CHAPTER 2

GENERAL MONITORING GUIDELINES

Monitoring Categories

The SWQM Program and the CRP facilitate an integrated evaluation of physical, chemical, and biological characteristics of aquatic systems in relation to human-health concerns, ecological conditions, and designated uses. In order to balance the needs of multiple programs, monitoring is divided into the following categories:

- routine monitoring
- special-project monitoring
- permit-support monitoring
- systematic monitoring

Routine Monitoring

The routine-monitoring network collects physicochemical, biological, and hydrological data at varying frequencies from most of the 367 classified stream, reservoir, and estuary segments across Texas, as well as the Gulf of Mexico. Smaller unclassified water bodies are also monitored to evaluate and define water quality and to respond to perceived risk for pollution. This monitoring is also conducted on impaired water bodies that do not support the water quality standards.

- Monitoring should continue for at least two years.
- For all streams, quarterly monitoring is preferred; monitoring at least twice a year is required. Quarterly monitoring consists of four seasonal monitoring events (winter, spring, summer, and fall). Samples collected twice a year should include both summer and winter, representing both warm and cool seasons.
- Routine monitoring includes, at a minimum:
  - field measurements—dissolved oxygen (DO), pH, specific conductance, temperature, Secchi depth
  - conventional chemical parameter samples (for example, nutrients, chlorophyll *a*, chloride, sulfate)
  - bacterial measurements
  - flow measurements (or flow obtained from a USGS or an IBWC gauge)
- Routine monitoring may include the following (generally performed at least twice per year):
  - aquatic-life monitoring (ALM)
  - routine monitoring for toxics (metals or organics) in water or sediment
  - routine 24-hour measurements
  - monitoring at representative sites in each ecoregion (“ecoregion monitoring”)
- Routine monitoring does not include:

- ambient toxicity (biomonitoring)
- toxics (metals or organics) in fish tissue
- monitoring to characterize the degree or extent of an impairment

- For reservoirs and estuaries, the preferred monitoring frequency is four times per year, once in each season. Additional data are needed both to develop water quality criteria, and to adequately assess seasonal and long-term conditions in reservoirs and estuaries. Quarterly data collection is particularly useful at monitoring stations listed in Appendix F of the 2010 Texas Surface Water Quality Standards (TSWQS), adopted by the TCEQ on June 30, 2010.

  Where quarterly sampling is not feasible, discuss the possibility of two measurements per year (winter and summer) at annual coordinated monitoring meetings.

- The hierarchy for selecting unclassified waters for routine monitoring is as follows:
  1. perennial streams
  2. reservoirs and bays with high public use
  3. public water supply reservoirs unmonitored by the water supplier or other organization or authority
  4. intermittent streams with permanent pools that are in high public use or contain significant aquatic life

Coordinated Monitoring Schedule and Planning

The coordinated monitoring schedule (CMS) increases the efficiency of surface water data collection and analysis by the SWQM Program and its participating organizations. Coordinated statewide monitoring reduces the duplication of effort and improves spatial coverage of monitoring sites and consistency of data collection. Access the CMS online at <cms.lcra.org/>.

The TCEQ distributes guidelines for revising the routine monitoring schedule annually, before coordinated-monitoring meetings. This information is also available on the Web (see Appendix A).

Planning and development of the CMS takes place in January through May of the preceding fiscal year. The meetings are held in each major river basin and are hosted by the CRP basin planning agency. The schedule is continually updated during the annual planning process with a final version available on September 1 of each fiscal year. The Web-based CMS also allows for changes to be made during the year so the schedule is kept current. Those participating include the TCEQ SWQM and CRP staff, CRP partners, and other state, federal, county, and city agencies. All groups that collect SWQM data and commit to comply with TCEQ requirements for collecting quality-assured data are invited to participate in the meetings.

Special attention is focused on spatial gaps in station locations and gaps in various data needs. New sites are added, existing sites may be relocated, and monitored parameters may be changed based on the discussions at the meetings.

Routine Monitoring During Extended Drought

To ensure continuity of statewide routine SWQM activities during extended periods of

drought, the program has developed a guide to fulfilling the monitoring plan outlined in the CMS, available online (see Appendix A).

Special-Project Monitoring

Special-project monitoring involves data collection to better characterize nonattainment of water quality standards, the loading contributions of nonpoint sources of pollution in a watershed, and stakeholder concerns. Special projects are developed in consultation with other basin monitoring entities and TCEQ coordinators for the SWQM, Clean Rivers, Water Quality Standards (WQS), and TMDL programs.

Special projects improve the TCEQ's understanding of sources, distribution, and fates of particular constituents in selected reaches of water bodies. Special-project monitoring is used to assess toxicity in surface waters and impacts of point and nonpoint source discharges and to develop water quality controls and assess improvements after enforcement actions or implementation of controls. Special-project monitoring is also used to develop new or revised sampling and assessment procedures, to describe impacts of habitat modification on water quality, and to describe water quality in intermittent streams and unclassified streams.

- Monitoring usually continues for at least two years.
- Special-project monitoring is often performed to better characterize impairments and therefore takes place at or near sites where previous sampling identified impairment or concerns.
- Special-project monitoring may include:
  - TMDL project-support monitoring
  - independent 24-hour DO or sediment study (not in conjunction with routine monitoring)
  - independent one-time or multi-year fish-tissue studies
  - ambient toxicity sampling (the SWQM Program produces an annual statewide schedule)
  - monitoring effectiveness of best management practices
  - monitoring to identify and characterize nonpoint source pollution

Sediment Sampling for Metals and Organics

Independent sediment sampling is generally conducted as part of a special project. The sampling plan should specify the generation of at least four samples in 1–2 years. At a minimum, samples are collected twice each year for two years. The data is screened using SWQM Program–derived 85th percentiles and NOAA probable effects levels. If no secondary concerns are identified after four samples are collected, sampling is to be terminated at the site and a new one selected the following year. If secondary concerns are identified, sediment sampling is continued and the other components of the sediment sampling triad approach (toxicity testing and benthic macroinvertebrate sampling) are conducted to determine if the aquatic-life use is impaired by contaminated sediment. Guidelines for sediment sampling appear in Chapter 6.

Fish-Tissue Sampling

Fish-tissue sampling is considered a special project. The project plan outlines sampling to generate at least four composite samples (to assess ecological health) and four individual fillets (to assess human-health risk) in 1–2 years. Collect fillet and composite samples twice each year for two years, or all four samples within one year. Evaluate the fillet data according to human health–based screening levels in the 305(b) guidance. If no secondary concerns are identified after four samples are collected, sampling is terminated at the site and a new one selected the following year. If any secondary concerns are identified in the fillet samples, the TCEQ will notify the Texas Department of State Health Services, and request of the DSHS a more in-depth special study to determine human-heath risk and whether a consumption advisory or aquatic-life closure is warranted. The TCEQ will be developing predator-protection levels for screening whole-fish composite-sample data.

Sediment samples are generally collected from the same water bodies as part of a fish-tissue special study designed to address pollution by toxic contaminants. Details for sampling fish tissue, including target species, appear in Chapter 7.

Where to Collect Samples

Give priority to sites where previous assessments have failed criteria for acute or chronic criteria or human-health criteria, or shown biological impairment. When selecting a site, consider placement where there is a perceived risk of contamination with metals or organic substances. Also consider sites downstream from domestic or industrial discharges, hazardous-waste sites, metropolitan areas, or areas experiencing high nonpoint source loads. Samples are not collected in areas where the DSHS has issued consumption advisories or aquatic-life closures or where it has previously sampled and determined the fish to be safe for human consumption. However, if an advisory is more than eight years old, sampling may be considered with an emphasis on contaminants of concern to determine if the DSHS should revise the advisory.

Sampling Considerations

Field sampling with a boat-mounted electrofisher, gill nets, or trawls should normally be conducted in the summer to early fall when lipid content is generally highest in fish and water levels are low.

Permit-Support Monitoring

Permit-support monitoring is conducted to directly support a TCEQ wastewater-discharge permit action. The TCEQ identifies specific water bodies where permitting programs would benefit from additional information on water quality and quantity. This type of monitoring generally supports the development or modification of effluent limits by determining the appropriate aquatic-life use. Table 2.1 summarizes the objectives.

Use-attainability analyses (UAAs) are assessments of the physical, chemical, and biological factors affecting attainment of a use. UAAs are used to determine if existing criteria and uses described in the TSWQS are appropriate and are being maintained, or to determine causes of use or criteria not being attained. Receiving-water assessments (RWAs) are special-purpose UAAs to assess characteristics on unclassified streams, primarily to obtain data so that appropriate aquatic life uses can be assigned. Procedures for conducting UAAs, RWAs, and other biological and habitat monitoring are described

Table 2.1. Objectives for permit-support monitoring.

General Objective	Approach	Prioritizing Resources
UAA. Determine if existing designated uses and criteria are appropriate and, if not, develop designated-use or criteria-adjustment information.	Collect chemical, biological, and habitat information following prescribed protocols (TCEQ publication RG-416).	Scheduled by the WQS Development Team after review of recent monitoring data.
RWA. Determine appropriate aquatic-life use and criteria for unclassified water bodies receiving permitted discharges.	Collect biological and habitat information following prescribed protocols (TCEQ publication RG-416).	Scheduled by the WQS Implementation Team in response to permit requests.
IS. Evaluate loading from wastewater discharges.	Collect hydraulic and water quality information under low-flow conditions.	Requested by TCEQ water quality modelers.

in *SWQM Procedures, Volume 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (TCEQ publication RG-416). The manual and other associated biological monitoring documents and forms are available at the TCEQ website (see Appendix A).

Intensive Surveys are short-term studies where specific hydraulic and water quality measurements (primarily dissolved oxygen) are made under low-flow conditions over several days. These are used by the TCEQ to evaluate loading from wastewater discharges, verify TSWQS, address existing or potential special water quality problems, and document water quality after controls are implemented.

Systematic Watershed Monitoring

Systematic watershed monitoring is similar to routine monitoring but with a shorter duration (1 to 2 years) and is designed to screen waters that are not routinely monitored. Systematic monitoring has several common objectives including:

- Screening waters that would not normally be included in the routine monitoring program.
- Monitoring at sites to check the status of water bodies (improvements or concerns).
- Investigating areas of potential concern.

This type of monitoring, primarily used by CRP partner agencies, can follow either a rotating-watershed approach or an intensive watershed evaluation. Additional information on this monitoring approach appears in Task 3 of the CRP Guidance (see Appendix A). Table 2.2 summarizes systematic watershed monitoring objectives.

Selecting a Monitoring Site

It is important to consider monitoring sites that will best characterize water quality, especially when selecting sites for routine ambient fixed-station monitoring.

Special projects may include nonambient sites. Keep in mind that some types of special study data (data collected during stormwater runoff, inside the mixing zone of a wastewater discharge, during a single low-flow period, or from a single season) may be limited to very specific uses.

Table 2.2. Objectives for systematic watershed monitoring.

General Objective	Approach	Prioritizing Resources
Impairment characterization—for water bodies on the 303(d) List.	Continue monitoring to develop an adequate data set to define geographic extent and severity of the impairment.	State agencies and local stakeholders assist in determining priority.
Develop ecoregion-specific background data.	Develop an ecoregion-specific monitoring plan.	Plan developed by the TCEQ and TPWD biological workgroup.
Aquatic-life assessment. Confirm support or nonsupport of presumed aquatic-life use and criteria for unclassified water bodies not included in Appendix D of the TSWQS; identify appropriate aquatic-life use and dissolved-oxygen criteria.	Collect chemical, biological, and habitat information following prescribed protocols.	State agencies and local stakeholders assist in determining priority.
Determine statewide percentages for use support and concerns—reports to the Texas legislature and EPA.	Comprehensive probability-based or watershed monitoring plan.	10 to 30 percent of total resources for all routinely monitored parameters.
Determine the quality trend for a water body.	Develop a water body– and parameter-specific plan or continue some of the monitoring already under way.	State agencies and local stakeholders assist in determining priority.
Determine pollutant sources.	Develop watershed and parameter specific plan.	Local interest determines priority at this time *or* as part of a TMDL-initiated investigation.
Determine if existing point source controls are effective.	Conduct compliance monitoring of effluents and receiving waters.	A plan is developed from results of the assessment, compliance history, grant commitments, and relative risk to the environment.
Verify effectiveness of BMPs.	Develop a watershed- and parameter-specific plan.	As required by TMDL-implementation plans.

Site Access

Select sites where sampling can be conducted safely during most expected flow conditions.

Historical Sites

Consider historical water quality data—very useful in assessing use attainment, impairment, and the analysis of trends. Consider continued sample collection at sites that are on current or past monitoring schedules.

Water Quality

Establish more than one station for segments with very different water quality or pollution potential. This allows representative data to be collected for all parts of the segment—even for small segments.

Designated Uses

Designated uses are assigned to specific water bodies in Appendix A or D of the TSWQS. Typical designated uses include public water supply, aquatic life, contact recreation (such as swimming or wading), and human health. Consider designated uses for a segment before monitoring. For example, if attainment of the aquatic-life use is to be assessed, choose a site suitable for collecting representative fish or benthic macroinvertebrate samples. Access the TSWQS (30 TAC 307) at the TCEQ website (see Appendix A).

Note: Collect bacteriological samples at all routine monitoring sites and under all flow conditions.

Locating Representative Sites

Spatial Considerations

To evaluate compliance with the TSWQS, water quality data are reviewed station by station within classified and unclassified waters to estimate the geographical extent of use and criteria support, and to identify water quality concerns, based on the following:

- a review of existing data
- the spatial distribution of monitoring sites having the required minimum number of samples
- known sources of pollution
- the influence of tributaries and hydrological modifications
- the best professional judgment of personnel from the TCEQ and CRP partner agencies
- the intent of data collection

Streams are measured in miles, reservoirs in acres, and estuaries and oceans in square miles. A single monitoring site is considered to be representative of:

- no more than 25 miles in freshwater and tidal streams
- no more than 25 percent of the total reservoir acres or estuary square miles
- not more than 5,120 acres or 8 square miles

Major hydrological features, such as the confluence of a major tributary or an instream dam, may also limit the spatial extent of an assessment based on one station.

Sample locations in streams, and in open water bodies such as reservoirs and estuaries, should be characteristic of the main water mass or distinct hydrologic areas.

The following criteria may be considered in determining where sampling sites are needed to characterize water quality:

- All classified segments (including reservoirs) should have at least one routine monitoring site that adequately characterizes the water body.
- Segments that have very different hydrologic conditions or water quality in specific areas should have more than one station so that representative data are collected in each distinct part of a segment—even for small segments.
- Very long segments may require more stations. As a rule, stream segments from 25 through 50 miles long require two stations; those longer than 50 miles require three or

more, depending on the presence or absence of areas with significantly different sources of contamination or potential water quality concerns.

- In reservoirs, there should be stations in the major arms and near the dam and, for estuaries, in secondary and tertiary bays.
- Sites should be accessible. When possible, stream sites should have a USGS or IBWC streamflow gauge. If not, it should be possible to measure flow during routine visits.
- Because historical water quality data can be very useful in assessing use attainment, select sites that are on current or former monitoring schedules.
- The site should provide representative samples. On large rivers, specific conductance can be measured from bank to bank to determine if the stream is homogeneous and well-mixed at a proposed site. The site should also be free of backwater effects.
- At impaired sites, monitoring should take place at historical sites that best represent the impaired portion of the water body.

Type of Water Body

Select monitoring sites that best represent water quality conditions of an entire water body based on its type. A water body with varying water quality—due to things such as wastewater treatment plant discharges, significant tributary inflow, spring flow, and stormwater runoff—may require additional sites.

Rivers and streams. Locate sites so that samples can be safely collected from the centroid of flow. If few sites are available for a stream segment, choose one that would best represent the water body, and not an unusual condition or contaminant source. The *centroid* is defined as the midpoint of that portion of stream width which contains 50 percent of the total flow. Avoid backwater areas or eddies when selecting a stream site. For freshwater streams and rivers, sites must either have a streamflow gauge or be suitable for conducting flow measurement. Exceptions may be made for special studies.

Reservoirs. At a minimum, locate sites near the dam and in the major arms. Larger reservoirs might also include stations in the middle and upper (riverine) areas. Select sites that best represent the water body by avoiding coves and backwater areas.

Bays and estuaries. Locate sites that represent the segment. Stations located near freshwater inflow (rivers, streams), a connecting water body, or close to shoreline activities, or discharges from wastewater treatment plants, would not represent true conditions in a bay or estuary.

Select coastal stations so that a representative sample can be collected, regardless of the tidal cycle. Where water masses are likely to change over the tidal cycle (inlets, lower portion of tidal rivers and streams), collect samples during an outgoing tide, or just before the tide turns back. If consistently collection of representative samples at a site is not possible, then consider a new station.

Mixing Zones

A *mixing zone* is defined as the area adjacent to a wastewater discharge point where effluent mixes with the ambient surface water (TSWQS, 2010). In selecting a monitoring site, be aware that locations below effluent discharges may not accurately represent water-quality conditions of a water body and must be located outside the mixing zone.

For a specific delineation of mixing-zone boundaries, see Table 2.3.

Monitoring Below Dams

Water quality conditions created by a dam release are generally not characteristic of a water body. Monitoring sites should be located far enough downstream to be outside any area influenced by a dam release. The acceptable location will vary depending on the size of the stream and release. A low-water dam may cause turbulence only for a short distance, whereas the release from a major reservoir may influence the receiving stream for a kilometer or more. Also keep in mind whether the release is from the top or bottom of the dam. Water released from the bottom (*hypolimnion*) of a reservoir will have lower levels of dissolved oxygen (DO) than water released from the top (*epilimnion*).

Temporal Considerations

Sampling data used to characterize water quality and evaluate compliance with water quality standards must be representative of the range of temperature and flow conditions in the water body. Samples are distributed over at least two seasons (to include *inter-seasonal* variation) and over two years (to include *inter-year* variation), with some collected during the index period, March 15–Oct. 15.

Unattended 24-hour DO sampling can be year-round. The data set should not be biased toward unusual flow conditions, e.g., from drought, runoff, or season. One way to ensure temporally representative data is to collect the data routinely with the same time intervals between sampling events. Detailed information on conducting 24-hour DO monitoring appears in Chapter 3.

Requirements for biological monitoring are located in *SWQM Procedures, Volume 2* (TCEQ publication RG-416).

Data used for determining standards compliance on perennial streams must be collected when the stream is flowing above the seven-day, two-year low flow (7Q2), except when applying the acute criteria for aquatic-life use. The TSWQS define the 7Q2 as the seven-day, two-year low flow, or the lowest average streamflow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data. Samples collected on perennial streams at flow less than the 7Q2 cannot be used for assessment purposes. However, extreme low-flow sampling results contribute to the understanding of water quality changes during drought conditions and aid in long-term water-resource planning. The 7Q2 values for many stream locations are published in the TSWQS, 30 TAC 307. See "Flow Conditions for Collecting Samples," below, for additional information.

Table 2.3. Mixing-zone boundaries.

Type of Water Body	**Location of Mixing Zone**	
Perennial stream or river	30.5 m (100 ft) upstream of a discharge	91 m (300 ft) downstream of a discharge
Lake, reservoir	The typical mixing-zone radius is no greater than 30.5 m (100 ft) or half the width of the receiving water at the discharge point	
Bay, estuary, or tidal rivers—greater than 122 m (400 ft) across	The typical mixing-zone radius is no greater than 61 m (200 ft) or half the width of the receiving water at the discharge point	

Details on temporal considerations can be found in the most current version of *Guidance for Assessing and Reporting Surface Water Quality in Texas* (see Appendix A).

Generating New Monitoring Stations

Procedures for generating a new monitoring station are found in Chapter 3 of the *SWQM Data Management Reference Guide* (*SWQM DMRG*), available online (see Appendix A).

Check the list of existing stations before submitting a station location form for a new Station ID. The SLOC form and a list of existing stations, arranged by basin, can be found online—see Appendix A.

Note: Station ID numbers are not assigned sequentially. A review of the entire list may be necessary. Unclassified water bodies appear first on the list.

The *SWQM DMRG* contains detailed instructions and information necessary to complete a SLOC form. SLOC forms can be found in the *SWQM DMRG* or online (see Appendix A).

Flow Conditions for Collecting Samples

Baseline water-chemistry monitoring includes samples collected over a range of flow conditions (except metals in water). When samples are collected during abnormally high or low flow, record with each sampling any abnormal conditions in field notes and enter them as an observation when submitting the data.

Metals-in-Water Samples

Metals-in-water samples for status monitoring are not collected during periods of abnormally high turbidity. Samples collected during high turbidity are unstable with regard to soluble metals and are seldom representative. See Chapter 5 for details on monitoring metals in water.

Sediment and Tissue Samples

Methods for sediment and tissue collection generally require normal to lower flow.

Flow Data Requirements

It is important to record measured instantaneous flow, flow severity, and days since last significant rainfall for each sampling event. This information is very useful for interpreting historical data and assessing compliance with the TSWQS. For example, some standards do not apply when evaluating data taken at extremely low flows (below the 7Q2), and in some water bodies DO criteria require a discrete flow value for their determination.

The 7Q2 restrictions apply only to freshwater streams. Reservoirs, bays, estuaries, tidal streams, coastal ship channels, and the Gulf of Mexico are not subject to 7Q2 restrictions.

Flow must be measured at all routine freshwater stream–monitoring sites. A flow measurement is also required for each 24-hour DO-monitoring event and for any biological or habitat assessment activities. See Chapter 3 for detailed flow-measurement methods.

Flow estimates should not be reported in place of an actual instantaneous flow

measurement. However, flow-estimate methods may be used if no other means of flow measurement are available. Use the appropriate parameter code to report flow-estimate data. See Chapter 3 for detailed information on flow-measurement methods.

Required Equipment

See Chapter 9 for the list of basic SWQM equipment.

SWQM Internet Resources

A web page titled "Surface Water Quality Monitoring" <www.tceq.state.tx.us/compliance/monitoring/water/quality/data/wqm/mtr/> serves as a single access point for SWQM guidance documents, data-reporting forms, and data management. In addition to these essential SWQM resources there are additional reference materials available on the web. See Appendix A for Monitoring Resources on the Web.

Guidance Documents

Guidance documents include:

- *SWQM Procedures Manual, Volume 1* (TCEQ publication RG-415)
- *SWQM Procedures Manual, Volume 2* (TCEQ publication RG-416)
- *SWQM Quality Assurance Project Plan* (QAPP)
- *SWQM Data Management Reference Guide (DMRG)*

See the References for full citations.

Forms Online

The SWQM page contains links—in PDF and Word formats—to all SWQM forms used for collecting and managing surface water quality monitoring data, and guidance references for their use. The forms available include:

- biological data forms (benthic-macroinvertebrate, fish and habitat-assessment)
- field data forms and log sheets
- data-management forms and checklists

Quality Control

Various quality-control measures are required for collecting SWQM data. Specific requirements for field measurements are detailed in Chapter 3, for multiprobe instrument calibration in Chapter 8, and for water-sample collection in Chapter 5.

General QC information and SWQM-CRP requirements are outlined in Chapter 10.

Interim Method Changes

A complete revision of the SWQM manuals is done every three to five years. The looseleaf format facilitates the insertion of interim updates between full revisions. A process is in place to facilitate minor and major revisions to the manuals. Details can be found in *Procedures for Making Interim Changes to the SWQM Procedures Manuals* (see Appendix A).

Alternate SWQM Sample Collection Methods

The methods contained in this manual are required for all routinely collected surface

water quality data. Proposed changes or variations to these methods must be submitted to the TCEQ for approval. Once approved the method must be included in an approved quality assurance project plan prior to implementation. At a minimum there must be documentation showing that the revised method yields data comparable to the existing method.

Data Reporting

Appropriate procedures and parameter codes necessary for submitting data are discussed in the *SWQM DMRG*.

Minimum Data Requirements for the Assessment of Surface Waters

Information on the minimum data requirements for use in the water quality assessment required by Section 305(b) of the CWA can be found in the most current version of *Guidance for Assessing and Reporting Surface Water Quality in Texas* (see Appendix A).