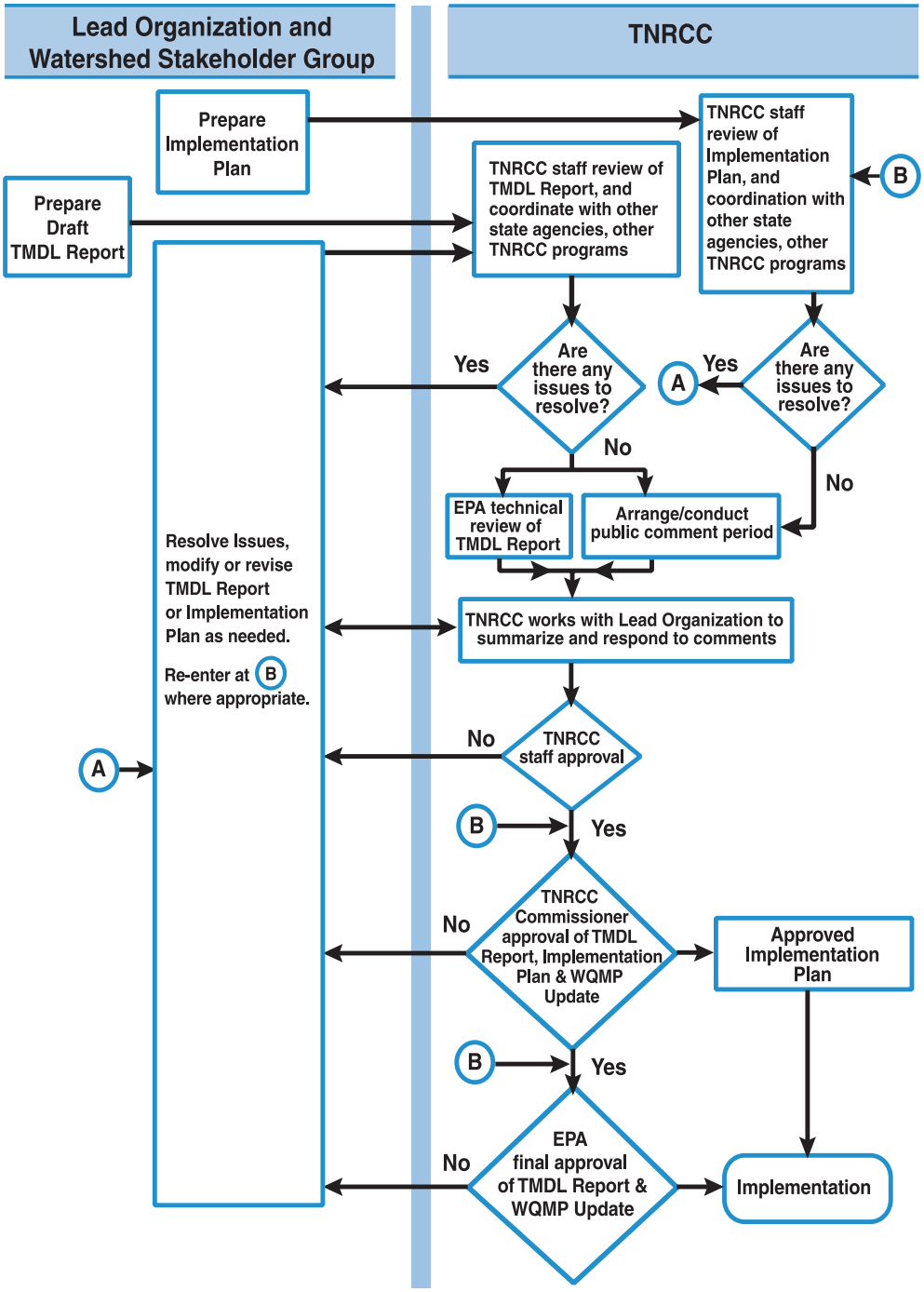
Ideally, you will complete a TMDL report and implementation plan simultaneously, submitting them together for our approval. However, you may complete the TMDL report before the implementation plan is done and it may then make sense for us to review the report standing alone. If we do separate the approval process for the TMDL report from the approval process for the implementation plan, then you will need to offer at least two opportunities for public comment and appear before at least two meetings of the Commission.

Receiving Public Comment

After you submit your draft TMDL report and draft implementation plan to us, we will arrange a hearing to gather public comment. This hearing is not a substitute for you involving the stakeholder group in your project. The public participation element of your project is designed to provide early and continual stakeholder group involvement throughout the TMDL project. In contrast, the hearing provides an opportunity for concerned citizens and organizations who are not part of the stakeholder group to have input into your TMDL project. Where appropriate, we will collaborate with the TSSWCB and you in conducting this hearing. The hearing will be at a time and location generally convenient to the residents within the watershed of the TMDL project. At a minimum, notice will be published in a newspaper of general circulation in the watershed. We may also

use additional press releases or public service announcements in order to provide ample opportunity for the public to receive notice of the hearing. For very large populations or wide-ranging watersheds, more than one hearing may be needed. We will record all hearings held to gather public comments.

Figure 8-1. Review and Approval Process of TMDLS



Public hearings will be conducted consistent with applicable federal and state requirements. Also, under federal regulations [40 CFR § 130.6(c)(1)], TMDL reports must be included in the state's water quality management plan (WQMP). Consequently, TNRCC intends that each hearing on a TMDL report will be announced and conducted in a way that satisfies federal and state requirements for revising the WQMP—particularly 40 CFR Part 25 and Texas Water Code § 26.037. We will also ensure that continuing planning process (CPP) requirements and other procedural requirements for adopting TMDLs and changing the WQMP are followed throughout our review of your TMDL report. By taking this approach, we make it possible for the EPA to concurrently review our updated WQMP and your TMDL report.

Responding to Public Comment

As appropriate, we will either respond, or direct you to respond, to all public comments received. The extent of revisions needed to your draft TMDL report and implementation plan based on public comment will depend on the nature of the comments received. One appropriate response to public comment may be to prepare an appendix to the TMDL report, implementation plan, or both to summarize the comments and concerns. We will expect you to assist as necessary in responding to comments and making necessary changes to your report and implementation plan.

Review and Approval of Your TMDL Report

Once the public comments have been received and addressed, TNRCC staff will review your TMDL report and implementation plan. The TNRCC will also coordinate its review of the TMDL report and implementation plan with the TSSWCB for TMDL projects where agricultural and silvicultural nonpoint source pollutants are addressed. If they are acceptable, TNRCC staff will put the matter before the Commissioners for their consideration and action in an open meeting.

If we believe that there are deficiencies in your report, your implementation plan, or both, we will return the document or documents to you with suggested modifications. After you rectify these deficiencies, you may again submit one or both of the documents to us. Another public hearing will be held if necessary. When we are satisfied that your report and implementation plan are satisfactory, we will recommend that our Commissioners approve the TMDL report and implementation plan. We will then forward your TMDL report to the EPA for their review and for inclusion in the Texas WQMP.

Review by the EPA may result in a need to do additional work or to make revisions to your TMDL report. If the EPA rejects your TMDL report, we may return it to you for revisions. The revisions you make may need to go through the public participation and TNRCC review process again. For example, if the analysis or load allocations change significantly because of EPA comments, you may need to gather additional stakeholder group input or hold more public hearings. Once the EPA has approved your report, you may begin to put your implementation plan into action—assuming that our Commissioners have given it their approval. Ac-

tually, it is likely that stakeholder groups in the watershed will begin taking voluntary steps based on the implementation plan to address water quality problems before formal regulatory approval occurs.

Upon our adoption of the TMDL report and implementation plan, a watershed action plan will be in place. The watershed action plan will provide the direction necessary for stakeholders and water resource managers at the local, regional, state, and federal levels to restore and maintain the beneficial uses in the body of water targeted by your TMDL project.

Appendix A
Example TMDL Work Plan

This example work plan includes the necessary elements of a TMDL project work plan submitted by a lead organization under contract with us through state or federal funds. It is not meant to be a "fill-in-the-blank" form. We give you discretion with respect to style or wording, as long as your work plan includes the essential elements shown here. In carrying out your TMDL projects, you may use this example as a resource but must adapt your work plan to the specific requirements of your project. Portions of this example work plan may not pertain to organizations that develop TMDLs without using state or federal funds. Still, these organizations must work closely with us to ensure that all requirements are met to allow for approval by us and the EPA.

Dry Creek TMDL Work Plan

Introduction

Dry Creek is located in the upper portion of the Little River Basin and runs north to south along the eastern portion of Montrose County, Texas. The upper half of Dry Creek is normally dry except during rainfall runoff events. The lower half of Dry Creek flows except during extended droughts. Dry Creek is a major tributary to the Little River and is the most natural watercourse flowing through the city of Montrose. The primary uses of the lower portion of Dry Creek are recreation and irrigation. Because parks along Dry Creek are well maintained and close to residential areas, large numbers of people use the parks and creek for recreation and fishing at all times of the year. Local interests have proposed to maintain the Dry Creek area as a greenbelt, which would probably increase its recreational usage.

Dry Creek (Segment 3113) appears on the state's 1998 Clean Water Act Section 303(d) list because it does not support its designated uses due to high levels of fecal coliform bacteria and depressed levels of dissolved oxygen. In response to the 303(d) listing and concerns with water quality, Dry Creek has been selected for a total maximum daily load (TMDL) project to restore water quality to sup-

port its designated uses. The Dry Creek TMDL project will involve a characterization of point, nonpoint, and background loads; analysis and projections within the framework of water quality monitoring and modeling; a determination of loading allocations for various sources; and the development of an implementation plan.

The causes and sources of pollutants that affect Dry Creek are not thoroughly identified. Because of the large number of potential sources, it will be necessary to implement a water quality monitoring network to determine where pollutants are entering Dry Creek. In addition, because impacts may be seasonal, monitoring will be necessary for a number of months. As the city of Montrose continues to develop, it will become increasingly important to restore and maintain the water quality of Dry Creek and protect it from both point and nonpoint source pollution. Analysis of these sources will allow development and implementation of management practices to enhance water quality and protect an important water resource.

Task 1: Project Administration

Objective: To manage administrative functions to support the Dry Creek TMDL project, including:

- informative and timely progress reports
- timely and accurate reimbursement forms with submission of only allowable costs
- proper documentation to support allowable costs
- oversight and monitoring of subcontractors
- demonstration and documentation of "good-faith efforts" in procurement processes
- timely, accurate, and high-quality deliverables
- operation under a provisional or approved indirect rate
- participation in annual audits where federal grants and contracts exceed $300,000
- adherence to TNRCC contract provisions
- budget monitoring and cost accountability

Task Description: The lead organization, MSV Consultants, will develop a project plan and budget. MSV Consultants will keep accurate and complete records of all costs incurred during each reporting period and submit reimbursement forms with supporting documentation on a quarterly basis in accordance with the TNRCC fiscal year (September 1 through August 31). The supporting documentation will follow generally accepted accounting practices. MSV consultants will also submit quarterly progress reports and will include in these reports the status of deliverables for each task as well as narrative descriptions of the progress and findings of each task. MSV Consultants will provide updates of any changes relating to personnel, subcontractors, and equipment purchases to the TNRCC.

Resources: [*List here the equipment, supplies, computer software, subcontractors, data from external sources, and other resources you need to accomplish the work in each task.*]

Deliverables and Due Dates (September [*year*] through August [*year*]):

A. **Progress Report** (2 copies on computer diskette in ASCII digital format), to include: status of deliverables for each task and a narrative description in Progress Report format (Exhibit ___ to the TMDL project contract)—Quarterly
B. **Reimbursement Forms** (2 copies) (purchase voucher, 269a, and 269a1-4) with documentation as listed in contract Exhibit ____ for each budget category—Quarterly
C. **Historically Underutilized Business Progress Assessment Report (HUB PAR) forms**—Where applicable, document why good faith effort did not result in the utilization of a HUB vendor
D. **Participation in Lead Organization Evaluation**—To be determined
E. **Copies of Any Subcontracts with TNRCC Acceptance**—Prior to execution

F. **Copies of Executed Subcontracts**—As completed
G. **Complete Required Clause Checklist(s)** for subcontracts with copy of proposed subcontracts prior to execution (Exhibit ___ to the TMDL project contract)—To be determined
H. **Annual Submission Documentation for Reimbursement**—Upon request
I. **Updates to Equipment Inventory List** containing equipment description (name of item and manufacturer), serial and/or inventory number, purchase amount, date purchased, and working condition—With progress report as purchased

Task Budget: [*Outline your anticipated budget here.*]

Task 2: Promote Public Outreach and Involvement[1]

Objective: To enhance public participation in the Dry Creek TMDL project by developing and implementing these outreach strategies:

1) establishing a TMDL stakeholder group;
2) promoting public involvement through other public forums;
3) providing information to the public through appropriate media;
4) preparing status reports and presentations about the project for meetings of the TMDL stakeholder group and Clean Rivers Program (CRP) Little River Basin steering committee.

Task Description: MSV Consultants will establish a TMDL stakeholder group, comprised of appropriate stakeholders within the Dry Creek watershed, to meet as needed during the project to:

- assist in identification of appropriate stakeholders
- identify desired water quality conditions and measurable goals (*target identification*)
- make decisions regarding water quality monitoring and modeling needed to identify the pollutant sources and to estimate pollutant loadings
- review and make decisions on pollutant loading allocation alternatives
- review and identify possible pollution prevention options
- review and make decisions on public education strategies for nonpoint source issues
- identify funding sources to support control action and management measure implementation
- develop achievable strategies for TMDL implementation
- communicate implications of the project to appropriate parties within the Dry Creek watershed
- contribute to the development of the TMDL implementation plan

MSV Consultants will also inform the public through appropriate media and by conducting and attending meetings to review the activities of the TMDL project. This will be accomplished through:

- providing information to the public on a Web page, through local newspapers, and in other appropriate media (written materials should be approved by the TNRCC before distribution)
- conducting TMDL stakeholder group meetings on a regular basis
- participating in and presenting status reports at TMDL meetings and basin Clean Rivers Program meetings

Resources: [*List here the equipment, supplies, computer software, subcontractors, data from external sources, and other resources you need to accomplish the work in each task.*]

[1]See Chapter 5, "Public Participation in TMDL Projects."

Deliverables and Due Dates (September [*year*] through August [*year*]):

A. Copies of public outreach materials, newsletters and other written products, or narrative description of other public outreach efforts (with progress reports)—Obtain TNRCC approval before distribution—Quarterly
B. Summaries of TMDL stakeholder group and public meetings, with lists of attendees (with progress reports)—Quarterly
C. List of TMDL stakeholder group members—To be determined
D. Conduct TMDL stakeholder group meetings on a regular basis—To be determined

Task Budget: [*Outline your anticipated budget here.*]

Task 3: Develop Detailed Project Work Plan

Objective: To develop a detailed project work plan that will identify and describe the project objectives, tasks, deliverables, and costs of project tasks.

Task Description: The detailed work plan will be developed by MSV Consultants according to TNRCC guidance, review, and input. This work plan will include:

- TMDL work plan summary (project introduction, purpose, and schedule)
- project administration task
- public outreach and involvement task
- reporting task
- monitoring and quality assurance task
- TMDL loading allocation task
- TMDL implementation plan task
- other appropriate tasks as determined by the TMDL stakeholder group

Resources: [*List here the equipment, supplies, computer software, subcontractors, data from external sources, and other resources you need to accomplish the work in each task.*]

Deliverables and Due Dates (September [*year*] through August [*year*]):

A. Draft detailed project work plan—To be determined
B. Revised detailed project work plan—To be determined

Task Budget: [*Outline your anticipated budget here.*]

Task 4: Reporting on TMDL Activities

Objective: To develop an interim status report on the Dry Creek TMDL Project to summarize key activities for the TNRCC, TMDL stakeholder group members, and the Clean Rivers Program basin steering committee.

Task Description: MSV Consultants will prepare an interim status report to include discussion of project activities conducted to date. This report will summarize major stages of the project, including stakeholder group activities, a watershed monitoring and quality assurance project plan (QAPP), geographic scope of the project (definition of the watershed or project area), pollutant sources (point, nonpoint, and background), modeling scenarios, loading allocation scenarios, and implementation strategies.

This interim status report will include an inventory of the Dry Creek watershed for all known factors that influence water quality. These factors might include permitted industrial and municipal wastewater discharges, concentrated animal feeding operations (CAFOs), animal waste application sites, grazing lands, forestry operations, industrial stormwater, urban runoff, and other sources. This information will be collected and maintained on a subwatershed basis to enhance the identification of cause-and-effect relationships. This watershed inventory will be compiled from special investigations, TNRCC complaint investigations, TNRCC permit databases, surface water monitoring data, and watershed stakeholder input.

Resources: [*List here the equipment, supplies, computer software, subcontractors, data from external sources, and other resources you need to accomplish the work in each task.*]

Deliverables and Due Dates (September [*year*] through August [*year*]):

A. Draft interim status report (5 copies for TNRCC internal review)—To be determined
B. Final interim status report (5 copies for TNRCC internal review; distribute to stakeholder group and other interested parties)—To be determined

Task Budget: [*Outline your anticipated budget here.*]

Task 5: Quality Assurance Project Plan[2]

Objective: To ensure that water quality data are collected, compiled, transferred to the TNRCC, and managed in accordance with a TNRCC-approved quality assurance project plan (QAPP). Monitoring activities will be designed and coordinated through development of the QAPP, which documents the quality requirements for collection and submission of water quality data. The QAPP includes a monitoring plan to coordinate monitoring efforts and a data management plan to ensure completeness and accuracy of data transmission to the TNRCC. The approved plan ensures that the data collected meet TNRCC and EPA quality standards, minimizes the duplication of monitoring efforts within the watershed, and focuses on watershed coverage that provides water quality data to support these efforts:

- analysis of water quality trends within the Dry Creek watershed;
- focus on areas of concern;
- analysis of the appropriateness of relevant water quality standards;
- determination of point and nonpoint source loadings;
- evaluation of the health and integrity of aquatic life;
- evaluation of unclassified water bodies that contribute to water quality impairment;
- existing water quality monitoring efforts;
- evaluation of the water quality data needed for calibration and operation of mathematical models used.

Task Description: MSV Consultants will develop a quality assurance project plan (QAPP) to ensure that water quality data are collected, transferred to the TNRCC, and managed in a manner consistent with TNRCC data quality standards.

Quality Assurance Project Plan (QAPP). The QAPP will address elements described in the EPA's QA/R-5 document, including project management, measurement/data acquisition, assessment/oversight, and data validation and usability. Laboratory analysis of the water samples will be conducted in accordance with the EPA-approved methods as reported in EPA regulations (40 CFR Part 136). The QAPP will be reviewed and approved by the TNRCC and by the EPA, [*if federally funded*] before data collection begins. Quality assurance management protocols will be consistent with TNRCC policies as specified in the TNRCC Quality Management Plan (QMP). The QAPP on file with the TNRCC must be updated annually or within 120 days of significant changes, whichever is sooner. The QAPP includes a monitoring plan and a data management plan.

The monitoring plan that is approved in the QAPP will specify the parameters, frequency, and sampling locations, with GPS-verified latitude and longitude coordinates. The monitoring plan will be formatted in a table as provided by the TNRCC (see Exhibit __ to the TMDL project contract). The monitor-

[2]For more information about developing your QAPP, see Chapter 6, "The Quality Assurance Project Plan."

ing plan will be coordinated with the TNRCC regional offices and other watershed monitoring entities to minimize duplication of effort. Monitoring coordination efforts will be documented on the Monitoring Plan Review Questionnaire. The monitoring plan will include fixed and targeted monitoring sites throughout the study area for all monitoring entities and maps that identify sampling site locations. The monitoring plan will be approved by watershed stakeholders.

MSV Consultants will ensure that the data collected are processed according to the procedures outlined in the QAPP's data management plan. The data management plan will specify these points:

- data handling and quality assurance techniques
- global positioning system (GPS) verification of locations
- mapping methods
- deadlines for submittal of data to TNRCC
- a plan to make data available to the TMDL stakeholder group members

MSV Consultants will ensure that all data collected through the project are accessible to the public over the Internet, on diskettes, or in hard copy. The data management plan will also define acceptance criteria for historical and other available data and describe the process by which data quality was verified.

Resources: [*List here the equipment, supplies, computer software, subcontractors, data from external sources, and other resources you need to accomplish the work in each task.*]

Deliverables and Due Dates (September [*year*] through August [*year*]):

A. Draft QAPP for TNRCC internal review—To be determined
B. Final QAPP (amendments to QAPP due as changes occur; especially after project work plan is complete and approved)—To be determined
C. Data management checklist (with monitoring data)—To be determined
D. Data correction request forms—Submit these forms with corrections after data has been sent to the TNRCC—When applicable
E. Completed monitoring systems checklist and audit of monitoring subcontractors—to include recommendations for corrective action—To be determined
F. Participate in random TNRCC monitoring systems audit—Upon request
G. Surface water quality monitoring data in acceptable TNRCC database format—To be determined

Task Budget: [*Outline your anticipated budget here.*]

Task 6: Watershed Action Plan

Objective: To develop a watershed action plan for the Dry Creek watershed. This plan has two major components: a TMDL report and a TMDL implementation plan.

Task Description: The watershed action plan summarizes the entire TMDL project and includes these features:

- information on water quality issues, and their causes and sources
- a compilation of existing water quality data, related information, and historical information
- a summary of the pollutant loading allocation alternatives for point and nonpoint sources
- an indication of where improvements to water quality have been implemented throughout the watershed—for example, wastewater plant upgrades, best management practices, pollution prevention by industrial facilities, public education for nonpoint source pollutants, and other measures
- a review of the options for further action
- a determination of participants in the implementation phase of the TMDL project

Specifically, the watershed action plan contains the TMDL report and the TMDL implementation plan. The TMDL report describes the loading allocation process, and the TMDL implementation plan describes the strategies to be used for restoring water quality. The key aspects of these components are listed below.

TMDL loading allocation

- Target identification
- Problem definition (variance from the target)
- Source analysis
- Linkage between pollutant sources and receiving water
- Loading allocation

TMDL Implementation Plan

- Description of actions (control actions, management measures or both) that will be implemented to achieve the TMDL target.
- A schedule for implementing specific activities deemed necessary to achieve the load adjustment. This schedule addresses source actions as well as activities expected from the state and the EPA, such as follow-up water quality monitoring or evaluation.
- Legal authority under which control actions will be carried out and whether those actions are enforceable.
- Reasonable assurances that nonenforceable actions will result in the load allocations for nonpoint sources required by the TMDL.
- A monitoring plan designed to determine the effectiveness of the implementing actions and whether allocations are met.
- Measurable milestones for determining whether the implementation plan is being properly executed and for determining whether applicable water quality standards are being achieved.

Resources: [*List here the equipment, supplies, computer software, subcontractors, data from external sources, and other resources you need to accomplish the work in each task.*]

Deliverables and Due Dates (September [*year*] through August [*year*]):

A. TMDL report—To be determined
B. TMDL implementation plan—To be determined
C. Updated watershed inventory provided on diskette in TNRCC database format and plotted on baseline maps—To be determined

Task Budget: [*Outline your anticipated budget here.*]

Appendix B
EPA Guidance

Several sources of guidance published by the EPA can be helpful to you in completing your TMDL project. This appendix presents information from these sources that is pertinent to this publication. Consult the publications referenced for further details.

EPA Regional Guidance

TMDL load allocations for water bodies on the 303(d) list must be approved by the EPA. EPA Region 6, which includes Texas, Oklahoma, New Mexico, Louisiana, and Arkansas, has issued guidance for submitting reports on TMDL projects to the EPA for their review and approval. The Region 6 guidance summarizes the administrative process and technical elements required for submission of information from a TMDL project (EPA 1997b).

Technical Elements

EPA Region 6 requires these technical elements to be in submitted TMDL reports:

1. **Problem Definition:** The pollutant or stressor of concern, pollutant sources, water body characteristics, and applicable water quality standards are identified. The following information should also be included: 1) whether the segment is included on the state's latest 303(d) list and its priority; 2) a general description of the segment and the basin or ecoregion in which it is located; and 3) the segment number and Reach File 3 water body identification.
2. **Endpoint Identification:** Endpoints are indicators of the desired condition of the water body and provide a measurable goal for water quality. An endpoint is tied to water quality standards for the pollutant of concern.
3. **Source Analysis:** The type, magnitude, and location of sources of pollutant loading to the water body should be determined or estimated.

The loading conditions, data available, and appropriate analytical methods are determined. The following information should also be included:

- the facility name and permit number for all sources within or affecting the segment;
- a description of all current sources of loading to the segment, including point sources, nonpoint sources, background sources, tributaries, and upstream flow.

4. **Linkage between Sources and Receiving Water:** The correlation between pollutant sources and a receiving water body is usually provided by monitoring and water quality modeling. The water body's assimilative capacity, range of conditions, and the cause-and-effect relationships between the endpoint and pollutant sources are determined. The following information should be included:

   a) a description of the type of technical effort and the level of modeling—for example, bioassessment survey, screening model, or calibrated and verified model;
   b) a description of the calibration and verification process, rationale for the modeled conditions—for example, "critical conditions" or "wet-weather discharge," and origin of data;
   c) if water quality modeling is used, a listing of model inputs, hydraulic parameters, and kinetic rates relevant to the pollutant of concern along with the source and justification of its use—for example, ecoregion study, survey, or monitoring;
   d) copies (electronic file if possible) of the calibration and verification model runs, if any, and the input and output files for the proposed allocation.

5. **Margin of Safety (MOS):** The MOS accounts for uncertainty in the modeling process and overall technical uncertainty and should be described in the final TMDL report. The MOS may be incorporated into conservative modeling assumptions (with justification presented) or included as an additional load.

6. **Loading Allocation:** All known or suspected loading to the segment should be considered and a recommendation made for loadings to be allocated among the sources (point and nonpoint). The report should include a summary of the wasteload allocations (WLAs) and load allocations (LAs). WLAs are assigned to all existing and future point sources of pollution. LAs are attributed to existing and future nonpoint sources of pollution and to natural background sources. Tributaries and loading in upstream flow may also be considered LAs.

Submission Process

A TMDL report submitted to the EPA for approval should adequately document and describe the stream conditions, technical analysis, and methodology used to

propose loading allocations. A draft of this report should be provided to the EPA for technical review by staff before the final report is submitted. The EPA will determine whether the draft is technically valid. The state is required to make the draft report available for public review and comment in accordance with the Continuing Planning Process (CPP). If necessary, the report will be revised based on public comment. The final TMDL should be submitted in the form of a letter to the EPA. If no changes were made, a new cover page noting the report is "final" should be submitted with the letter requesting approval. If changes were made, the entire TMDL report must be resubmitted with the request for approval. Within 30 days of receipt of this final document, the EPA is expected to approve or disapprove the TMDL report. If the TMDL report is disapproved, the EPA will establish a TMDL within another 30 days.

FAC Recommendations for Developing TMDLs

In November 1996, the EPA created a national advisory group of stakeholders (the Federal Advisory Committee on the Total Maximum Daily Load Program, referred to as the "FAC") to recommend improvements to the effectiveness and efficiency of the TMDL program. The FAC issued its final report in May 1998 (EPA 1998a), to recommend that the following list of components be included in TMDL development and implementation:

1. **Target Identification:** Determine the pollutant or pollutants of concern and quantify the target for the TMDL process.
2. **Identification of Current Deviation from the Target:** Quantify the degree to which conditions in the water body deviate from the desired target.
3. **Source Identification:** Identify the responsible sources or categories of sources of each pollutant of concern, and quantify the degree to which each source or source category contributes to the problem.
4. **Allocation of Pollution Loads**: Set quantified pollution reduction responsibilities among the identified sources along with a quantified margin of safety, allocation for future growth, seasonal variations, and, if necessary, other factors to address variable flow conditions.
5. **Implementation Plan:** Specify and quantify control actions and implementation tools, methods, and authorities that will be used to achieve the allocations and eliminate the impairment. Additionally, include in the plan the schedules and milestones for implementing the called-for actions, evaluating the TMDL, and adjusting the TMDL if it is found to be ineffective.
6. **Process for Monitoring/Assessing Effectiveness:** Determine the degree of use attainment, remaining variance from the target, compliance with implementation plan, and the accuracy of sources and source contributions identified through TMDL development activities.

7. **Process for TMDL Revision:** Describe how the TMDL will be modified or revised to ensure water quality standards are met in response to follow-up monitoring and evaluation results.

Appendix C
TMDL Example Summaries

The first two summaries presented below outline case studies of TMDL projects that have been completed in other parts of the country. For a more detailed summary of these projects and other TMDL projects, go to the EPA's TMDL Web page, http://www.epa.gov/OWOW/tmdl/. The third summary, although not an official TMDL project, is another good example of the components necessary in a TMDL. Each of these summaries presents the major components necessary in TMDL projects, but you should review the entire project documentation to gain a more complete knowledge of the process used.

TMDL Case Study: The Lower Minnesota River

Key Feature:	A TMDL undergoing assessment as part of a basinwide river assessment project
Project Name:	Lower Minnesota River
Location:	EPA Region 5/Southern Minnesota
Scope/Size:	Minnesota River Watershed (16,770 mi^2); Lower Minnesota River drainage area (320 mi^2)
Land Type:	Irregular plains
Type of Activity:	Agriculture (residential and commercial development)
Pollutants:	CBOD, ammonia
TMDL Development:	Point source and nonpoint source
Data Sources:	STORET, Reach Files, PCS
Data Mechanisms:	Models (QUAL II, RMA-12, HSPF)
Monitoring Plan:	Yes
Control Measures:	BMPs, NPDES permits
Program Integration:	State/local/federal

The major steps in this project included assessing the water quality problem, setting a water quality target, modeling the system, developing loading allocations, implementing controls, and monitoring the results. The water quality standards for cool- and warm-water fisheries and aquatic recreation use were chosen

as the target. The deviation from the target was identified by examining water quality data, state water quality standards, and effluent limitations and flow for wastewater discharges. The project identified headwater loads, two wastewater treatment plants (WWTPs), and benthic loads as the primary pollutant sources. Load adjustments were allocated to these sources with a margin of safety incorporated into conservative approaches in modeling and permitting. Implementation of control actions involved WWTP treatment process improvement to meet NPDES permit requirements and a 40 percent reduction goal for nonpoint sources. Monitoring in major tributaries and in the mainstem was used to determine whether the TMDL achieved water quality goals.

TMDL Case Study: Nomini Creek Watershed

Key Feature:	Use of GIS and watershed models to identify areas of critical nonpoint pollution
Project Name:	Nomini Creek Watershed GIS Study Location: EPA Region 3/Westmoreland County, Virginia/Potomac River
Scope/Size:	Small watershed, 1505 hectares
Land Type:	Ecoregion 65, SouthEastern plains
Type of Activity:	Agriculture
Pollutants:	Nutrients, sediment
TMDL Development:	Nonpoint source
Data Sources:	State, local, federal
Data Mechanisms:	Modeling (SLOSS, PHOSPH); GIS (VirGIS)
Monitoring Plan:	Yes, long-term BMP effectiveness monitoring
Control Measures:	BMPs

The Nomini Creek project is part of the Chesapeake Bay program. Project stakeholders identified causes and sources of water quality problems, set an achievable goal, and targeted controls for specific point and nonpoint pollution sources. The project goal was established to help achieve a 40 percent nutrient reduction goal for the drainage basin. Critical nutrient loading areas were identified using a GIS and a sediment and nutrient model. With this locational information, BMPs were installed in critical areas. An intensive water quality monitoring system for storm water and ambient conditions was also established to verify sediment and nutrient loads and to test the effectiveness of BMPs.

Clark Fork–Pend Oreille Basin Water Quality Study[1]

The main objectives of this study were to characterize water quality problems, identify sources of the problems, and develop and prioritize actions to enhance water quality. The project placed a strong emphasis on stakeholder involvement. A steering committee was formed and solicited comments from stakeholders. The steering committee recommended specific water quality goals for the basin

[1]Environmental Protection Agency. 1993. *Clark Fork –Pend Oreille Basin Water Quality Study.* EPA Report No. 910/R-93-006. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

based on research findings and on stakeholder input. The steering committee also used stakeholder input to outline and prioritize more than 70 management actions. The steering committee generally recommended voluntary controls but developed optional allocations so that mandatory controls could be implemented if these voluntary measures failed to achieve the desired results.

Even though this report was generated from a water quality study, not from a TMDL project, it contains the elements of a TMDL project from target identification to allocation of pollutant loads and development of an implementation plan. The following abbreviated list of chapter topics from the study illustrates the range of subjects and approaches taken.

- Executive Summary
- Response to the Citizens' Concerns: The Purpose and Organization
- The State of the Basin
- Previous Studies and Current Management Programs
- Scoping the Sources: Research Objectives
- Research Findings
- Managing the Watershed: The Management Plan
- Taking the First Steps: Priorities for Action

Appendix D
Arroyo Colorado TMDL Stakeholder Ground Rules

Watershed Steering Committee Ground Rules

The signatories to these Ground Rules agree as follows:

A. Goals

The goal of the Arroyo Colorado TMDL Watershed Steering Committee (Committee) is to help develop and implement a Watershed Action Plan that includes Total Maximum Daily Loads (TMDLs) for the Arroyo Colorado Watershed for the pollutants listed on the State of Texas Clean Water Act § 303(d) List. The watershed includes the drainage areas for the Arroyo Colorado and the Lower Laguna Madre, which are Segments 2201 and 2202, as described in the Texas Surface Water Quality Standards, and Segment 2491 south of the land cut near the Willacy-Kenedy county line.

The Watershed Action Plan will incorporate, to the greatest degree possible, additional uses of the Arroyo Colorado and the Lower Laguna Madre (beyond those described in the Texas Surface Water Quality Standards) in a manner that:

- considers economic feasibility, affordability and growth;
- works to maintain and improve the unique environmental resources of the watershed;
- complements the regional water quantity planning efforts under Senate Bill 1; and
- facilitates regional cooperation.

These uses include: recreation, flood control and shipping; as a water source for aquaculture; and as a waterway for agricultural return flows, and municipal, industrial, and aquacultural wastewater discharges.

The Committee has been established by the Texas Natural Resource Conservation Commission (TNRCC) in partnership with the Texas State Soil and Water

Conservation Board (TSSWCB). The Committee is the main avenue for public participation in the TMDL process. The Committee will be instrumental in obtaining local support for actions aimed at restoring surface water quality.

The TNRCC and the TSSWCB will support TMDLs developed by the Committee that meet all necessary legal and scientific requirements. The TNRCC is responsible for submission of the TMDL to the U.S. Environmental Protection Agency for final approval. The TNRCC and the TSSWCB reserve the right to take any action the agencies, individually or jointly, decide is necessary to comply with applicable law and regulation, or that the TNRCC or the TSSWCB decides is necessary for the successful development, implementation, and approval of the TMDL. Notwithstanding any other provision of this document, nothing in this document constitutes or is intended to constitute a legal obligation enforceable against the TNRCC, the TSSWCB or the members of this Committee.

B. Time Frame

The development of a TMDL for the Arroyo Colorado will require an 18-month period from the first meeting of the watershed steering committee to the submittal of the TMDL to EPA. The time required for implementation of the TMDL is dependent on the TMDL, and cannot be estimated until the details of the TMDL have been determined.

C. Participants

Selection of Members

Members were selected under a process developed by the TNRCC and the TSSWCB. This process involved: (1) consultation with members of the Texas Clean Rivers Program Lower Rio Grande Basin Steering Committee, local and regional governments, various civic groups, and other interested parties to determine the stakeholder interests in the Arroyo Colorado watershed related to the TMDL, (2) meetings with the various stakeholder interest groups and individuals, and (3) self-nomination or selection by the various interest groups or individuals. Selection criteria included: representation of the full geographic area within the watershed; representation from the full range of stakeholder interests; emphasis on establishing a Committee that was large enough to represent the full range of interests yet small enough to function.

Stakeholders

The Committee is composed of stakeholders in the Arroyo Colorado/Lower Laguna Madre watershed. A stakeholder is defined as someone who may be affected in a significant way by the TMDL process, either economically or in quality of life.

Members

The Committee is composed of members representing the interests listed in the table at the end of this appendix. All members of the Committee serve at the pleasure of the TNRCC. If a member resigns, dies, becomes incapacitated, is removed by the TNRCC, or otherwise vacates his or her position, TNRCC may appoint a replacement in consultation with the TSSWCB.

Proxies

All members hereby agree to make a good faith effort to attend all Committee meetings; however, the members recognize that emergencies may arise necessitating the absence of a member. The absent member may designate in writing to the TNRCC or TSSWCB the name of a specific person who may participate on his/her behalf at any Committee meeting. The members agree that proxies shall not count toward member attendance.

Additional Members

The members agree that new individuals may be added to the Committee if (1) a Committee member vacates a position or (2) if important stakeholder interests are identified that are not represented by the existing membership. In either event, the TNRCC and the TSSWCB will work with the Committee to appoint additional members.

Attendance at Meetings

A Committee member may be accompanied by such other individuals as the Committee member believes to be appropriate; however, only the Committee member will have the privilege of sitting at the table, speaking during the meetings, and participating in consensus determinations. Committee members are expected to attend all full meetings and participate fully in the Committee's deliberations. If a member misses three consecutive meetings or more than half of all Committee meetings in any 12-month period, that member automatically vacates his/her position on the Committee. Proxies shall not count for meeting attendance.

Absent Members

All members agree to make a good faith effort to attend all Committee meetings; however, the members recognize that emergencies may arise necessitating the absence of a member. The absent member may:

(1) communicate to the TNRCC or the TSSWCB any issue or view that member wishes to convey to the other members. The TNRCC/TSSWCB will present the absent member's position or view but will not argue for it or vote on behalf of that member, or
(2) may designate a proxy as described in the "Proxies" section above.

Workgroups

Generally, the Committee will operate as a whole. However, some tasks (such as research or drafting) may be better performed by smaller groups. The Committee has discretion to form workgroups to carry out specific assignments from the Committee. Committee members may serve on workgroups; in addition, the Committee may invite outside individuals to attend workgroup meetings or conference calls if it feels particular expertise or perspectives not held by Committee members are needed. The TNRCC will make its best effort to notify each Committee member of all workgroup meetings, and each committee member is welcome to attend any workgroup meeting. Workgroups are not authorized to make decisions for the Committee as a whole.

D. Decision Making

Substantive and Major Procedural Matters

In developing the TMDL and the watershed action plan, this committee will operate by consensus to the extent possible, for both substantive matters such as determining loading allocations and major procedural matters such as adoption of the ground rules. Generally, "consensus" means that each member of this committee can agree to at least abide by the proposed approach, even if the member might prefer another approach.

Minor Procedural Matters

For minor procedural matters such as setting the meeting time, this committee will vote.

E. Procedures

Open Meetings

Committee meetings will be open to the public and, if time allows, the Committee may invite members of the public to comment during designated public comment periods. In addition, public workshops may be held in conjunction with scheduled Committee meetings in order to solicit additional public input to Committee deliberations.

Meeting Summaries

Draft summaries of Committee meetings will be prepared by the Lower Rio Grande Valley Development Council (LRGVDC), the TNRCC, and the TSSWCB, and will be approved by the Committee.

Agendas

Meeting agendas will be drafted by the TNRCC in consultation with the TSSWCB and based on the Committee's instructions at the last meeting. The agenda will be reviewed at the beginning of each meeting and may be refined by the Committee.

Background Materials

The TNRCC and the LRGVDC (and, on occasion, other sources) may provide background materials to Committee members in advance of Committee meetings. All requests for, and distribution of, background materials to all Committee members will occur through the TNRCC to ensure equal sharing of information. Members may draft position papers or provide other material to be circulated by the TNRCC. The TNRCC and/or the LRGVDC will use their best efforts to distribute any written information any member of the Committee wishes the Committee as a whole to receive.

Thoroughness of Deliberations

During the course of Committee deliberations, every relevant issue raised will be recorded and addressed. To expedite the process, agreed-upon lower priority issues may be recorded and set aside to be dealt with at a later date. If issues raised are not those identified by the Committee for deliberation, they will be recorded as such.

F. Roles and Responsibilities

TNRCC and TSSWCB

The TNRCC and the TSSWCB will lead the meetings and work with all of the members to ensure that the process runs smoothly. The role of the TNRCC/TSSWCB includes developing meeting agendas, focusing discussions, assuring fair opportunity for members to participate in Committee proceedings, working to resolve any impasses that may arise, distributing background materials, working with the LRGVDC to prepare meeting summaries, assisting in the location and/or preparation of background materials, distributing documents the Committee or a workgroup develops, assisting workgroups, conducting public outreach and assuring appropriate public participation, moderating public workshops, providing assistance to Committee members regarding Committee business between meetings, and other functions as the Committee requests. The TNRCC will prepare the final TMDL document (editing and distributing drafts, compiling comments, etc.). The TNRCC will maintain all records of the Committee. The TNRCC will coordinate the activities of the Science and Technical Advisory Committee (see "STAC" section below) and the Committee.

Committee Members

Committee members will be expected to assist the TNRCC and the TSSWCB to:

- Identify the desired water quality conditions and measurable goals
- Make recommendations regarding water quality monitoring and modeling needed to identify and assess the sources of pollutant loadings in the Arroyo Colorado
- Help determine the pollution reduction targets
- Help develop a watershed action plan, which is the document describing how the pollution reduction will occur
- Lead the effort to implement this plan at the local level
- Communicate implications of TMDL to other interested parties in the watershed.

Committee members are expected to attend all full Committee meetings. In addition, members may be asked to participate in public meetings that may be held to obtain additional public input on TMDL activities. All members agree to act in good faith in all aspects of the Committee's deliberations. Committee members are expected to present their own personal opinions based on their experience, perspective, and training, and to work constructively and collaboratively with other members toward reaching consensus.

Lower Rio Grande Valley Development Council (LRGVDC)

The LRGVDC will be responsible for recording meeting deliberations and summarizing important topics and decisions. A written summary will be prepared for review by the Committee. The LRGVDC will assist in public outreach activities and will provide logistics and organizational support to the TNRCC and the Committee. The LRGVDC will maintain a current record of the names and addresses of Committee members and will assist TNRCC in sending out notices of meetings.

Science and Technical Advisory Committee (STAC)

The STAC will be composed of representatives of various federal and state agencies, academia and other experts in the field of water quality. The STAC will advise the TNRCC, the TSSWCB, and the Committee and ensure the scientific and technical validity of the TMDL. Input from the STAC will be presented by TNRCC or by individual STAC members who may be called upon to brief the Committee about technical issues (and/or prepare background materials). The STAC will meet on a regular basis at a central location in the Arroyo Colorado watershed. Committee members are encouraged to attend the STAC meetings, and STAC members are encouraged to attend the Committee meetings.

G. Safeguards

Right to Withdraw

Any member may withdraw from the Committee at any time.

Others' Positions

By participating, members agree that they are entering into a covenant of mutual respect and professional courtesy. When speaking in outside public forums, each member may express his or her point of view about the issues before the Committee; however, members agree not to report, by name, any other member's position or point of view. The members also agree that they will not publicly predict the outcome of the Committee's deliberations. Personal attacks and prejudiced statements will not be tolerated at any time during the process.

Information

(1) All members agree to openly exchange relevant information that is readily available to them. If a member believes he or she cannot or should not release relevant information, the member will provide the substance of the information in some form (such as by aggregating data, by deleting non-relevant confidential information, by providing summaries, or by furnishing it to the facilitator to use or abstract) or a general description of it and the reason for not providing it directly.

(2) Members will provide information as much in advance of the meeting at which it is to be discussed as is reasonably possible.

(3) Information and data provided to the Committee are a matter of public record.

(4) The Committee does not have authority to protect confidential business information (CBI). When information required for Committee deliberations can only be derived from CBI (i.e., innovative technology, cost, or pricing information), the information may only be received by the Committee in aggregate form so as to protect specific CBI from release.

(5) No member is expected to share advance information on its plans or strategy for filing or defending against litigation over TMDL issues. No member is expected to share any information that is subject to attorney/client privilege.

News Media

Representatives from the news media may attend Committee meetings and may also ask members to comment or answer questions about the Committee's business. Committee members agree that each member may offer his or her individual perspective; each member agrees not to attribute positions or views to other members by name, nor predict the outcome of the Committee's deliberations. To ensure consistency and accuracy in reporting on general Committee operations, members are encouraged to direct press inquiries concerning overall Committee plans and procedures to the TNRCC or the TSSWCB.

H. Products

Meeting Summaries

The LRGVDC, in consultation with the TNRCC and the TSSWCB, will prepare and distribute draft meeting summaries following each meeting of both the Committee and the STAC. Committee meeting summaries will be reviewed by Committee members and upon unanimous approval, they will become work products of the Committee.

Final TMDL Document

The Committee will provide input into the preparation of a draft and final consensus report, which includes: (1) problem identification, (2) endpoint identification, (3) source analysis, (4) linkage between sources and receiving water, (5) margin of safety, and (6) loading allocation. All Committee members will have the opportunity to review and comment upon the draft document. All Committee members will be asked to sign the final report.

Watershed Action Plan

The Committee will provide input into a draft and final Watershed Action Plan that incorporates, but is not limited to, the implementation of the TMDL. All Committee members will be asked to sign the final plan.

I. Meeting Plans

Number of Meetings

There will be a minimum of ten Committee meetings which are expected to occur in the 18-month period beginning with the first meeting on June 30, 1998. The Committee will determine the scheduling of additional meetings. The Committee will also determine the timing and number of workgroup meetings, if any.

Location of Meetings

Meetings will take place in a central location in the Arroyo Colorado watershed.

Arroyo Colorado TMDL Watershed Steering Committee	
INTEREST	ENTITY
State Agencies responsible for development and implementation of TMDLs	Texas Natural Resource Conservation Commission Texas State Soil and Water Conservation Board
Permittees: *Municipal*	McAllen PUB Harlingen Water Works City of La Feria City of Mission
Industrial	Central Power and Light
Aquaculture	Arroyo Aquaculture
Agriculture	Cameron Co. Farmer Hidalgo Co. Farmer Soil & Water Conservation District #319 Hidalgo Soil & Water Conservation District #350 Farm Bureau
Others (government)	International Boundary & Water Commission (IBWC) Cameron Co. Health Department Hidalgo Co. Drainage District #1 Laguna Atascosa NWR, U.S. Fish & Wildlife Service
Others (port, environmental, recreational, civic)	Port of Harlingen Sierra Club Coalition to Save the Arroyo Colorado, Lower Laguna Madre Foundation, Coastal Conservation Association Valley Sportsman Club, Cameron Co. Parks Advisory Committee
Council of Government	Lower Rio Grande Valley Development Council

Appendix E
Partial List of Potential Federal and State Contacts

Below is a partial list of groups that can play a role in the development and implementation of the watershed management approach.

Government Agencies

Federal

Agency for Toxic Substances and Disease Registry
Bureau of Land Management
Bureau of Reclamation
U.S. Department of Agriculture
Consolidated Farm Service Agency
Natural Resources Conservation Service
Agricultural Research Service
U.S. Department of Defense
U.S. Army Corps of Engineers
U.S. Department of Energy
Department of Health and Human Services
U.S. Department of Transportation
U.S. Environmental Protection Agency
U.S. Forest Service
Federal Emergency Management Agency
U.S. Fish and Wildlife Service
General Services Administration
National Oceanic and Atmospheric Administration
National Biological Survey
National Park Service
U.S. Geological Survey

State

Office of the Adjutant General
Office of the Attorney General
General Land Office
Office of the Governor
Texas Agricultural Extension Service
Texas Bureau of Economic Geology
Texas Railroad Commission
Texas Department of Agriculture
Texas Department of Health
Texas Department of Information Resources
Texas Department of Public Safety, Division of Emergency Management
Texas Department of Transportation
Texas Forest Service
Texas Historical Commission

State Agencies (Cont'd)

Texas Natural Resources Information System
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife Department
Texas State Soil and Water Conservation Board
Texas Water Development Board
University of Texas
Texas A & M University
University of North Texas
Texas Institute for Applied Environmental Research
Blackland Research Center

Interstate/International

Border Governors Association
International Boundary and Water Commission
Tribal governments
Arkansas
Colorado
Louisiana
New Mexico
Oklahoma

Local Governments

City councils
County commissioners
Local health districts
Local irrigation districts
Mayors and city managers
Parks and recreation departments
Public works departments
Water and wastewater departments
Barton Springs/Edwards Aquifer Conservation District
Flood control, irrigation, & water/sewer districts

Regional Agencies

Agriculture Resources Protection Authority
Alamo Area Council of Governments
Ark-Tex Council of Governments
Brazos Valley Development Council
Canadian River Compact Commission
Capital Area Planning Council
Central Texas Council of Governments
Coastal Bend Council of Governments
Concho Valley Council of Governments
Houston-Galveston Area Council
Angelina & Neches River Authority
Brazos River Authority
Canadian River Municipal Water Authority
Central Colorado River Authority
Cibolo Creek Municipal Authority
Colorado River Municipal Water Authority
Guadalupe-Blanco River Authority
Gulf Coast Hazardous Substance Research System
Gulf Coast Waste Disposal Authority
Gulf Coast Water Authority
Lavaca-Navidad River Authority
Lower Colorado River Authority
Lower Concho River Water and Soil Conservation District
Lower Neches Valley Authority
Nueces River Authority
Palo Duro River Authority
Pecos River Compact Commission

Regional Agencies (Cont'd)

Red Bluff Water Power Control District
Red River Authority of Texas
Red River Compact Commission
Rio Grande Compact Commission
Rio Grande Council of Governments
Rio Grande Valley Municipal Water Authority
Rio Grande Valley Pollution Control Authority
Sabine River Authority of Texas
Sabine River Compact Commission
San Antonio River Authority
San Jacinto River Authority
Soil and water conservation districts
South Texas Development Council (Laredo)
Sulphur River Basin Authority
Trinity River Authority
Underground water conservation districts
Upper Colorado River Authority
Upper Guadalupe River Authority
Upper Neches River Municipal Water Authority

State Associations and Special Committees

Texas Alliance of Groundwater Districts
Texas Association of Counties
Texas Association of County Judges
Texas Association of Regional Council
Texas Board of Realtors
Texas Cattle Feeders Association
Texas Chemical Council
Texas Ground Water Association
Texas Metropolitan Sewer Association
Texas Municipal League
Texas Section American Wastewater Association
Texas Shrimpers
Texas Utilities Electric
TNRCC Water Well Drillers Advisory Council
Texas Water Conservation Association

Businesses

Privately owned water utilities
Privately owned electric utilities

Agricultural Organizations

Agriculture Resources Protection Authority
Agricultural Advisory Committee
Texas Farm Bureau
Texas Irrigation Council
Texas Rural League
Texas Rural Water Association

Civic/Environmental/Research/Policy/Groups

Audubon Society
Environmental Defense Fund
Gulf Coast Conservation Association
Houston Advanced Research Center
League of Women Voters
National Watershed Coalition
Natural Resource Defense Council
Sierra Club
Sportsmen Conservationists of Texas
Texas Center for Policy Studies

Appendix F
Contents of Your Data Management Plan

Your data management plan should include the following elements.

Personnel–Provide a description of all staff responsibilities associated with data management including planning entity and associated subentity personnel. Provide an organizational chart which shows in detail lines of communication of all personnel involved with data management.

Systems Design (Hardware and Software)–Describe the hardware and software used to support data processing, including any planned system upgrades that will alter data collection or management. Provide detail as to how the project will meet the minimum requirements for submitted information to TNRCC. (for example, Paradox format, ASCII text files).

Data Dictionary–For the purposes of this Data Management Plan, all terminology and field descriptions are included in the *SWQM Data Management Reference Guide* (TNRCC 1999).

Data Management Plan Implementation–Provide a flow chart and describe the project data management scheme, tracing the path of the data from their generation in the field or laboratory to their final use and storage. This includes procedures for addressing data generated as part of the project as well as data from other sources. Describe or reference the standard record-keeping procedures, document control system, and the approach used for data storage and retrieval on electronic media. Discuss the control mechanism for detecting and correcting errors and for preventing loss of data during data reduction, data reporting, and data entry to forms, reports, and databases. Provide examples or reference any forms or checklists to be used.

Quality Assurance/Control–See Section D of *Guidance for Data Quality Assessment: Practical Methods for Data Analysis* (EPA Report No. 600/R-96/084 ; EPA 1998c).

Migration/Transfer/Conversion–Provide detailed procedures explaining file transfer protocols used for ensuring proper importation and exportation of data from the local information system relative to the specific project. All migration, transfer, and conversion of data, as well as data history, should be documented, including an explanation of responsible personnel.

Backup/Disaster Recovery–Provide details on how data will be backed up routinely. This should include how often data are backed up, the type of media used for backup, the type of backup (data or system), and where backup data are stored. This information should include documented procedures that will be followed to accomplish full data recovery in the event of catastrophic systems failure that renders an electronic database unusable and an estimated time line for total systems recovery.

Archives/Data Retention–Complete original data sets are archived on permanent media (*specify tape backup, CD-ROM, etc.)* and retained on-site by the Planning Entity for a retention period specified in the original QAPP approved by the TNRCC Project Manager. *Include an exhaustive list of procedures and explanation of where archived files are stored (on-site or off-site).*

Information Dissemination–Include procedures that allow for public access to data.

Glossary

Antibacksliding. The federal policy that calls for a newly-issued discharge permit to contain restrictions at least as stringent as those of the expired permit.

Antidegradation. The Texas policy stating that water quality shall not be degraded below its existing uses unless it can be shown to the TNRCC's satisfaction that lowering of the water quality is necessary for important economic or social development.

Best management practice (BMP). A practice or combination of practices determined to be the most practicable means of preventing or reducing to a level compatible with water quality goals the amount of pollution generated by nonpoint sources. BMPs are selected on the basis of site-specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility.

Conservative substance. Substance that does not undergo any chemical or biological transformation or degradation in a given ecosystem.

Designated uses. Uses specified in water quality standards for each water body or segment regardless of actual attainment.

Dispersion. The spreading of chemical or biological constituents, including pollutants, in various directions from a point source. Dispersion occurs at different speeds in different directions depending on the differential instream flow characteristics.

Effluent trading. Market-driven approach in which an agreement is made between pollutant contributors in the same watershed to alternatively allocate pollutant reduction responsibilities among contributors.

Empirical models. Models based on a statistical summary of measured data.

Facilitation. A process in which a person who is neutral and has no decision-making authority intervenes to help a group improve the way it identifies and solves problems and makes decisions in order to increase the group's effectiveness.

Intermittent stream. A water body that has measurable flow only intermittently in an annual cycle, such that the stream flows for only a few weeks or months during a given year, depending on contributing discharges to the stream, such as rainfall or groundwater.

Load or Loading. The amount of a certain constituent entering a water body, measured as mass per unit time.

Load allocation (LA). The portion of a receiving water's loading capacity that is attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural background and nonpoint source loads should be distinguished from each other.

Loading capacity. The greatest amount of pollutant loading that a water body can receive without violating water quality standards.

Margin of safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant load and the quality of the receiving water body. The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by the EPA. If the MOS needs to be larger than that which is allowed through the conservative assumptions, an additional MOS can be added as a separate component of the TMDL. In this case quantitatively,

$$TMDL = LC = WLA + LA + MOS.$$

Mathematical models. In the context of this publication, a system of mathematical expressions used to simulate the aquatic system in order to understand interactions between various contributing variables under study. A model represents the studied water system in order to make assumptions about the water body and interactions between parameters within it.

Mechanistic models. A model that attempts to quantitatively describe a phenomenon by its underlying causal mechanisms.

Nonconservative substances. Substance that undergoes chemical or biological transformation in a given environment.

Nonpoint source pollution. Pollution that is not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related to either land use or water use, including failing septic tanks, improper animal-keeping practices, agricultural and forestry practices, and urban and rural runoff.

Pollutant. A contaminant in a concentration or amount that adversely alters the physical, chemical, or biological properties of a natural environment. The term includes pathogens, toxic metals, carcinogens, oxygen-demanding substances, or other harmful substances. Examples of pollutant sources include dredged soil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical waste, biological material, radioactive materials, heat, wrecked or discharged equipment, sediment, cellar dirt, hydrocarbons, oil, and municipal, industrial, and agricultural waste discharged into surface water or groundwater.

Pollution prevention. The reduction or elimination of pollution before it is generated. In Texas, this includes source reduction and waste minimization.

Quality assurance. An integrated system or program of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality assurance project plan (QAPP). A plan that provides a project- or task-specific blueprint for the collection of environmental data to ensure that the results obtained are of the type and quality needed. The purpose of the QAPP is to reduce the risk of the users making an incorrect decision because of faulty data. The QAPP applies methods of quality assurance and quality control to achieve this goal.

Quality control. The overall system of routine technical activities, the purpose of which is to measure and control the quality of a product or service so that it meets the needs of the user.

Reaeration. The net influx of air occurring to a body of water.

Sensitivity analysis. The process of identifying model component processes and parameters that have relatively greater impacts on the model output.

Source reduction. Any activity that prevents the generation of pollution at the source.

Stakeholder group. Entities involved in or affected by watershed management activities within a watershed. The term "stakeholder" covers a broad range of people and organizations, including government agencies, nongovernmental organizations, businesses, agricultural entities, the public, and the regulated community.

Stream segment. A portion of a water body, classified under the water identification system utilized by the TNRCC, and the management unit to which water quality standards and regulations are applicable under the Clean Water Act. Segmented waters include most rivers and their major tributaries, major reservoirs, lakes, and marine waters that have designated physical boundaries, specific uses, and specific numerical physicochemical criteria.

Toxicant. A poisonous agent that kills or injures animal or plant life.

TPDES permit. A permit issued by the TNRCC under the Texas Pollutant Discharge Elimination System (TPDES) program that sets specific limits on the type and amount of pollutants that the recipient can discharge to a receiving water. It also includes a compliance schedule for achieving these limits. The TPDES permit process was established under the National Pollutant Discharge Elimination System (NPDES) in accordance with provisions of the Federal Clean Water Act.

Validation. The process of confirming that a model functions properly and produces reasonable results under specific conditions.

Waste load allocation (WLA). The portion of a receiving water's loading capacity that is allocated to its existing and future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation.

Water quality criteria. Water quality criteria comprise numeric and narrative criteria. Numeric criteria are scientifically-derived concentrations developed by the EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal.

Water quality standard. A law or regulation that consists of the beneficial designated use or uses of a water body, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular water body, and an antidegradation statement.

Watershed action plan (WAP). The written end product of the basin management approach, a watershed action plan (WAP) should contain a quantitative assessment of water quality problems and contributing sources (TMDL report) and an implementation plan identifying responsible parties and specifying actions needed to restore and protect water quality standards.

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