

**TECHNICAL REVIEW OF WATER-QUALITY LABORATORIES
PROVIDING ANALYTICAL SERVICES FOR THE
WATER RESOURCES DIVISION OF THE U.S. GEOLOGICAL SURVEY**

by David E. Erdmann

U.S. GEOLOGICAL SURVEY

Open-File Report 91-223

Denver, Colorado
1991



U.S. DEPARTMENT OF THE INTERIOR

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ABSTRACT

Protocols for reviewing the quality assurance practices of water-quality laboratories providing analytical services for the Water Resources Division of the U.S. Geological Survey are documented. The responsibilities associated with quality assurance reviews, procedures, and records management are defined. Evaluation, method, and instrumentation forms used to obtain technical and quality assurance information about the operation of a water-quality laboratory are included.

INTRODUCTION

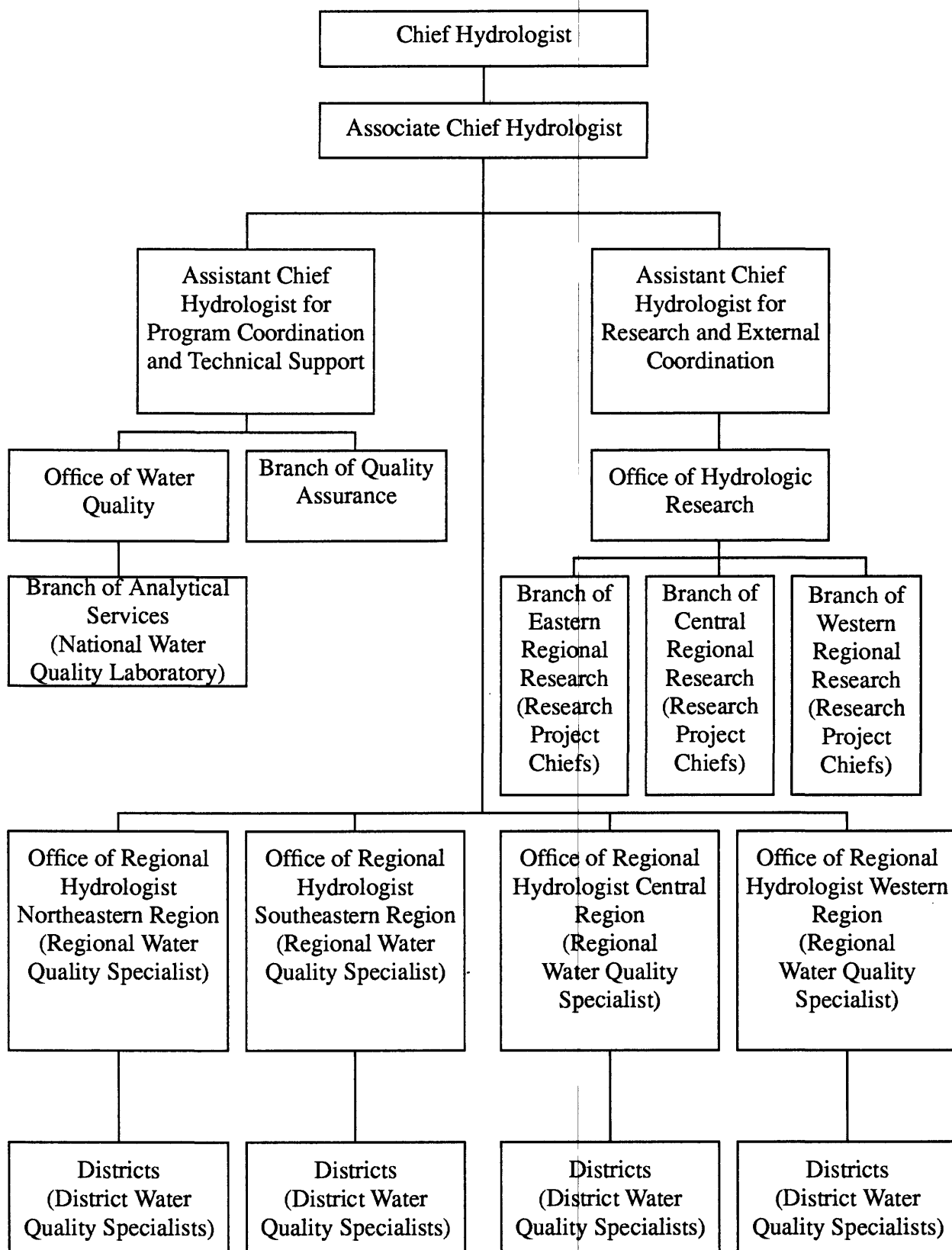
As part of the continuing effort to provide the public and local, State, and Federal agencies with accurate and precise hydrologic data, the Water Resources Division (WRD) of the U.S. Geological Survey (USGS) has established the Branch of Quality Assurance (BQA) (table 1). The primary function of the BQA is to develop protocols for the collection and analysis of accurate and precise hydrologic data. As part of this primary function, the BQA, in conjunction with the Office of Water Quality (OWQ), has the responsibility for developing protocols for reviewing the quality assurance practices of water-quality laboratories providing analytical services for the WRD of the USGS. All water-quality laboratories providing analytical data for storage in the National Water Data Storage and Retrieval System (WATSTORE) of the USGS (Hutchison, 1975) are technically reviewed by the BQA.

This report documents a formal and consistent process for technically reviewing water-quality laboratories providing analytical services for the WRD of the USGS. The responsibilities associated with technical reviews, procedures, and records management are defined. Evaluation, method, and instrumentation forms used to obtain technical and quality assurance information about the operation of a water-quality laboratory are included.

DEFINITIONS

- o National Water Quality Laboratory (NWQL)--The WRD's principal analytical laboratory (table 1) located in Arvada, Colo. This laboratory analyzes environmental samples for a variety of inorganic and organic constituents.
- o Internal laboratory--Any water-quality laboratory (other than the NWQL) being operated by WRD personnel. This category includes laboratories of personnel in the Branches of Regional Research, laboratories in District offices throughout the country, and field service units that determine field constituents, such as pH, specific conductance, and alkalinity.

Table 1.--The part of the Water Resources Division's organization applicable to this report



- o External laboratory--Any laboratory operated by non-WRD personnel. This category includes all water-quality laboratories other than the NWQL and internal laboratories; such as commercial laboratories, Geologic Division (USGS) laboratories, and cooperator (local, State, or Federal agencies) laboratories.
- o WATSTORE--The national data base of the WRD. The WATSTORE data base, located in Reston, Va., contains extensive surface-water, water-quality, and ground-water information from throughout the United States.
- o Quality assurance--All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

RESPONSIBILITIES

- o Branch of Regional Research or District personnel, usually the Research Project Chief or District Water Quality Specialist (table 1), are responsible for notifying the BQA of the scope and type of analytical services performed by internal and external laboratories; recommending laboratory technical reviews; making review arrangements with laboratories; participating in reviews; and verifying that corrective actions have been taken to correct quality assurance deficiencies as outlined in the technical report summarizing the review.
- o The WRD's Regional Water Quality Specialists (table 1--located in Reston, Va.; Atlanta, Ga.; Denver, Colo.; and Menlo Park, Calif.) are responsible for maintaining a record of internal and external laboratories providing analytical services in their Region and for recommending technical reviews of appropriate laboratories.
- o The BQA has the responsibility for compiling data pertaining to the volume and type of analytical work performed by non-NWQL laboratories; recommending laboratory technical reviews; scheduling periodic laboratory reviews; conducting reviews and formal debriefings; completing technical reports; and monitoring corrective-action programs. A list of approved laboratories, based on results from the WRD's interlaboratory Standard Reference Water Sample Program and laboratory reviews, is maintained by the BQA.

TECHNICAL-REVIEW PROCESS

Notification of Proposed Analytical Services

Prior to the use of a laboratory for water-quality analyses, Research Project Chiefs, District Water Quality Specialists, or Regional Water Quality Specialists shall notify the OWQ of the proposed analytical services required and the internal or external laboratory proposed to provide the analytical services. The BQA will, at the request of the OWQ, review the performance of the proposed laboratory using data obtained from the Standard Reference

Water Sample Program (Janzer, 1985) or from evaluation samples provided to the proposed laboratory prior to the review. The BQA will determine if the proposed laboratory can provide the analytical services, including accurate and precise data, and will notify the OWQ of its findings. The OWQ will then notify the Research Project Chief, District Water Quality Specialist, or Regional Water Quality Specialist as to the acceptability of the proposed laboratory.

Prioritization of Technical Reviews

The BQA shall select internal and external laboratories for technical review based on the following criteria:

1. Recommendations or requests from WRD personnel.
2. Volume of analytical work being performed. Information pertaining to the type and volume of analytical services from internal or external laboratories is annually provided by each District.
3. Laboratory performance as determined by results from the WRD's Standard Reference Water Sample Program. The need for an onsite technical review of a laboratory is considered urgent if the laboratory's overall performance rating for analytes determined is less than 2.4 or if low performance ratings for specific analytes have been a continuing problem or both. The performance ratings for individual analyte determinations are assigned according to the following scale:

Rating	Number of standard deviations that the value reported by the laboratory is from the most probable value
4	0.00 - 0.50
3	0.51 - 1.00
2	1.01 - 1.50
1	1.51 - 2.00
0	Greater than 2.00

4. WRD program and project needs. The frequency of technical reviews might increase if an onsite review is specified in the quality assurance plan for a specific WRD program or project.
5. The types of analyses being performed. These are considered, but are not a major factor.

Frequency of Technical Reviews

A technical review of the NWQL will be conducted annually by the BQA. For internal and external laboratories, the technical-review interval will not exceed 3 years if the cost of the analytical services provided is greater than \$100,000 per year. This technical-review interval will be lengthened to 4 years if the annual cost of the analytical services provided is between \$15,000 and \$100,000. A technical review will be conducted on request of WRD personnel if the cost of the analytical services provided is less than \$15,000 annually. The above intervals might be shortened if the volume of analytical services increases substantially, if a laboratory begins to analyze a greater variety of analytes, or if the laboratory performance, based on the Standard Reference Water Sample Program, decreases.

Preliminary Planning and Information

Laboratory technical reviews will follow a protocol in which the BQA will notify the appropriate Research Project Chief, District Water Quality Specialist, or Regional Water Quality Specialist and ask them to make arrangements with the laboratory for a suitable time for the technical review and to have the laboratory provide the BQA with the following preliminary information:

- o A copy of the laboratory's quality assurance/quality control plan.
- o A list of the relevant analytical methods in use. If the methods being used are described in detail in readily available published sources, references to the publications are sufficient. If, however, the referenced methods have been modified, are not readily available, or are unpublished, a copy of the actual method shall be provided.
- o A copy of the laboratory's organizational chart and brief resumes of key managerial and supervisory personnel.
- o Results from any recent external performance evaluation-samples that might be available.
- o A list and description of relevant major laboratory instrumentation used in providing the analytical services for the WRD.

Review of Available Data for Performance-Evaluation Samples

The BQA will review all available data for performance-evaluation samples. If such data are unavailable, incomplete, or unsatisfactory, performance-evaluation samples, if available, will be submitted to the laboratory by the BQA prior to the technical review. If such samples are submitted, analytical results are to be provided to the BQA before the technical review.

Technical-Review Team

The BQA will select the review team, usually consisting of two to three persons. It is mandatory that a member of the WRD office that is obtaining or that will obtain analytical services from the laboratory participate in the review.

Technical-Review Procedures

The review team will use the Laboratory Evaluation, Method Summary, and Laboratory Instrumentation Forms (attachments 1, 2, and 3, respectively). The reviewers will complete the Laboratory Evaluation Form during the technical review. The laboratory will provide the information requested in the Methods Summary Form and the Laboratory Instrumentation Form prior to the technical review. These forms will ensure that the following major items are considered:

1. Sample-management system.
2. Qualifications and responsibilities of major personnel.
3. Space and other physical resources.
4. Conformance of laboratory operations to quality assurance/quality control plan.
5. Analytical methods used.
6. Standard operating procedures of the laboratory.
7. Records including analysts' notebooks, quality control charts, and instrument-maintenance notebooks.
8. Types and numbers of instruments available.
9. Use of reference materials and other quality assurance samples in the laboratory.
10. Quality control checks used to verify adequacy of completed analysis.
11. Data-entry and data-review procedures.
12. External-evaluation programs in which the laboratory participates and results from these programs.
13. Safety and training procedures.

After completion of the review and while still at the laboratory, the review team will debrief laboratory managers and supervisors regarding significant findings of the review team.

Technical-Review and Corrective-Action Reports

The BQA will prepare a formal, written report within 30 days after completion of the technical review. Copies of the report will be sent to the appropriate District/Research Project Chief or Water Quality Specialist and the appropriate Regional Hydrologist. The Research Project Chief or District Water Quality Specialist, in turn, will send a copy of the report to the Director of the reviewed laboratory.

If deficiencies resulting in the production of analytical data of inadequate quality are identified during the technical review, a written response with an appropriate corrective action program will be required of the reviewed laboratory. The Research Project Chief or District Water Quality Specialist

(table 1) has the responsibility of ensuring that the corrective actions are implemented by the laboratory. The Office of Water Quality (table 1) and the BQA will provide technical assistance, as required, by the laboratory. Corrective action at the laboratory should be completed within 6 months after receipt of the technical-review report. The BQA will monitor the corrective-action program to ensure compliance.

Failure of the laboratory to satisfactorily meet minimum performance standards within 6 months will result in a notification of noncompliance being forwarded to the Assistant Chief Hydrologist for Program Coordination and Technical Support (table 1).

The BQA will maintain a file of all technical-review and corrective-action reports, applicable Standard Reference Water Sample Program reports and evaluations, and any other pertinent documents generated as part of the technical-review process for 5 years.

REFERENCES CITED

- Hutchison, N.E., 1975, WATSTORE--National water storage and retrieval system of the U.S. Geological Survey--User's guide (volume 1): U.S. Geological Survey Open-File 75-426, 565 p.
- Janzer, V.J., 1985, The use of natural waters as U.S. Geological Survey reference materials, in Taylor, J.K., and Stanley, T.W., eds., Quality assurance for environmental measurements: Philadelphia, American Society for Testing and Materials, Special Technical Publication 867, p. 319-333.

ATTACHMENTS

Attachment 1

Laboratory Evaluation Form

1. General Information

1.1 Laboratory name _____

1.2 Location _____

1.3 Director _____

1.4 Telephone number _____

1.5 Staff: Professionals _____ Technicians _____

Support personnel _____

2. Sample Volume

Approximate number of samples analyzed annually by category

(Total = total number of samples analyzed by laboratory;

USGS = number of samples analyzed in cooperation with USGS

investigations):

<u>Category</u>	<u>Total</u>	<u>USGS</u>	<u>Category</u>	<u>Total</u>	<u>USGS</u>
Major ions	_____	_____	Radiochemical	_____	_____
Trace metals	_____	_____	Stable isotopes	_____	_____
Nutrients	_____	_____	_____	_____	_____
Volatile organic					
compounds	_____	_____	_____	_____	_____
Pesticides	_____	_____	_____	_____	_____
Base/neutral and acid					
extractable					
compounds	_____	_____	_____	_____	_____
Biological	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

3. Methods, Calibration Ranges, and References

See Method Summary Form. This usually will be completed by laboratory personnel prior to the technical review.

Date Method Summary Form received _____

4. Laboratory Quality Assurance Plan. A copy of the laboratory quality assurance plan is to be provided to the review team by laboratory personnel prior to the technical review.

Date laboratory quality assurance plan received _____

5. Major Laboratory Equipment

See Laboratory Instrumentation Form. This usually will be completed by laboratory personnel prior to the technical review.

Date Laboratory Instrumentation Form received _____

6. Laboratory Staff

Yes No Reference¹

6.1 Resumé of key individuals available

6.2 Key individuals qualified

6.3 Staffing appropriate for workload

7. Laboratory Facilities

Yes No Reference¹

7.1 Facilities adequate for analytical
services offered

7.2 Laboratory airflow, temperature,
and circulation adequate

7.3 Space clean and well organized

7.4	Hoods:	Yes	No	Reference ¹
7.4.1	Adequate space	_____	_____	_____
7.4.2	Adequate airflow	_____	_____	_____
7.4.3	Airflow regularly checked	_____	_____	_____
7.4.4	Used as storage area	_____	_____	_____
7.5	Safety program:	Yes	No	Reference ¹
7.5.1	Safety plan available	_____	_____	_____
7.5.2	Safety officer designated	_____	_____	_____
7.5.3	Safety goggles used	_____	_____	_____
7.5.4	Safety showers available	_____	_____	_____
7.5.5	Eye-wash stations available	_____	_____	_____
7.5.6	Fire extinguishers available	_____	_____	_____
7.5.7	Chemicals properly stored	_____	_____	_____
8.	<u>Sample-Management System</u>	Yes	No	Reference ¹
8.1	Computerized sample-management system used	_____	_____	_____
8.2	Samples logged in promptly	_____	_____	_____
8.3	Samples analyzed, digested, or extracted within recommended holding times	_____	_____	_____
8.4	Storage facilities for samples and sample extracts adequate	Yes	No	Reference ¹
8.5	Chain-of-custody program:	_____	_____	_____
8.5.1	Required	_____	_____	_____
8.5.2	In place	_____	_____	_____
8.5.3	Effective	_____	_____	_____

9. <u>Quality Assurance Program</u>	Yes	No	Reference ¹
9.1 Quality assurance plan satisfactory	_____	_____	_____
9.2 Laboratory conformance to quality assurance plan satisfactory	_____	_____	_____
9.3 Quality assurance plan available to laboratory personnel	_____	_____	_____
9.4 Quality assurance officer on staff	_____	_____	_____
9.5 Quality assurance officer reports to laboratory management	_____	_____	_____
9.6 In-house quality assurance evaluation conducted at least annually	_____	_____	_____
9.7 Employees aware of quality assurance responsibilities	_____	_____	_____
9.8 Methods manual(s) available to analysts	_____	_____	_____
9.9 Methods manual(s) being followed	_____	_____	_____
9.10 Written protocol established and followed for approving or modifying methods	_____	_____	_____
9.11 Records kept of method changes	_____	_____	_____
9.12 Standard operating procedures for tests and procedures available	_____	_____	_____
9.13 System for corrective actions in place	_____	_____	_____

10.	<u>Calibration Procedures</u>	Yes	No	Reference ¹
10.1	Calibration standards traceable to National Institute of Standards and Technology or certified by supplier	_____	_____	_____
10.2	Calibration process adequate	_____	_____	_____
10.3	Procedure for determining acceptability of calibration process defined	_____	_____	_____
10.4	Calibration process verified by reference material or independent standard	_____	_____	_____
10.5	Analytical system monitored during analysis	_____	_____	_____
10.6	Newly prepared standards compared to previously prepared standards	_____	_____	_____
10.7	Records kept of:			
	10.7.1 Calibration data	_____	_____	_____
	10.7.2 Standard preparations	_____	_____	_____

11.	<u>Quality Assurance Materials</u>	Yes	No	Reference ¹
11.1	Reference materials used	_____	_____	_____
11.2	Surrogates used	_____	_____	_____
11.3	Blanks used	_____	_____	_____
11.4	Duplicate samples used	_____	_____	_____
11.5	Spiked samples used	_____	_____	_____
11.6	Quality control charts with defined limits used	_____	_____	_____
11.7	Corrective-action steps defined and followed for out-of-control conditions	_____	_____	_____
11.8	Quality assurance/quality control summaries prepared regularly	_____	_____	_____
11.9	Analysts responsible for data entry on quality control charts	_____	_____	_____
11.10	Quality control charts reviewed by appropriate person	_____	_____	_____
12.	<u>Data Entry and Verification</u>	Yes	No	Reference ¹
12.1	Data approved by supervisor. or designee	_____	_____	_____
12.2	Data-entry verified	_____	_____	_____
12.3	Data receive final quality control checks before release	_____	_____	_____
12.4	System established for reanalysis of samples	_____	_____	_____

13.	<u>General Laboratory Protocols</u>	Yes	No	Reference ¹
13.1	Schedules established for instrument maintenance	_____	_____	_____
13.2	Maintenance performed and documented	_____	_____	_____
13.3	Service contracts available for instruments	_____	_____	_____
13.4	Balances serviced within 1 year by a certified technician	_____	_____	_____
13.5	Balances regularly checked with class S weights	_____	_____	_____
13.6	Temperature of following units checked daily and recorded:			
	13.6.1 Refrigerators	_____	_____	_____
	13.6.2 Freezers	_____	_____	_____
	13.6.3 Ovens	_____	_____	_____
13.7	Purity of water satisfactory	_____	_____	_____
13.8	Purity of water checked regularly	_____	_____	_____
13.9	Reagent preparations properly labelled	_____	_____	_____
13.10	Reagents properly stored and dated	_____	_____	_____
13.11	Sample bottles, preservatives, and other supplies quality assured	_____	_____	_____

14.	<u>Training and Safety</u>	Yes	No	Reference ¹
14.1	Written training plan available	_____	_____	_____
14.2	Training documentation available	_____	_____	_____
14.3	Appropriate individuals perform training	_____	_____	_____
14.4	Written safety plan available	_____	_____	_____
14.5	Personnel involved in safety program	_____	_____	_____
15.	<u>Records</u>	Yes	No	Reference ¹
15.1	Systematic and proper protocol established for laboratory records	_____	_____	_____
15.2	Records easily understood	_____	_____	_____
15.3	Records regularly reviewed and approved	_____	_____	_____
15.4	System established for record storage, retrieval, and disposal	_____	_____	_____
16.	<u>External Performance Evaluation Program</u>	Yes	No	Reference ¹
16.1	Laboratory participates in evaluation programs of:			
16.1.1	U.S. Geological Survey	_____	_____	_____
16.1.2	U.S. Environmental Protection Agency	_____	_____	_____
16.1.3	Other _____	_____	_____	_____
16.2	Results satisfactory	_____	_____	_____
16.3	Pre-review evaluation samples sent	_____	_____	_____
16.4	Results satisfactory	_____	_____	_____

17.	<u>Contract Laboratories</u>	Yes	No	Reference ¹
17.1	Contract laboratories used	_____	_____	_____
17.2	Contract-laboratory quality			
	assurance programs equivalent to			
	guidelines of own laboratory	_____	_____	_____

¹Reference refers to applicable page number(s) of appropriate section in the technical-review report addressing that specific topic.

Method Summary Form

Date _____

DETER-	METHOD NAME	INSTRUMENT	CALIBRATION	
<u>MINATION</u>	<u>OR SOURCE</u>	<u>USED</u>	<u>RANGE</u>	<u>REFERENCE</u> ¹

18

Laboratory Instrumentation Form

Date _____

Item

Model

No.

Age[illegible]