AN ASSESSMENT OF THE COLLECTION AND ANALYSIS OF HYDROLOGIC DATA BY PRIVATE CONTRACTORS FOR THE U.S. GEOLOGICAL SURVEY

By F. A. Kilpatrick, A. Condes de la Torre, and R. D. Hutchinson

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 83-4104

UNITED STATES DEPARTMENT OF THE INTERIOR

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An Assessment of the Collection and Analysis of Hydrologic Data by Private Contractors for the U.S. Geological Survey

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ABSTRACT

During fiscal years 1978 through 1981, the U.S. Geological Survey contracted for the acquisition and analysis of hydrologic data from 104 surface water stations, 26 ground water stations, and 15 precipitation gages as well as for several hundred miscellaneous surface water measurements of flow and water quality. The work was performed in Montana, North Dakota, Wyoming, Utah, New Mexico, and Oklahoma, terminating at the end of fiscal year 1981. This report is an assessment of this contracting effort from the standpoint of cost and of the quality control measures employed to ensure an acceptable product.

For the entire period, costs to perform the work by outside contractor were approximately 55 percent greater than the estimated in-house cost. This dropped to 33 percent in fiscal year (FY) 1981 due possibly to greater contractor experience, operation of the maximum number of stations, and the fact that all work was performed by a single contractor in the last year. Inclusion of the U.S. Geological Survey District quality control costs into the total cost of the contractor effort escalated the average increase for the period to 120 percent; 84 percent for the final year.

The quality of the contractor's work was judged to be good. Measures taken to ensure a successful contractor effort were: (1) careful selection of qualified contractors by use of a negotiated procurement type contract whereby selections are based on an evaluation criteria as well as cost; (2) precise and detailed specifications; (3) classroom and on-the-job training of contractor personnel; (4) supply and maintenance of hydrologic equipment by the Survey; (5) field inspections and check measurements by Survey hydrologists; and (6) close coordination between contractor and Survey personnel in analyzing and processing data; and (7) adherence to absolute uniformity between the contractor and the Survey in equipment and techniques.

INTRODUCTION

Starting in fiscal year (FY) 1977, the Water Resources Division (WRD) of of the U.S. Geological Survey (USGS) was provided $1.8 million to acquire hydrologic data in the major coal lease areas of Montana, North Dakota, Wyoming, Utah, New Mexico, and Oklahoma. Four personnel positions were provided, with two being assigned to the Administrative Division to manage the additional contracting work that was anticipated. Because of the lack of positions, the decision was made to contract for the data collection; a first of this magnitude for the USGS. This report is a review and analysis of this effort and covers:

- Preparation of specifications
- Evaluation of bids
- Quality control measures
- Cost comparisons
- Product quality
- Summary and recommendations

Philosophy

Acquisition and analysis of hydrologic data has long been considered a mainstay of the USGS and an area of extensive competence. The Geological Survey has a reputation for accurate and reliable hydrologic data. Of considerable concern was the maintenance of quality control in any contractor operated basic data collection program. It was concluded that five major measures should to be undertaken to assure quality control. They were:

1. Detailed specifications that clearly define the work, and the techniques and standards to be used in performing the work.

2. Training of contractor personnel, both formal and on-the-job in techniques acceptable to the USGS.

3. Supply and maintenance of USGS hydrologic measuring equipment and instrumentation to the contractor.

4. Check measurements and station inspections by USGS field hydrologists.

5. Close coordination and interfacing of contractor and USGS District hydrologists in analyzing and processing of data.

Study Area and Scope of Work

Figure 1 shows the areas where work was contracted as well as the type and extent. All aspects of hydrologic data collection were undertaken to include measurements of:

- o Surface-water quantity
- o Surface-water quality
- o Surface-water sediment
- o Ground-water levels
- o Ground-water quality
- o Surface-water gain/loss of discharge and water quality
- o Precipitation measurements

The hydrologic data collection sites shown in figure 1 are those operated during the 1978-1981 fiscal years. The work in Montana was dropped at the end of FY 1980; because of a drastic Federal budget reduction, all contracting was terminated at the end of FY 1981.

As can be seen, the contracted work covered a wide area--so large that small contractors would be discouraged from undertaking the work if not presented and made available in smaller work units. Therefore, the work was awarded in several contracts rather than as one large contract. Table 1 shows the actual breakdown of the work by States and years.

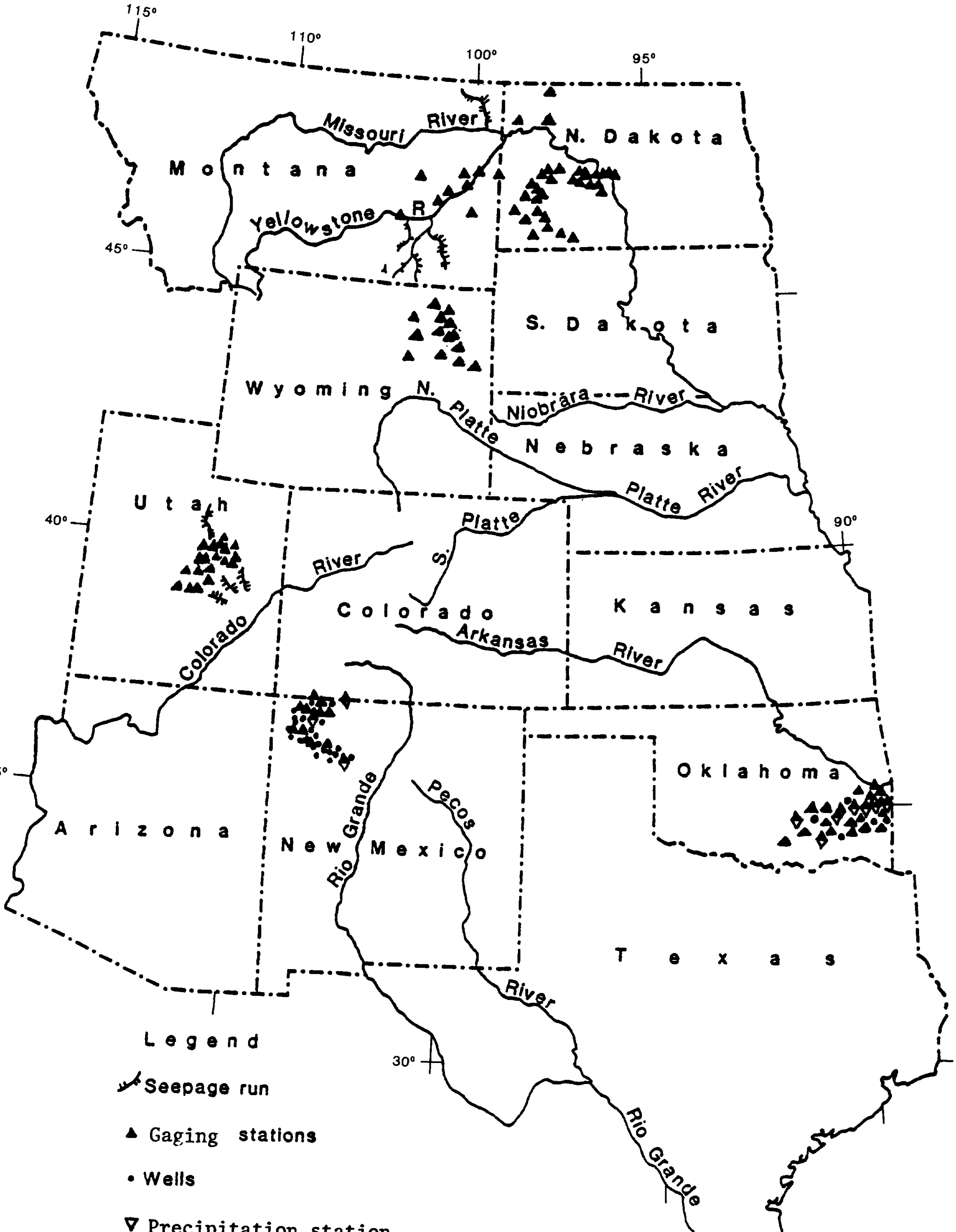


Figure 1. Location map for hydrologic data collection

Table 1. Summary of contractor operated data stations.

Contract Area	Surface-Water Quantity	Surface-Water Quality	Surface-Water Sediment	Ground-Water Levels	Ground-Water Quality	Surface-Water Gain/Loss Sites Quantity	Surface-Water Gain/Loss Sites Quality	Special Equipment
Montana								
1978	2	8	8	0	0	160	112	
1979	1	7	7	0	0	59	28	
1980	1	7	7	0	0	37	17	
1981	0	0	0	0	0	0	0	
New Mexico								
1978	12	12	12	15	15	0	0	
1979	12	12	12	15	15	0	0	
1980	12	12	12	15	15	0	0	
1981	13	13	13	21	17	0	0	3 precipitation gages; 3 automatic sediment samplers
North Dakota								
1978	23	23	23	0	0	0	0	
1979	30	30	30	0	0	0	0	
1980	33	33	33	0	0	0	0	
1981	33	33	33	0	0	0	0	
Wyoming								
1978	11	11	11	0	0	0	0	
1979	11	11	11	0	0	0	0	
1980	13	13	13	0	0	0	0	
1981	14	14	14	0	0	0	0	2 automatic sediment samplers
Oklahoma								
1978	0	0	0	0	0	0	0	
1980	12	12	12	0	0	0	0	
1981	13	13	13	0	0	0	0	
1982	26	25	25	5	0	0	0	12 precipitation gages; 10 automatic sediment samplers
Utah								
1978	0	0	0	0	0	0	0	
1979	12	12	12	0	0	52	13	
1980	15	15	15	0	0	56	0	
1981	18	19	19	0	0	74	0	
Totals								
1978	48	54	54	15	15	160	112	
1979	78	84	84	15	15	111	41	
1980	87	93	93	15	15	93	17	
1981	104	104	104	26	17	74	0	15 precipitation gages; 15 automatic sediment samplers

QUALITY CONTROL MEASURES

Detailed Specifications

A review of past USGS contracts dealing with services and the complexity of basic hydrologic data collection and analysis revealed conclusively the necessity for very precise and detailed specifications to define the data to be collected, frequency of collection, and method of collection and analysis. Good specifications are essential to good performance; hence, they are an important factor in quality control. Complete specifications provide:

1. The contractor with the exact workload required to do the job so that he can more accurately bid for the work. If workload requirements are not clear, the contractor must add an "ignorance" factor to his price which may be detrimental to the best interests of the Government as well as to his successful bidding. He may under-bid only to find out later that he cannot really live up to the contract; again detrimental to both the contractor and the Government.

2. A clear basis for requiring performance by the contractor. Poorly defined work requirements may be expected to result in poor performance with little recourse by the Government but to improve the specifications the next time.

The specifications described in detail the operation and maintenance of gaging stations, collection of streamflow discharge, correlation of streamflow and stage data, computation of daily discharge values, field measurement of selected water quality parameters, field collection of water samples for chemical, biological, and sediment analysis, and in some contract areas the field measurement of ground water levels. In addition, special project requirements were included to promote successful management of the contract. A work schedule submitted to the Government in advance for each months work was required. Quarterly progress reports, in table form to reduce paperwork, were specified. Qualification requirements of the contractors' personnel were also defined. The detailed specifications for the work in Oklahoma are presented as Appendix A. Appendix A is complete except that repetitious location maps and station listings have been omitted as well as general instructions to bidders.

Training of Contractor Personnel

One of the factors in the evaluation of the bids is the education and experience level of the prospective contractor's personnel. While this is very important in evaluating bidders, very few consulting engineering firms were found to have engineering and technican level personnel with training specific to the work involved. It was therefore to the best interests of the USGS to provide both classroom and on-the-job training in the various techniques and the use of equipment in performing field data collection and limited data analysis. The availability of such training was made an option in the specifications, whereby a week of classroom training was provided at the Survey's Denver Training Center at Government expense, excluding travel and subsistance costs of the contractors' personnel. The training both in the classroom and field featured the following:

- o Operation of continous record gaging stations.
- o Performance of current meter discharge measurements.
- o Processing and analysis of data to include development of rating curves.
- o Coding of data for computer input.
- o Operation of crest stage gages.
- o Field measurement of water quality and use of related equipment.
- o Sampling, preservation, and shipment of water quality, biological and radiochemical samples to the USGS Denver Laboratory.
- o Collection and processing of sediment samples.
- o Ground-water field techniques and data analysis.
- o Operation of precipitation measuring equipment.

Numerous new gaging stations were installed as a result of this program. These were constructed prior to being turned over to the contractors, but were not instrumented. As a part of the on-the-job training, they were instrumented jointly by Survey and contractor personnel. At the same time, Survey hydrologists observed and taught contractor personnel in the performance of discharge and water quality measurements. Where new gaging stations were required, the specification called for the contractor to furnish two-man days per station for instrumentation and on-the-job training. As each station was completed, it was inventoried and equipment signed for by the contractor.

Follow-up training was provided during routine inspection trips and as a result of the contractor working with the USGS Technical Officer (TO) assigned from each USGS District. In reality, the contractor functioned like a subdistrict or field office of the USGS.

Provision and Maintenance of Hydrologic Equipment

It was recognized that most consulting firms would not and could not be expected to maintain an inventory of field equipment necessary to carry out and sustain a regular hydrologic data collection program of this magnitude. Furthermore, the initial costs of acquiring such equipment might discourage an otherwise competent contractor from considering the work which could not be guaranteed for more than a year at a time. Some contractors were also found to have equipment not acceptable to the USGS. It was concluded than an important quality control measure was the use of good equipment that is well maintained. Thus, the USGS elected to supply and service all equipment installed in the gaging stations as well as in use for field measurements. Field equipment was supplied in proportion to the workload detailed in the specifications. A comprehensive list of equipment for one contract is shown as Part VI in Appendix A and is part of the specifications. In addition to signing for gaging station equipment as each station was inventoried, the contractor signed and was held responsible for all other Government furnished equipment.

Equipment repair and station maintenance could be expected to be an unknown cost for which a prospective bidder would have uncertainty in pricing; uncertainty might produce higher bids or poor maintenance if the successful bidder found actual costs excessive. Thus, an additional quality control measure was the USGS specifying its responsibility for equipment and major station maintenance. Routine station maintenance was specified as the responsibility of the contractor to include regular yearly datum check leveling surveys.

Field Inspections and Verifications

An additional quality control measure consisted of periodic and unscheduled field inspections by USGS hydrologists; either the District TO or his designated representative. This consisted of check discharge and water quality measurements as well as examination of station equipment for proper operation and maintenance. Field inspections were made of each station on an as needed basis, being reduced in succeeding years as the competence of the contractor was demonstrated.

Interfacing with Districts and Laboratories

In effect, the contractor's operation was designed to function similar to a subdistrict or field office: operating a set number of gaging stations and preparing data for input to the Survey computer system. Similarly, water quality samples were shipped to one of the Survey's Central Laboratories at Government expense. The cost of the laboratory analysis was borne by each USGS District and funds were provided to each District based on the specified workload. Consideration was given to the contractor analysis of water quality samples. However, analysis of water samples by the USGS assured quality control and eliminated the uncertainty of laboratory costs to the contractor.

KEY FEATURES OF CONTRACTS

Evaluation of Contract Proposals

The contract type used was a negotiated procurement. The negotiated contract provided more flexibility than a formally advertised contract. In a formally advertised contract the award is made to the lowest responsible and responsive bidder. In a negotiated procurement the contractor who is responsible and responsive can be selected on the basis of criteria determined to be in the best interest of the Government. The evaluation criteria are stated in the solicitation, and the potential contractors are asked to address the stated criteria with their qualifications and experience.

For the data collection contract, the solicitation contained the following evaluation criteria and the points (designating importance) obtainable in each category:

1.	Experience in hydrologic data collection:	
	Streamflow data collection	15
	Water-quality data collection	15
2.	Management capabilities of firm--ability to manage and perform all tasks in a contract of this magnitude and complexity	20
3.	Qualifications of personnel assigned to this contract --including experience in hydrologic data collection	25
4.	Completeness of proposal and contractor's demonstrated understanding in his proposal response of the scope of work and solution approach thereto	15
5.	Ability to complete work on time	10
	TOTAL	100

A four-person committee was formed consisting of USGS professional personnel experienced in hydrologic data collection and analysis. Their job was to perform a technical evaluation of the proposals received in response to the solicitation.

The proposals were submitted to the USGS Procurement Office by interested contractors in two parts--a technical proposal and a price proposal. The Contracting Officer in the Procurement Office separated the price proposals from the technical proposals and forwarded only the technical portion to the four-person technical evaluation committee.

A rating form was developed for use by the technical evaluation committee (figure 2). Each member of the committee reviewed each proposal and completed a rating form for each contractor's proposal. Comments on the strong and weak points of each contractor's proposal were written on the back of the form. After each member had rated the proposals, each proposal was discussed and an agreement was reached on the committee rating to be given to each contractor. A summary of the findings and ratings of the technical evaluation committee was prepared, and a cutoff point value was determined below which a contractor's proposal would be considered technically unacceptable. A summary report was written describing the ratings and was submitted to the Procurement Office. The Contracting Officer then reviewed the prices only for those contractors whose proposals had been found technically acceptable. Price was not considered for those found technically unacceptable. The Contracting Officer then prepared a list of those contractors whose proposals had been found technically acceptable showing the prices submitted and stating that an award would be made to the contractor with the lowest price unless it was in the best interest of the Government to award to another contractor with a higher price based on technical merit. To award to other than the lowest price offer, the technical evaluation committee had to justify--based on the point differential and descriptions given in the technical evaluation--why paying the difference in price which would result from awarding to other than the low price offer would be in the best interest of the Government. Although difficult, this has been done when the technical capabilities and probability of success of one contractor was far superior to that of the low offeror although both had been determined technically acceptable. When the technical evaluation committee was satisfied with the contractor with the low price offer, they recommended an award be made.

Specifications

The specifications for the collection and processing of hydrologic data in Oklahoma are listed in Appendix A. Similar specifications, tailored to the work, were prepared for the other areas. The specifications for Oklahoma are presented here because they are the most complete set covering the major work requirements for the collection and processing of surface water flow, quality and sediment data as well as for the acquisition of ground water and precipitation data. Examination of this set of specifications will reveal the considerable detail provided as to methods and techniques which are necessary if prospective bidders are to accurately price the work and the Government is to exercise control over products received. It is important to emphasize that such detail is necessary if the prospective contractor is expected to bid intelligently on the work as well as to perform the work in a manner acceptable to the Survey.

RFP No. ____________

Date ____________

Firm ____________

Total Score ____________

STATE ____________

Remarks: ____________

	Check if Covered	Points in Category	No Data (0)	Unsat. (0)	Poor (20)	Average (60)	Good (80)	Excellent (100)	Sub Total	Total Points
1. Experience in Hydrologic Data Collection		30								
A. Streamflow Data Collection Experience		15								
1. Company presently involved in streamflow data collection		3								
2. Company previously involved in streamflow data collection		3								
3. Personnel available experienced streamflow data collection		6								
4. Degree of related experience		3								
B. Water Quality Data Collection Experience		15								
1. Company presently involved in W.Q.D.C.		3								
2. Company previously involved in W.Q.D.C.		3								
3. Personnel available experienced in W.Q.D.C.		6								
4. Degree of related experience		3								
2. Management Capabilities of Firm		20								
A. Previous Experience In Related Work		15								
1. Technical jobs of similar magnitude completed successfully		10								
a. Specific examples of jobs given?										
b. Were schedule commitments met?										
c. Past performance satisfactory?										
2. Jobs in hydrology completed successfully		5								
a. Specific examples of jobs given?										
b. Were schedule commitments met?										
c. Past performance satisfactory?										
B. Proposed Management Plan		5								
1. Are the right types of management people being utilized?										
2. Will a special management group be formed for this project or will there be organization-wide participation?										
3. Is it clearly shown how project management will operate on a day to day basis?										
3. Personnel Assigned to this Contract		25								
A. Administrative Personnel		5								
1. Biographies (including education).										
2. Management capabilities indicated.										
3. Capability to handle job of this size shown.										
B. Professional Staff		10								
1. Biographies (including education).										
2. General Experience indicated										
3. Are qualifications shown adequate for this job?										
C. Technicians		5								
1. Biographies (including education).										
2. Do they have adequate technical experience?										
3. Have they had any experience in hydrologic data collection?										
4. Is the experience they've had directly relate?										

"Check if Covered" Column

O Not Covered

✓ Covered

X Unsatisfactory

	Check if Covered	Points in Category	No Data (0)	Unsat. (0)	Poor (20)	Average (60)	Good (80)	Excellent (100)	Sub Total	Total Points
D. Depth of Staff		5								
1. Does proposal show a depth of personnel?										
2. Are the right types of people being utilized?										
3. Is the availability of specific people clearly detailed?										
4. Completeness of Proposal										
A. Discussion of Surface Water Work										
1. Are technical problems clearly delineated (such as rating definition)?										
2. Does proposal address problem of access and travel?										
3. Does proposal address human and environmental problems involved in the data collection?										
4. Does proposal indicate understanding of high flow measurement requirement?										
5. Does proposal acknowledge responsibility and understanding of record computation?										
6. Does proposal discuss gaging station maintenance?										
B. Discussion of Water Quality Work		5								
1. Does proposal indicate understanding of field measurement requirement?										
2. Does proposal indicate understanding of coliform analysis?										
3. Does proposal discuss problem of mailing samples to Central Lab?										
4. Does proposal acknowledge responsibility for imputing field data to computer?										
5. Does proposal acknowledge responsibility for review and updating of laboratory results?										
C. Clarity of Proposed Procedure and Logical Presentation		5								
1. Does the proposal make an accurate assessment of the requirements set forth in the Statement of Work?										
2. Is the proposal clear and concise on the technical requirements?										
3. Does technical discussion show recognition and understanding of all problems and requirements?										
4. Is proposal approach logical?										
5. Ability to Complete Work		10								
A. Does Proposer Have the Personnel, Facilities, and Equipment Required to do this Work?										
B. Are Proposed Field Offices Logically Located and Staffed to Accomplish Work Effectively?										
C. Is Proposed Work Schedule Realistic?										
Summary										
(30) Experience in Hydrologic Data Collection										
(20) Management Capabilities										
(25) Personnel Assigned										
(15) Completeness of Proposal										
(10) Ability to Complete Work										
(100) Total										

Figure 2. Form used in technical evaluation of contractor's proposals.

Data Collection Calendars

One of the most difficult aspects of preparing specifications for hydrologic data collection is the variability of and uncertainty associated with the occurrence of hydrologic phenomena. While total flexibility to collect data as needed would be preferred, it is necessary to compromise and attempt to quantify the workload requirements.

An example of a Data Collection Requirements and Calendar form for two of the 13 surface water gaging stations that comprised the Oklahoma contract is shown in figure 3. In the manner depicted, the contractor is told the types and frequency of the data that are to be collected. At the same time, the flexibility to obtain more frequent data during high runoff periods such as March, April, and May is provided. Consideration was given to providing a bonus system for data collected on weekends and holidays with the occurrence of floods. This was not found necessary but might be given future consideration.

Station Descriptions

Essential to the specifications is complete descriptions of where the work is to be performed. Figures 4 and 5 are examples of narrative job locations and map descriptions, respectively, for gaging station; ground-water well and precipitation stations. These are identified by station number and keyed to the work requirements calendar discussed above.

COMPARISON OF COSTS

An analysis of the comparative costs of acquiring hydrologic data by a contractor or by the U.S. Geological Survey must be based on the same scope of work and include all identifiable costs. Under rigid cost-analysis procedures, start-up costs are a valid expense of the Government. These costs are excluded from this report, however, because they are for reusable products (specifications and equipment) or the expenses would have been the same whether or not the work was contracted. The start-up costs which were excluded are:

- Preparation of contract documents and selection of contractors.
- Technical equipment provided to contractor, including shipping.
- Construction of gaging stations.
- Orientation and initial training of contractor's staff.

Operational costs of the USGS for laboratory analyses, computer services, and manuscript publication are also excluded from this cost comparison because these activities are beyond the scope of the contracts.

ATTACHMENT 3 DATA COLLECTION REQUIREMENTS AND CALENDAR FOR *Oklahoma*

The contractor shall collect the data required at the gage sites identified below by station numbers in accordance with the indicated schedule.

STATIONS: 07246615

07247550

Data Required	Laboratory Schedule	Frequency – Month												Remarks
		O	N	D	J	F	M	A	M	J	J	A	S	
1. Station Inspection		2	2	2	2	2	2	←	8	→	2	2	2	
2. Discharge Measurement		1	1	1	1	1	1	←	8	→	1	1	2	
3. Digital Tape Removal		1	1	1	1	1	1	1	1	1	1	1	1	
4. Field Determinations: a. Water and Air Temperature b. Specific Conductance c. pH and Dissolved Oxygen d. Alkalinity/Acidity[b]		←					d						→	
5. Chemical: a. Major Constituents	425	1	1	1	1	1	1	1	1	1	1	1	1	
b. Nutrients	426	1		1		1		1		1		1		
c. Minor Constituents – Dissolved	1076	1		1		1		1		1		1		
d. Minor Constituents – Total	1176	1		1		1		1		1		1		
e. Emission Spectrograph – Dissolved	1090					NONE								
f. Bottom Material	1292				ONCE A YEAR @ LOW FLOW									
g. Phenols	LC0052					NONE								
h. Cyanide	LC0023					NONE								
i. Barrum, Lithium, Strontium	427	1						1						
6. Sediment: a. Suspended, Concentration		←					d						→	g
b. Suspended, Size c. Bed Size									2				1	f
d. Coal Separation[b]	LC1038				ONCE A YEAR @ LOW FLOW									
7. Biological: a. Phytoplankton	1706		1			1			1			1		
b. Periphyton	1708		1			1			1			1		
8. Radiochemical	1405				ONCE A YEAR @ LOW FLOW									

General: Discharge measurements will be made using current-meter or other acceptable direct methods; number indicates number of measurements required for period shown; observence of zero flow constitutes a measurement. Where more than one measurement or sample is indicated per period it is desired that to the best of the contractor's ability these be made during a flood or above average runoff. These frequencies shown are based on the Survey's best estimate of the months when major runoff may be expected. When it is impossible to estimate when major runoff may be expected the additional visits shown under "Remarks" are to be made in an effort to define the relation of discharge to stage, sediment and chemical quality throughout the range of discharge during the year. Frequencies shown will apply for succeeding years unless otherwise modified.

[a] Acidity should be determined only when field measured pH of a sample is less than 7.0

[b] On bottom material at low flow only. Samples are to be wet sieved in the field to pass a 2.00 mm sieve but not to pass a 0.06 mm sieve.

[c] Water Quality Field Determinations will be made at the time of each discharge measurement as well as samples obtained for sediment concentration.

[d] Three samples during period – one at high flow caused by snowmelt, one at high flow caused by rainfall, and one at low flow – each concurrent with other highflow, major, and suspended concentration samples.

[e] Two samples during period – 1 at high flow caused by snowmelt and 1 when runoff is due to rainfall concurrent with sampling for minor constituents.

[f] If no flow, obtain samples during remaining part of year to provide at least ___ per year.

[g] Automatic sediment sampler (PS-69) installed requiring servicing by the contractor once every ___ days during normal flow conditions and after each runoff exceeding ___ hours duration.

Figure 3. Data collection requirements and calendar form.

JOB LOCATIONS
Streamflow Stations

07232010 Blue Creek near Blocker, OK, Lat 34°02'26", long 95°34'21", in SW ¼, NW ¼, sec. 36, T.7N., R.16E., Pittsburg County, Hydrologic Unit 11090204, on right bank at downstream side of bridge on State Highway 31, 1.5 mi south of Blocker, and at mile 3.9.

07232008 Blue Creek Tributary near Blocker, OK, Lat 35°02'25", long 95°34'15", NE ¼, NW ¼, sec. 36, T.7N., R.16E., Pittsburg County, Hydrologic Unit 11090204, approximately 400 feet east of State Highway 31 bridge along Blue Creek, 1.5 mi south of Blocker, and at mouth.

JOB LOCATIONS
Groundwater-Level Stations

Blocker area:

350241095341101, local number 07N-16E-25C CDC1, Hydrologic Unit 11090204, Pitsburg County, 0.35 mi north of streamflow gage on State Highway 31 and 1.15 mi south of Blocker, in borrow ditch on west side of highway.

Panama area:

351122094403901, local number 08N-25E-04 CDC1, Hydrologic Unit 11110105, LeFlore County, on State Highway 31 0.3 mi west of junction of State Highway 31 with U.S. Highway 59 and 271 and one mi north of Panama, about 50 feet south of road.

JOB LOCATIONS
Precipitation Stations

Blue Creek Watershed:

350218095315301, local number 07N-17E-32 ACA1, Hydrologic Unit 11090204, Pittsburg County, 0.6 mi south out of Blocker along State Highway 31 and 2.6 mi east along dirt road; about 75 feet east of gas well.

350306095340101, local number 07N-16E-25 ACA1, Hydrologic Unit 11090204, Pittsburg County, 0.6 mi south out of Blocker along State High 31 and 0.1 mi east along dirt road; about 50 feet on north side of road.

Figure 4. Typical narrative descriptions of job locations.

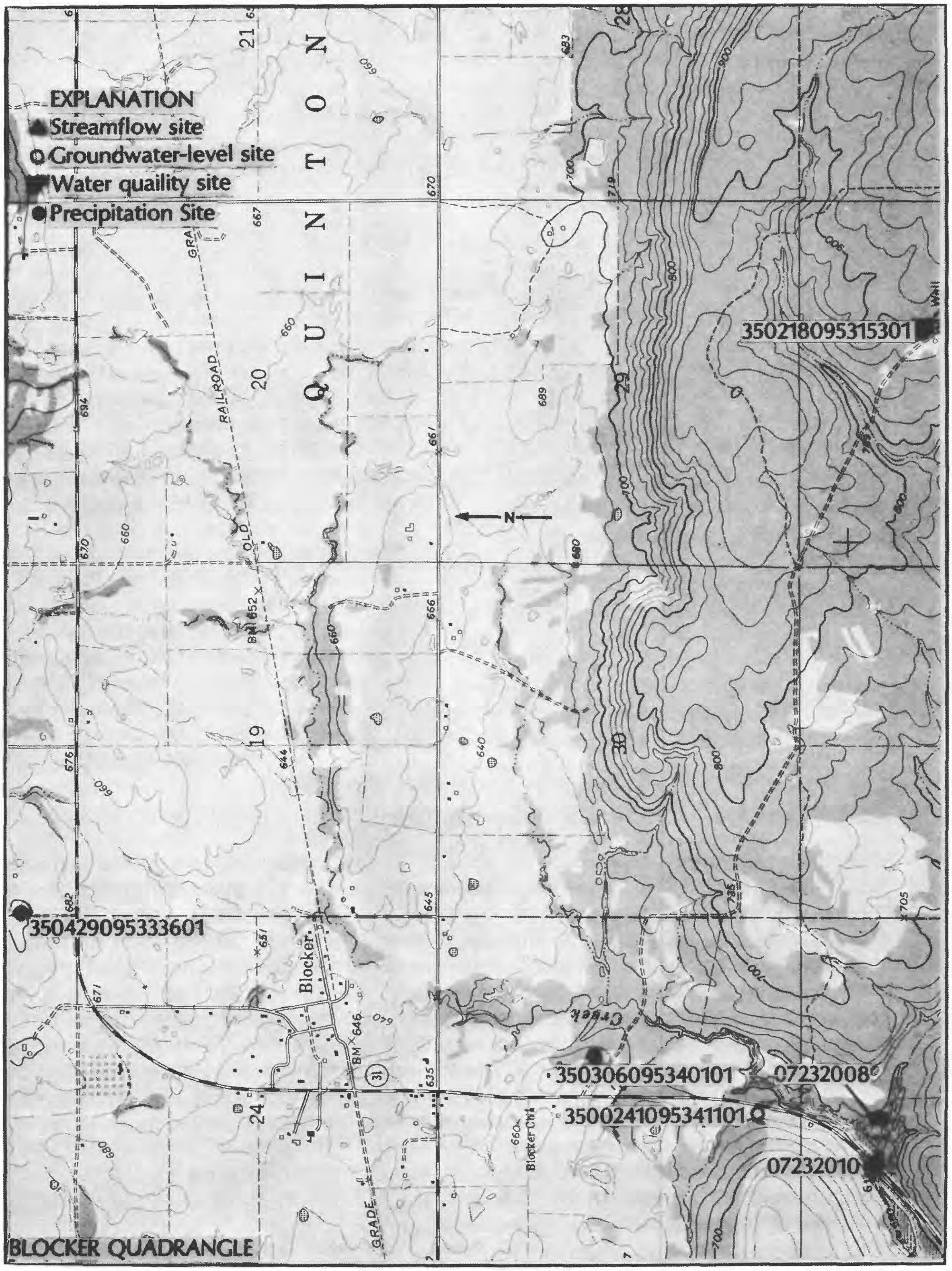
FORM 9 - 218C
(Rev. Nov. 69)

Location Map
07232010

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

BLUE CREEK nr BLOCKER, OK.

File ____________



Sheet No. ________ of ________ Sheets. Prepared by ____________________ Date ____________ Checked by ____________________ Date ____________

U.S. GOVERNMENT PRINTING OFFICE 16—25806-4

Figure 5. Typical job location maps.

Contract Costs

A total of $2,821,237 was awarded to contractors for the collection and computation of hydrologic data in Montana, New Mexico, North Dakota, Oklahoma, Utah, and Wyoming during fiscal years 1978 through 1981. The initial contract was awarded for work in Montana, New Mexico, North Dakota, and Wyoming for fiscal year 1978. Contracts were awarded for similar work in Oklahoma and Utah beginning in fiscal year 1979. With minor modifications, all contract work was continued through fiscal year 1981 except in Montana, where operation of the gaging stations was assumed by the District after fiscal year 1980. The cost of each contract is shown in table 2.

Quality Control Costs

Cost estimates for the contract monitoring and quality-control measures undertaken by the USGS are shown in table 2. They were obtained from reports of funds obligated to the coal hydrology project in each District. In making the cost estimates, it was assumed that two-thirds of the cost of salaries and benefits, supplies and equipment, were in support of District personnel directly involved in the contract quality-assurance program. All travel costs were assumed to be for contract monitoring. The figures show that the cost of contract monitoring and quality-control measures ($1,186,000) was about 30 percent of the total cost of contracting ($4,007,237).

In-House Performance Costs

Cost estimates for the USGS to perform the identical scope of work as the contractors are also given in table 2. In-house performance estimates were provided by program managers in each of the Districts where hydrologic data acquisition contracting was performed. The estimates include all of the usual operational and overhead expenses except for the cost of laboratory analyses, computer services, and report publication. These costs were excluded because they were not part of the responsibilities of the contractors.

Cost Comparison

Contracts awarded for hydrologic data acquisition during fiscal years 1978-1981 are estimated to have been about $1.0 million dollars greater, or 55 percent greater than the cost of performing the same work using USGS personnel (table 2). Contracts during fiscal years 1978-1980 ranged from 61 to 72 percent greater than the in-house performance cost. In fiscal year 1981, contracting costs dropped to 33 percent greater than the in-house performance cost, apparently due to more efficient network operation. Fiscal year 1981 was also the period during which the maximum size network was operated. Also, the entire contract was secured by one contractor in FY 1981. Quality control measures remained relatively constant during the contract period, ranging from 39 to 45 percent of the contracts. The quality control measures increased the cost of contracting to nearly $2.2 million, or 120 percent greater than the estimated cost of performing the work in-house. This dropped to 84 percent in FY 1981.

Table 2. Comparison of costs for the acquisition of hydrologic data by private contractors and by in-house performance by the Geological Survey.

CONTRACT AREA	FY 1978		FY 1979		FY 1980		FY 1981		TOTALS	
Montana, New Mexico, North Dakota, Wyoming										
Contract award	493,300		559,900		581,500		453,000		2,087,700	
Quality control	224,000		220,000		247,000		195,000		886,000	
Total contracting cost	717,300		779,900		828,500		648,000		2,973,700	
In-house performance cost		307,300		318,300		342,000		337,900		1,305,500
Contract cost minus in-house cost		186,000		241,600		239,500		115,100		782,200
Percentage difference		61		76		70		34		60
Total contracting minus in-house		410,000		461,600		486,500		310,100		1,668,200
Percentage difference		133		145		142		92		128
Oklahoma										
Contract award	----		114,700		122,500		195,000		432,200	
Quality control	----		43,000		54,000		43,000		140,000	
Total contracting cost	----		157,700		176,500		238,000		572,200	
In-house performance cost		----		80,300		85,800		136,900		303,000
Contract cost minus in-house cost		----		34,400		36,700		58,100		129,200
Percentage difference		----		43		43		42		43
Total contracting minus in-house		----		77,400		90,700		101,100		269,200
Percentage difference		----		96		106		74		89
Utah										
Contract award	----		95,000		101,300		105,000		301,300	
Quality control	----		52,000		55,000		53,000		160,000	
Total contracting cost	----		147,000		156,300		158,000		461,300	
In-house performance cost		----		49,800		69,700		92,700		212,200
Contract cost minus in-house cost		----		45,200		31,600		12,300		89,100
Percentage difference		----		91		45		13		42
Total contracting minus in-house		----		97,200		86,600		65,300		249,100
Percentage difference		----		195		124		70		117
Totals										
Contract awards	493,300		769,600		805,300		753,000		2,821,200	
Quality control	224,000		315,000		356,000		291,000		1,186,000	
Total contracting cost	717,300		1084,600		1161,300		1044,000		4,007,200	
In-house performance cost		307,300		448,400		497,500		567,500		1,820,700
Contract costs minus in-house costs		186,000		321,200		307,800		185,500		1,000,500
Percentage difference		61		72		62		33		55
Total contracting minus in-house		410,000		636,200		663,800		476,500		2,186,500
Percentage difference		133		142		133		84		120

SUMMARY AND CONCLUSIONS

In general, all aspects of the work performed by the contractors were quite satisfactory. The emphasis placed on quality control and the interfacing and close cooperation of the contractor and USGS personnel at the field level led to an amiable situation and the collection of quality hydrologic data.

Contractor costs were about 55 percent greater than was judged to be the cost of performing the same work in-house. The disparity was even greater if allowance was made for quality control inspection procedures on the part of the Survey, being on the average of 120 percent greater in cost than if done in-house. The success in contracting for basic hydrologic data must be viewed in light of circumstances. If the objective was to perform a portion of the Government's functions with no additional personnel, then the program was a success if increased costs are acceptable. Nevertheless, Survey personnel still had to observe the contractors work and be involved in data analysis and processing. However, if fiscal restraint is the objective then there seems little question that contracting for basic hydrologic data is more expensive than if performed in-house. There is evidence that this disparity might be reduced with increased contractor experience and by increasing the size of the effort.

Two not readily apparent advantages of contracting exist. First, a program based on contractor supported data collection can be quickly terminated to the advantage of the Government, when sudden fiscal restraints require it (as was the case in the Coal Hydrology Program) or project completion permits it. Also, travel expenses, frequently not viewed favorably by budget authorities, are not a visible program element if performed by a contractor.

If funding is available but not manpower, good results can be achieved by contracting data collection if stringent specifications and quality control measures are exercised. These quality control measures though have their own cost in excess of what might normally be visible in-house.

If the decision is to contract basic data collection, the work should be of sufficient size to make it worthwhile to a contractor to establish a field office or offices and hire personnel and for the Survey to implement the necessary preparation of specifications, training, management, and quality control of the work. A minimum work unit would be about 10 gaging stations or the equivalent. Real economy for larger work units will be realized for all concerned. The wide separation of work in different geographical areas into separate biddable units is advisable to encourage small contractors. Provision for separate or cumulative bids on one or more work units is advisable both from a cost standpoint as well as for greater ease of management, whereby not too many different contractors are involved.

APPENDIX A

SPECIFICATIONS FOR THE COLLECTION AND PROCESSING OF HYDROLOGIC DATA IN OKLAHOMA

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OKLAHOMA
COLLECTION AND PROCESSING OF HYDROLOGIC DATA

Part I
SPECIAL PROJECT REQUIREMENTS

Article I. **DESCRIPTION OF WORK:**

Work to be done consists of furnishing all plant, labor, materials, and equipment for performing all work in strict accordance with these specifications, attachments, and contract for collection and processing of hydrologic data.

Article II. PURPOSE:

The United States Geological Survey (USGS) has established a network of hydrologic monitoring stations in regions of actual or anticipated coal mining and development to serve as a system of environmental monitoring that will assess the impact of such mining, reclamation, and associated development on the surface water resource of the specified area.

Article III. LOCATION:

The work to be done under this contract is in the State of Oklahoma. The area covered and station locations are shown in Attachment 1,
A summary of equipment installed at gaging stations is shown in Attachment 8.

Article IV. PRINCIPAL FEATURES:

A. The work to be done includes the following principal features:

1. Operation and maintenance of gaging station with continuous stage recorders, collection of stream flow discharge, correlation of stream flow and gage-height data, and computation of daily discharge values.

2. Field measurement of selected water quality parameters and field collection of surface water samples for chemical, biological, and sediment analysis.

3. Operation and maintenance of water quality monitors which record continuous dissolved oxygen (D.O.), pH, specific conductance, and temperature data at each gaging site; correlating field measurements of D.O., pH, specific conductance, and temperature with corresponding monitor readings; and computation of mean daily and daily extremes of D.O., pH, specific conductance, and temperature. The work specified in this pararaph shall be performed at only two (2) locations.

4. Operation and maintenance of automatic sediment samplers; collection and shipping of sediment samples, providing records showing time collection of each sample.

5. Operation and maintenance of ground water level recording stations with continuous ground-water level recorder, correlation of tape-down measurement with recorded water level data, and computation of mean daily water levels.

6. Operation and maintenance of precipitation gages with continuous recorders, and providing record of the precipitation.

7. Operation and maintenance of crest-stage partial-record station, collection of streamflow discharge; correlation of streamflow and stage data; and computation of annual peak-flow values.

B. The above general outline of the principal features does not in any way limit the responsibility of the Contractor to perform all work and furnish all plant, labor, materials, and equipment required by the contract, the specifications, and the attachments.

Article V. TECHNICAL DIRECTION:

A. The performance of work hereunder shall be subject to the technical direction of a Contracting Officer's Representative (referenced to herein as COR). The COR and the Contractor's Project Manager shall work together closely to insure that all contractual requirements are being met. The "technical direction," to be valid,:

1. Must be issued in writing consistent with the general scope of work set forth in the contract;

2. May not consititute new assignment of work or change to the expressed terms, conditions, or specifications incorporated into this contract; and

3. Shall not constitute a basis for extension to the contract delivery schedule.

B. Nothing contained in this Article authorizes the Contractor to incur costs in excess of the estimated cost or other limitations on funds set forth in this contract.

C. Copies of all correspondence between the COR and the Contractor shall be forwarded to the Cognizant Contracting Officer at the following address:

U.S. Geological Survey
Procurement and Contracts Section
Mail Stop 204, Box 25046
Denver Federal Center
Denver, Colorado 80225

D. Work shall receive technical direction from a COR located in Oklahoma City, Oklahoma.

Article VI. WORK SCHEDULE:

The Contractor shall perform the gage site inspection, tape changes, current meter measurements, chemical quality sampling, and sediment sampling at the frequency called for in the "Data Collection Requirements and Calendar" in Attachment 2. Failure of the Contractor to complete the work within the month or time frame specified in Attachment 2 will subject the Contractor to the default provisions of the contract.

The Contractor shall submit, each month, a monthly schedule of the proposed work to be done and shall specify which Contractor employees shall do the work on a copy of Attachment 3. The monthly schedule for the following month shall be submitted to the COR at least 5 days before the beginning of the month. Failure of the Contractor to submit the monthly work schedule as called for or failure to complete the work as shown on the schedule submitted without a justification acceptable to the Contracting Officer shall subject the Contractor to the default provisions of the contract.

Article VII. NOTICE OF DELAYS:

In the event the Contractor encounters difficulty in meeting performance requirements, or when he anticipates difficulty in complying with the contract delivery schedule or date, or whenever the Contractor has knowledge that any actual or potential situation is delaying or threatens to delay the timely performance of this contract, the Contractor shall immediately notify the Contracting Officer and the COR in writing, giving pertinent details; provided, however, that this data shall be informational only in character and that his provision shall not be construed as a waiver by the Government of any delivery schedule or day or of any rights or remedies provided by law or under this contract.

Article VIII. GOVERNMENT FURNISHED EQUIPMENT:

The Contractor shall be responsible for furnishing all additional equipment required to complete the work called for in the contract and specifications. The Government shall furnish the specialized hydrologic equipment listed in Part VI. While the Government shall furnish only the equipment listed in Part VI, the list does include most of the specialized hydrologic equipment required for this contract.

Article IX. GOVERNMENT FURNISHED MANUALS AND BULLETINS:

The Government will furnish technical information manuals and bulletins to the Contractor. The manuals and bulletins cover the methodology to be used in accomplishing the hydrologic work required under this contract. The manuals and bulletins to be furnished by the Government are listed in Part VI.

Article X. GOVERNMENT FURNISHED TRAINING:

The Government shall furnish up to 40 hours of training as deemed necessary by the COR on hydrologic techniques for field data collection and computation for the Contractor's personnel. The Government shall advise the Contractor at time of award the dates and place where training will be available to him. The training shall be done at the USGS Training Center in the Denver Federal Center at Lakewood, Colorado or at a USGS district office in Oklahoma City, Oklahoma. Contractor shall be responsible for providing housing, meals, and transportation for the trainee. Future training and field orientation can be mutually agreed upon between Contractor and Government.

Article XI. KEY PERSONNEL:

The personnel specified in the Contractor's proposal and listed in Attachment 4 are considered to be essential to the work being performed hereunder. Prior to diverting any of the specified individuals to other programs, the Contractor shall notify the Contracting Officer reasonably in advance and shall submit justification (including experience and qualifications of proposed substitutions) in sufficient detail to permit evaluation of the impact on the program. No diversion shall be made by the Contractor without the written consent of the Contracting Officer: Provided, That the Contracting Officer may ratify in writing such diversion, and such ratification shall constitute the consent of the Contracting Officer required by this clause. The attachment to this contract may be amended from time to time during the course of the contract to either add or delete personnel, as appropriate.

Article XII. TECHNICAL QUALIFICATIONS OF THE CONTRACTOR:

The Contractor shall maintain continuity of technical competence including adequate inhouse training to insure full and technically acceptable performance on this contract. The Contractor shall list and submit the names of those personnel he proposes to use in the project on Attachment 4.

The Contractor's personnel must have the following minimum qualifications:

A. Supervisory personnel must have:

1. At least a BS degree in a field such as geology, sanitary or civil engineering, chemistry, environmental science, hydrology, or others that provide a strong background in the study of water.

2. A minimum of one (1) year's experience in full time, related hydrologic work.

3. Professional registration or licensing in at least one State, or at least 10 years' professional experience in lieu thereof.

4. Qualifications to supervise and instruct field personnel on:

a. gaging-station operation and maintenance, procedures of discharge measurements, procedures of determining discharge ratings, and computing daily discharge;

b. collection of water samples for chemical and biological sampling;

c. field analysis of water samples for the determination of alkalinity, dissolved oxygen, pH, specific conductance, and temperature;

d. collection and shipment of Equal Transit Rate (ETR) sediment samples; labeling, adjustment and shipment of automatically-collected samples, correlating ETR sediment samples with automatically-collected samples; correlating sediment concentrations with discharge; and computing daily sediment loads.

e. Operation and maintenance of water-quality monitor (instructions can be taken from existing operating manuals).

f. Operation and maintenance of automatic sediment sampler (PS-69) (instructions can be taken from existing operating manuals).

B. Hydrologist must have:

1. At least a BS degree in field such as geology, sanitary or civil engineering, chemistry, environmental science, hydrology, or others that provide a strong background in the study of water.

2. A minimum of one (1) year's experience in full time, related hydrologic work.

C. Technican must have:

1. A minimum of one (1) years' experience in full time hydrologic work or surveying, or

2. A strong mathematical aptitude, and certification by the Contractor that each technician is adequately trained to do hydrologic work required by this contract.

Article XIII. RESPONSIBILITIES OF CONTRACTOR:

The Contractor shall be required to furnish all plant, labor, materials, and equipment required for performing this contract, except for that equipment which the Government will furnish. Among the equipment which the Contractor shall provide are:

A. Vehicles, their maintenance and their fuel;

B. Calculators;

C. Wet weather gear (waders, boots, clothing);

D. Maintenance supplies, hand tools.

E. Surveying equipment (i.e., levels, level rods, etc.)

Article XIV. QUARTERLY REPORT:

A. The Contractor shall submit a quarterly report to the COR within 10 days of January 1, April 1, July 1, and October 1. The quarterly report shall contain the following:

1. Name of each site where a currentmeter measurement has been taken and number of measurements taken at that site during the quarter.

2. Name of each site where a water-quality sample was collected and number of times sampling was done during the quarter. Number and type of samples submitted to Central Laboratory for analysis during the quarter for each site.

3. Name of each site where a sediment sample was collected and number of times sampling was done during the quarter. Number and type (equal transit rate or automatically collected) of samples submitted to the Oklahoma City Laboratory.

4. Continuous Recorders:

a. Name of each site for which digital tapes were submitted for processing and number and types (gage height or monitor) of tapes submitted for processing during the quarter.

b. Name of each site with continuous recorder (both gage height and monitor) and number of days of continuous record collected during quarter (period of satisfactory gaging station operation). Number of days the automatic sediment sampler collected samples correctly.

5. Brief discussion of problems encountered in contract operation during quarter.

B. The Contractor may choose to design a simple matrix at the beginning of the contract, listing sites and the information required above as headings in such a way that each quarter the required information may be filled in for submission to the COR.

Part II
SPECIFICATIONS FOR
COLLECTION AND PROCESSING OF SURFACE WATER DATA

Article I. SCOPE:

A. INTRODUCTION

This section of the specification covers and defines the work to be done in the collection of streamflow data. The Contractor shall be responsible for furnishing all labor, materials and equipment, except for that equipment listed in Part VI which the Government shall furnish, for performing all work required in the performance of the stream-flow data collection.

B. PRINCIPAL FEATURES

1. Work to be Performed. The work to be done under this section by the Contractor includes the following principal features:

a. Operation and maintenance of gaging stations, including datum control.

b. Maintenance and collection of complete and accurate continuous stage (water-surface elevation) record at each gage site.

c. Taking of current meter measurements and corresponding gage heights at each gaging station and at variable stages to adequately cover the range in stage for each water year.

d. Development of a relation between stage and discharge (instantaneous rate of flow), and continual adjustment of the relation to reflect current physical conditions.

e. Computation of mean daily discharge, volumes, and peak flow discharges from the continuous stage record and the relation between stage and discharge.

f. Computation of flow at time of each sample collection and annual peak-flow discharge at crest-stage sites.

2. Contractor's Responsibility. The above general outline of the principal features does not in any way limit the responsibility of the Contractor to perform all work and furnish all labor, materials and equipment required by the contract, the specifications and the attachments.

C. LOCATION OF GAGING STATIONS

The location of gaging stations in Oklahoma where work is required under this contract are shown in Attachment 1,

D. FREQUENCY OF INSPECTION AND MEASUREMENT

The frequency of inspection visits and measurements which the Contractor shall perform at each gage site is shown in Attachment 2,

E. GAGE DATUM

A permanent datum to which the records of stage at a gaging station are referred must be maintained if the records of streamflow are to be accurate. The best assurance of maintaining gages at correct elevations is obtained only by periodic checking by level of all station reference marks and gages. The frequency of levels shall depend in part on the degree of permanence of the gages and reference marks. However, regardless of their apparent permanency, the Contractor shall run levels, checking all station gages and reference marks at least once each year. For those stations where it is known or suspected that either gages or reference marks are not on solid foundations and subject to vertical movement, levels shall be run more often.

The Government has run the first levels and established the gage height and elevation of all gages and reference marks. The Contractor shall run a set of check levels from a base reference mark located near the gage site (to include any crest-stage gages, highwater marks, if any, and orifice) at each site at least once each year. If there is a difference between inside and outside gage readings that cannot be corrected, a short set of levels shall be run to determine which gage is correct.

Article II. STATEMENT OF WORK:

A. OPERATION AND MAINTENANCE OF GAGING STATION

1. General. The Contractor shall provide for the operation and routine field maintenance of hydrologic stations, and the collection, analysis, and processing of accurate hydrologic data related to stream flow quantities in accordance with applicable and recommended procedures now in use by the USGS and detailed in manuals or bulletins furnished by the Geological Survey and detailed herein. During every visit to each gaging station, the Contractor shall follow the procedures for taking and recording measurements and for proper and accurate accomplishment of all procedures and responsibilities. The Contractor shall insure that his employees follow the procedures outlined below. Failure to do so shall subject the Contractor to the default provision of this contract.

2. Maintenance of Gaging Station. Upon arrival at the station, the Contractor shall make a visual inspection of the station and the surrounding area to determine any changes or problems which may prevent continuation of later steps, and perform maintenance of the gaging station site.

a. Minor maintenance. The Contractor shall perform minor maintenance such as minor repairs necessary to keep the gaging station operational, safe, and to maintain its appearance. Such minor repairs include, but are not limited to, replacement of defective recorders and timers which cannot be repaired in the field, replacement of outside staff gages which have been damaged by debris or vandalism, relocation of bubble-gage tubing and orifices (temporarily in order to get a continuing record, and permanently when field schedules permit), replacement of defective floats, and repainting and repairing the shelter as required. The Contractor shall furnish all labor and materials necessary to perform the work, with the exception of those items of equipment that duplicate, replace, or repair instrument or appurtenant fixtures that were provided by the Government. Materials such as these shall be provided to the Contractor by the COR. The Contractor shall keep the shelter clean and oil hinges, locks, and hasps. The Contractor shall maintain a neat appearance at the site by clipping weeds and grass around the station and in high-water measuring section to ensure more accurate discharge measurements, removing debris, and generally keeping the area clean. Minor maintenance shall be done at no additional expense to the Government.

b. Major maintenance. Major maintenance is defined as repair or services required to make the station operational after a period when the station was inoperative because of vandalism, damage to station, or major stream channel changes due to natural or man-made causes. Such major repairs include, but are not limited to, extensive rebuilding of the gage house, replacement of stilling wells, and complete replacement of instrumentation. If the station is destroyed by natural or man-made causes, the Contractor shall set a temporary reference point and hire a local observer, if possible, to take daily or more frequent gage readings until the station can be repaired. If the gage is inundated or destroyed by flood, it is important that these gage readings be obtained during the flood or on the recession to reduce the period of missing record to a minimum.

The Contractor shall within 3-days of discovery of a situation that might require major maintenance, notify the COR and inform him of the amount and costs of remedial work planned. The COR shall within 5-days after notification, advise the Contractor whether or not to proceed with the work. All work shall be completed as soon as possible after approval and in all cases shall be completed within 30 days. Contractor shall furnish all labor and materials necessary to perform the work, with the exception of those items of equipment that duplicate, replace, or repair instrument or appurtenant fixtures that were provided by the Government. Materials such as these shall be provided to the Contractor through the COR.

All costs associated with major maintenance shall be handled outside of this contract. The Contractor may or may not be requested to perform certain major maintenance, but in no event shall the Contractor be obligated to perform such maintenance under this contract, unless the need for the major maintenance is due to negligence of the Contractor. If such negligence does exist, then the Contractor shall be responsible for accomplishment of the major maintenance at no expense to the Government.

All work performed shall be subject to inspection. Government shall have the right to require the Contractor to perform the work again if the maintenance work is defective or would reduce the major maintenance price to reflect reduced value of services provided.

c. Site Security. The Contractor shall close and lock all gates or doors wherever appropriate with regard to protection of the site.

d. Maintenance and Replacement of Nitrogen and Batteries. The Government shall furnish the original Nitrogen gas and tanks required at the gaging station sites and one spare tank for every six gaging stations equipped with bubble gages. The Government shall also furnish 7½ volt batteries to initiate operation of the equipment at each gage site.

The Contractor will be responsible for insuring continuous operation of the gaging sites and will be responsible for refilling the nitrogen tanks, supplying, and replacing the batteries. If operated correctly, a 112 cubic foot nitrogen tank will last over 12 months. The Contractor shall replace the nitrogen tanks every 12 months. The Contractor shall replace batteries on all recorders regularly at 6-month intervals. The Contractor shall replace all recorder batteries in October and March or when the no-load voltage drops below 7.0 volts.

Unforeseen events can cause batteries to run down and nitrogen gas to escape. Maintaining spare filled tanks and having replacement batteries on hand is the responsibility of the Contractor. Missing record because of failure to replace nitrogen or batteries is unacceptable performance on this contract and may subject the Contractor to a reduction in contract price, if warranted.

3. Initial Data Collected at Site. The collection of data from the station recorders and instruments is a continuous process that follows each step taken in the succeeding instructions, and to insure a permanent record of these data the Contractor shall use every precaution to assure adequate recording and documentation. The data and information collected initially and throughout station servicing shall include:

a. Station name, in full;

b. date: month (name, not number), day, and year;

c. time: watch time using 24-hour time system;

d. pen time of analog recorder, punch time on digital recorder;

e. types of inside and outside gages and gage height;

f. gage height by float tape or manometer dial, the reference gage, and the recorders;

g. initials of Contractor(s);

h. additional remarks related to station conditions, including control conditions.

4. Servicing the Stage Recorder. After the initial visual checks and preparation of the record sheet, the Contractor shall service the stage recorders. This servicing is done prior to discharge measurements so that the recorders can be observed to be functioning correctly after new tapes are started. It serves as a safety valve for prevention of record loss due to such common mistakes as leaving the pen up or clock stoppage after winding. The recorders shall be serviced using the following procedures as a guide:

a. Check to see if the clock and/or timer is running and mark the recorder charts.

(1) by marking the point where the pen or pencil is resting on the strip-chart recorder (adjust timer if needed or replace if timer has been malfunctioning), and

(2) by watching the instrument punch the digital tape and drawing a line across the digital tape, using the top of the punch block as the straight edge.

b. Compare gage readings and recorded gage heights and check to see if there is a malfunction of the equipment such as:

(1) if the stilling well intakes are plugged,

(2) if there are any malfunctions in the gas-purge system of the bubble gage or if the orifice lines are plugged,

(3) if there has been any oil loss from an oil cylinder, and

(4) if there are any inconsistencies between the recorded and reference gage heights, note them so that adjustments can be made to the <u>recorded</u> gage height. In stations equipped with a bubble gage, check the counter.

c. Records shall be removed from each recorder at intervals not to exceed 2 months. Change the record from each recorder as follows:

(1) Analog recorder

(a) At the time of initial inspection the time shall be indicated by a vertical mark of the pen or pencil. The float tape or cable should be grasped between the float and the float wheel and lifted a few hundredths and gradually released. The mark should not be made by rocking the float wheel because it places undue strain on the float wheel bearing. If equipped with a bubble gage, the Contractor shall mark the chart by pushing the up or down switch so that the pen trace is changed a few hundreds.

(b) Advance the chart about 1 inch. Run a reversal mark and adjust if necessary.

(c) Blot the ink at the end of the recording to prevent smears.

(d) Identify the chart by printing the name of the station, date, time, gage height readings and initials of person.

(e) Cut and remove the chart, leaving at least 1 full day in addition to the day of the visit on the end of the chart to provide ample room for joining the pieces in the office.

(f) Wind clock or negator spring.

(g) Check the amount of paper left on the supply roll and make certain that there is more than enough to last the interval between visits.

(h) Flush intakes or purge orifice line.

(i) Rethread the chart into take-up rolls and run reversals, read all gages again, and record all data and observations on the chart.

(j) Reset pen to agree with the gage height indicated by the reference gage, and advance chart to agree with watch time, and make a vertical mark. Be certain that pen is not in reversal.

(k) Check the ink supply of the pen and replenish it if necessary.

(m) Unroll and examine the chart in an effort to detect any recorder malfunction or clock stoppage since the last visit and if found note range line.

(2) Digital recorder: When arriving at a station, look at the face of the timer to see if a punch would occur in about the next 5 minutes, the time it would take to remove the punched record and reset the tape. If so, it is better to wait until the punch has occurred before starting the tape removal procedure. Fill in the removal block of the inspection slip. When ready to remove the punched record, follow the steps listed below.

(a) Turn the take-up roll to advance the tape about 9 inches beyond the last punch, cut the tape with a knife or razor blade just above the upper paper guide bar.

(b) Slip the roll of punched tape off the take-up roll.

(c) Note the date, watch time, clock time and gage height on the tape just removed but do not take the time for elaborate notes until after the tape has been reset.

(d) Check battery voltage or amperage and record. Replace battery if no load voltage is less than 7.0 volts.

(e) Flush intakes or purge orifice line.

(f) Thread the paper onto the take-up roll. Care should be exercised not to elongate the large feed holes in the tape on the pins protruding on the tape drive drum by turning the take-up roll too hard. Advance the tape until the printed line on the tape just above the punch block is about eight readings earlier than watch time. (On the 15-minute tape, this would be 2 hours earlier than watch time.)

(g) Record the station name, station number, date, time and initials of Contractor on the unused portion of the beginning of the new tape and start new inspection slip.

(h) Reset the punch mechanism, if necessary, to agree with the gage height indicated by the reference gage.

(i) Punch sufficient test punches so that the next punch caused by a properly set cam will be at the correct time.

(j) Draw a penciled line across the top of the punch block so that later the test punches can be separated from the automatically recorded data. If the preset action has already taken place before the line was drawn, the line will pass through the last test punch; if not, the line will be above the last test punch. Care must be exercised not to tear the paper with the pencil.

(k) After resetting the tape, record the station name and the remaining notes on the tape just removed. At this point take time to superficially examine the last portion of the tape just removed for any obvious trouble which would call for action before leaving the station. This examination should include rolling the tape back about 3 feet to check damaged or poorly spaced holes in the tape or places where feed holes are skipped (these can be seen most easily by looking at the reverse side of the tape). Gross time errors and timer stoppages can be found by checking day numbers against calendar days. Attach inspection slip to removed tape with a rubber band. Prior to leaving the station, check to see that there is sufficient tape on the supply roll. If the amount of tape on the supply roll is in question, remove the left flange on the supply roll holder and measure the thickness of the paper remaining. The following table gives the approximate thickness against days of tape remaining:

Days Remaining on Supply Roll

Thickness of remaining tape on supply roll	Days remaining on supply roll Reading frequency 5 min	15 min	30 min	60 min
1/4 inch	10	30	60	120
7/16 inch	20	60	120	240
9/16 inch	30	90	180	360
11/16 inch	40	120	240	480

(m) When visiting station but not changing tape or chart, note recorder readings and base reference gage readings on tape leader and chart, but do not advance tape or chart.

d. If the station consists of a stilling well with a float-operated recorder,

(1) check the float for leaks,

(2) check the float-clamp screw to make sure that there can be no slippage of the float tape where it joins the float,

(3) check the well for unduly large accumulations of sediment and remove such material,

(4) check the depth of oil in the oil tube, if there is one, to detect any oil leaks and if any oil should be added,

(5) flush the intakes regularly if the well is equipped with a flushing system, or if there is no such system, force clean the intakes with a plumber's snake, and

(6) if there has been a high discharge since the last visit, check the stilling well, both inside and out, for high-water marks as a check on the peak stage shown on the recorder. If the equipment malfunctioned since the last visit, the high-water mark information is used to estimate missing record. After this check, clean the marks off to prevent confusion with later high-water marks.

e. If the station is equipped with a bubble gage sensor, there are several other checks that are necessary:

(1) Inspect the bubble orifice to make sure it is not buried by sediment.

(2) Keep a log of gas-feed rate, gas consumption, and gas-cylinder replacement to insure a continuous supply of gas and to help check for leaks in the system; and

(3) If a high discharge has occurred since the last visit, look for a high-water mark near the base reference gage as another check on the recorded peak stage. Record gage height of outside high-water mark on measurement front sheet.

5. Completion of Gaging Station Servicing. After making the proper measurements:

a. The Contractor shall return to the stage recorder and repeat the first steps he took in servicing the recorder as a check.

b. The Contractor shall keep in mind several additional points when servicing the gaging station.

(1) Periodic cleaning and oiling of the recorder and clock or timer can reduce malfunction of the recorder.

(2) Humidity and temperature control reduce errors associated with paper expansion and contraction. Excessive humidity and temperatures in the gage house should be kept to minimum by proper ventilation.

(3) the datum of gage will be checked annually with levels to maintain datum control and assure reliability of gage readings. If conditions are known to be unstable, levels will be run more often;

c. The Contractor shall not leave the station without assuring himself that:

(1) the recorded gage height agrees with the gage height of the base reference gage;

(2) that the clock is running; pen and punch set to agree with watch time;

(3) that all necessary valves are open;

(4) that the float wheel, if any, is engaged;

(5) that the pen is marking, and the digital recorder is punching;

(6) all latches on instruments are fastened, and all gates and doors are locked.

6. Duties before Preparing for Discharge Measurement. After servicing the station and before preparing for the discharge measurement, the Contractor shall:

a. Make certain that his duties in the station have been done correctly and accurately and that the station is functioning properly.

b. Make certain that he has all of the appropriate forms and equipment needed for a discharge measurement and that all structures needed for this measurement are standing and in safe condition. Any problems should be noted on the note sheet, if they were not noted during the visual check earlier.

7. Preparation for Discharge Measurement. The Contractor shall prepare for the discharge measurement in the following manner.

a. Select a reach of stream for the cross-section measurement that has desirable qualities.

(1) If the stream cannot be waded and high-water measurements are made from a bridge or cableway, the Contractor has no choice with regard to selection of a measurement cross section.

(2) If the stream can be waded, the Contractor looks for a cross section of channel with the qualities below. (Note: It will often be impossible to meet all of the criteria and the Contractor must exercise judgement: cross section lies within a straight reach and flow lines are parallel to each other; velocities are greater than 0.5 ft/s (0.15 m/s) and depths are greater than 0.5 ft (0.15 m); stream bed is

relatively uniform and free of eddies, slack water, and excessive turbulence; and measurement section is relatively close to the gaging station control to avoid the effect of tributary inflow between the measurement section and control and to avoid the effect of storage between the measurement section and control during periods of rapidly changing stage.)

(3) If the stream cannot be waded and the measurement is to be made from a boat, the cross section should have the above attributes with a few exceptions: depth is not a consideration in this case because if the stream is too shallow for a boat, it can easily be waded; velocity in the measurement section is especially important, because if the flow is too slow, meter registration may be affected by an oscillatory movement of the boat from wind action; where a vertical-axis meter is used, meter registration may be affected by vertical movement of the boat by waves. If velocities are too fast, the tag line is difficult to string across the stream.

(4) If the station is downstream from a hydroelectric power plant, the stage generally changes too rapidly to assure a satisfactory discharge measurement regardless of the type of measurement to be made. In this case, the Contractor should obtain an up-to-date schedule of operations from the power plant operator or determine the operating schedule from the gage height recorded on the chart; and plan to make discharge measurements near the crest or trough of the stage hydrograph or during periods of near constant discharge from the power plant.

b. Determine the present width of the stream and the spacing of verticals.

(1) Several methods may be used to determine stream width: If a cableway or bridge is used regularly for making measurements, they are marked at 2-, 5-, 10-, or 20-foot intervals by paint marks, and the Contractor can simply use these marks to determine the stream width; if the measurement is made by wading, run a metallic tape or tag line from one bank to the other, take up the slack, and determine the width accordingly; if a boat is needed to make a measurement because there are no suitable bridges, or cableways, unreel the tag line as the boat crosses the stream, take up the slack with a block and tackle attached to the reel and to an anchored support on the bank, and determine the width accordingly. (Note: If the stream has boat traffic, take necessary precautions to insure that this traffic does not interfere with the tag line.)

(2) While preparing the tag line the spacing of verticals will be made to provide 25 to 30 subsections (if previous discharge measurements at the site have shown uniformity of both the cross section and the velocity distribution, fewer verticals may be used): space verticals so that no subsection has more than 5 percent of the total discharge (this is seldom achieved when 25 subsections are used); do not space all observation verticals equally unless the discharge is evenly distributed across the stream. Spacing between verticals should be closer in those parts of the cross section that have greater depth and velocities.

c. Prepare measurement note sheets for recording observations and data on the following:

(1) name of stream and location,

(2) date, party, type of meter suspension, and meter number,

(3) time the measurement was started (using 24-hour time system),

(4) bank of stream that was the starting point (use letters LEW for left edge of water or REW for right edge of water when facing downstream),

(5) control conditions,

(6) gage heights and corresponding times,

(7) water temperature,

(8) other pertinent information affecting the accuracy of the discharge measurement and conditions which might affect the stage-discharge relation.

d. Assemble appropriate equipment for current-meter measurement and depth measurements depending on the means to be used in the measurement, and check all assemblies and instruments before proceeding.

(1) Perform the following steps for general current-meter assembly and maintenance: Before each discharge measurement, examine the meter cups or vanes pivot and bearing, and shaft for damage, wear, or faulty alignment; check the balance of the current meter on the cable-suspension hanger; check the alignment of the rotor when the meter is on the hanger or wading rod; adjust conductor wire to prevent interference with meter balance and rotor spin; check stopwatch against Contractor's watch for accuracy; check the automatic electric counter for defects; check waders and boots for leaks; clean and oil meters daily when in use; clean the meter immediately after use if the measurement is made in sediment-pentagear, after oiling spin check the rotor to make sure it operates freely (any problem should be noted on the field note sheet).

(2) If the measurement is to be made by wading, use the type AA or the pygmy meter and attach it to the wading rod.

(3) If the measurement is to be made from a bridge or a cableway because the stream is too swift to wade, the type AA meter is also generally used, but the necessary supporting equipment must be assembled together with all auxiliary equipment.

(4) If the measurement is to be made from a boat, all of the necessary equipment must be assembled at this point.

(5) If the measurement is to be made from ice cover, all of the necessary equipment must be assembled at this point.

e. Measure and record depth (if any) first at the edge of the water and later at each vertical in the cross section. Depth determines the method of velocity measurement to be used, normally either the two-point (0.2- and 0.8-depth) or the 0.6-depth method. The 0.6-depth method is recommended whenever the depth is between 0.3 foot and 2.5 feet.

(1) If the current-meter measurement is to be made by wading, the graduations on the wading rod provide the instrument for depth measurement.

(2) If the current-meter measurement is to be made from a cableway or a bridge, depth can be measured with a sounding reel equipped with a depth indicator, tags placed on the sounding line at a known distance above the center of the meter cups, or a handline measured after a sounding weight has been lowered to the streambed and then raised.

(3) If the current-meter measurement is to be made from ice cover, the effective depth of the water is the total depth of water minus the distance from the water surface to the bottom of the ice. Total depth of water is usually measured with an ice rod or with a sounding weight and reel depending on depth.

f. Compute the setting of the meter for the particular method to be used after determining depth, and record the meter position. Several methods are used, depending on the depth of the stream: The vertical-velocity method, the two-point method, 0.6-depth method, the 0.2-depth method, the three-point method, and the subsurface method.

8. Taking of Discharge Measurement. The Contractor shall strictly follow the methods and procedures described in the "Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter A8, Discharge Measurements at Gaging Stations" and the procedures outlined below in making the discharge measurements.

a. If the measurement is to be made by wading:

(1) If natural conditions for measuring are in the range considered undependable, modify the measuring cross section. Often it is possible to build dikes to cut off dead water and shallow flows in a cross section, or to improve the cross section by removing rocks and debris within the section, from the reach of stream immediately upstream from it, and from the control. Allow the flow to stabilize before starting the measurement.

(2) Determine the depth and the method for velocity measurements as described above.

(3) Stand in a position that least affects the velocity of the water passing the current meter; this is usually obtained by facing the bank with the water flowing against the side of the leg. Holding the wading rod at the tag line, stand from 1 to 3 inches downstream from the tag line and 18 inches or more from the wading rod. Avoid standing in the water if the feet and legs would occupy a considerable percentage of the cross section of a narrow stream. In small streams where the width permits, stand on a plank or other support rather than in the water.

(4) Keep the wading rod in a vertical position and the meter parallel to the direction of flow while observing the velocity. If the flow is not at right angles to the tag line, measure the angle coefficient carefully.

(5) Place the current meter at the proper depth, point it into the current, and allow rotation of the rotor to adjust to the speed of the water current before starting the velocity observation. The time required for this is generally only a few seconds if velocities are greater than 1 fps; but for slower velocities, particularly if the current meter is suspended on a cable, a longer period is needed.

(6) When the adjustment is complete, count the number of revolutions made by the rotor for a period of 40 to 70 seconds; start the stopwatch simultaneously with the first signal or click and count is as "zero" not "one"; end the count at a convenient number coinciding with one of those given in the column headings of the meter rating table; stop the stopwatch at that count and read to the nearest second (or to the nearest even second if the watch hand is on a half-second mark); then record that number of seconds and number of revolutions.

(7) After sampling the velocity, obtain the mean of the vertical distribution of velocity. The partial discharge is now computed for any partial section at location X.

(8) If the velocity is to be observed at more than one point in the vertical, determine the meter setting for the additional observation, time the revolutions, and record the data.

(9) Move to each of the observation verticals and repeat the procedure until the entire cross section has been traversed, recording distance from initial point, water depth, meter-position depth, horizontal flow angle (if other than normal to the cross section), revolutions of the meter, and the time intervals associated with these revolutions. Between measurements, keep the following in mind: Periodically check the current meter when it is out of the water to be sure that the rotor spins freely; note the time on the left margin of the note sheet every 15 minutes, especially if the stage is changing; place the meter rod ahead of and upstream from the feet to prevent scoured depressions left by the feet from affecting soundings or velocities. (Record an accurate description of streambed and water-surface configuration each time a discharge measurement is made in a sand-channel stream.)

(10) When the measurement is complete, record the time and streambank where the measurement ended (LEW or REW), and repeat the procedures outlined in 7, d above for care and maintenance of the equipment.

b. If the measurement is to be made from a cableway:

(1) Measure the depth after the entire assembly is in order.

(2) After determining the proper method to be used for velocity measurement, the meter assembly is lowered into the water from the cable car to the appropriate depth and at the appropriate vertical. The procedure is basically the same as in wading measurements.

(3) There are a number of precautions to take when making a measurement from a cableway: Movement of the cable car from one station to the next makes the car oscillate for a short time after coming to a stop, so wait until this oscillation has dampened to a negligible amount before counting the revolutions of the current-meter rotor; if large amounts of debris are flowing in the stream, raise the meter up to the cable car several times during the measurement to be certain the pivot and rotor of the meter are free of debris; keep meter in water during measurement if the air temperature is considerably below freezing; and if the weight and meter become caught on a submerged object or on floating debris and it is impossible to release them, sometimes the cable car can be pulled to the edge of the water and the debris can be released. If safety becomes a predominant factor under an emergency situation, it may be necessary to cut the sounding line and sacrifice the meter and assembly.

c. If the measurement is to be made from a bridge:

(1) Many measuring sections under bridges are satisfactory for current-meter measurements, but cableway sections are usually better.

(2) No set rule can be given for choosing between the upstream or downstream side of the bridge when making a measurement, but each has its advantages and the decision should be made for each bridge individually.

(3) Use either a handline or a sounding reel supported by a bridge board or a portable crane to suspend the current-meter assembly from bridge, keeping the equipment several feet from piers and abutments if velocities are high. Estimate the depth and velocity next to the pier or abutment on the observations at the vertical nearest the pier. If there are piers in the cross section, more than 25-30 partial sections will be needed to get reliable results. Piers will often cause horizontal angles that must be carefully measured; they also cause rapid changes in horizontal velocity distribution in the section.

(4) Measure the velocity using methods discussed in the preceding sections.

(5) Footbridges are sometimes used for measuring canals, tailraces, and small streams, and rod suspensions can be used from many footbridges. Determine depth for low velocities in the same way as wading measurements and high velocities by taking the difference in readings at an index point on the bridge when the base plate of the rod is at the water surface and on the streambed. Handlines, bridge cranes, and bridge boards can also be used.

d. If the measurement is to be made from ice cover:

(1) Select the possible locations of the cross section to be used for a measurement from ice cover during open water season when channel conditions can be evaluated.

(2) Always test the thickness of the ice cover with sharp blows from a sharp chisel.

(3) Cut the first three holes in the selected cross section at the quarter points to detect the presence of slush ice or poor distribution of the flow in the measuring section. If poor conditions are found, investigate other sections to find one free of slush ice and that has good distribution of flow. Make at least 20 holes in the ice for current-meter measurement, spacing the holes in the ice so that no partial section has more than 10 percent of the total discharge.

(4) Determine the effective depth of the water, i.e., the total depth from streambed to the bottom of ice, accounting for difficulties in determining depth caused by the vertical pulsation of the water.

(5) The USGS recommends the use of the vane ice meter under ice cover because the vanes do not become filled with slush ice like the cups of the Price meter, because the yoke of the vane meter will fit in the hole of the ice drill, and because the yoke and ice rod can serve as an ice-measuring stick. The contact chamber can be rotated to any position, so the binding post is placed perpendicular to the axis of the yoke to avoid interference when using the top of the yoke to determine the underside of the ice.

(6) Because the velocity distribution under ice cover is similar to that in a pipe with a lower velocity nearer the underside of the ice, the USGS recommends use of the 0.2- and 0.8-depth method for effective depths greater than 2.5 feet. Two complete vertical-velocity curves must be defined when ice measurements are made, to determine whether any coefficients are needed to convert the velocity obtained by the 0.2- and 0.8-depth methods to the correct mean velocity. A coefficient of about 0.92 usually is applicable to the velocity obtained by the 0.6-depth method.

(7) Keep the meter as far upstream as possible to avoid any effect that the vertical pulsation of water in the hole might have on the meter; eliminate as much as possible the exposure of the meter to the cold air during the measurement; keep the meter free of ice when the velocity is being observed.

(8) If there is partial ice cover at a station, use the above procedures where there is ice cover, and open-water procedures elsewhere. If portions of the channel are alternatively ice covered and open, measure in open water as far downstream from the ice as possible.

e. If the measurement is to be made from a boat:

(1) String the tag line as the boat moves across the stream and mark the verticals to be measured and follow necessary procedures if the stream has heavy traffic to prevent interference with the line.

(2) If the maximum depth is less than 10 feet and the velocity is low, use a rod to measure the depth and to support the current meter; if the depth is greater, use a cable suspension with a reel and sounding weight.

(3) Boat measurements are not recommended at velocities less than 1 fps if the boat is subject to wave action, because the boat movement affects the velocity observations.

(4) The procedure for measuring from a boat using the boat boom and crosspiece is the same as that for measuring from a bridge or a cableway once the special equipment has been set up and the method of positioning the boat has been established.

f. If measurement during rapidly changing stage is needed:

(1) Make the measurement as quickly as possible to keep the change in stage to a minimum.

(2) Follow this 15- to 20-minute procedure to speed up the measurement: Use the 0.6-depth method, or the 0.2-depth method if this is not suitable; reduce the velocity observation time to about 20-30 seconds; reduce the number of sections taken to about 15-18. (Note: The expediencies used here shall not be used by the Contractor in other than emergency situations.)

g. If a series of measurements during a peak of short duration is required, use the following procedure:

(1) Take about 10 sections.

(2) Take velocity observations at 0.6 depth.

(3) Repeat velocity and depth observations at the same 10 sections with corresponding stages as often as possible throughout the period of the flood.

(4) Develop stage-velocity and stage-area curves for each of the 10 sections.

(5) Compute the discharge corresponding to selected stages by summation of the partial discharges from the curves thus defined.

h. After the discharge measurement has been taken using whichever method was necessary, determine the mean gage height of the discharge measurement.

(1) This represents the mean height of the stream during the period the measurement was made and is referred to the datum of the gaging station. It is one of the coordinates used in plotting the measurements to establish the stage-discharge relation, often called the rating curve. An accurate determination of mean gage height is therefore as important as an accurate measurement of the discharge to define the stage-discharge relationship.

(2) Computation of mean gage height presents no problem when the change in stage is 0.1 feet or less, for then the mean may be obtained by inspection, but during floods or regulation much greater changes may occur.

(3) To obtain an accurate mean gage height: Read the gage before and after discharge measurement; read the recorder chart at breaks in the slope of the gage height graph during the measurement; if station has a digital recorder, read the gage height punched during the measurement; at nonrecording stations the only way to obtain intermediate readings is for the stream gager to stop once or twice during the measurement to read the gage, or to have another qualified person do it for him.

(4) If the change in stage is greater than 0.1 foot, obtain the mean by weighting the gage-height readings rather than by inspection of the available readings.

(5) The mean gage height during periods of constant slope of the gage-height graph and the corresponding measured partial discharges are used to compute the mean gage height of the measurement.

(6) If a discharge measurement is made at a distance from the gage during a change in stage, the discharge passing the gage during the measurement will not be the same as the discharge at the measuring section because of the effects of channel storage between the measuring section and the gage. Adjustment is made for channel storage by applying to the measured discharge a quantity obtained by multiplying the channel surface area by the average rate of change in stage in the reach.

(7) If a flood has reached a stage such that an estimate of the discharge is two or more times the discharge of the highest current-meter measurement, then high water marks should be flagged by the Contractor for an indirect measurement to be made by the Government.

i. Measurement of discharge by miscellaneous methods when conditions are such that use of a current meter is not feasible. (Note: The expediencies used here shall not be used by the Contractor in other than emergency situations.)

(1) During periods of high flow, floats may be used when no current meter is available but the measurement structure such as a bridge or cableway has been destroyed and boat measurement equipment is unavailable or when a current meter is available but floating ice or drift make use of the meter impossible. A float may be almost any distinguishable article that floats, such as wooden disks, bottles, oranges, floating ice cakes, or distinguishable pieces of drift. To make a discharge measurement using a float, follow this procedure:

i. select two (2) cross sections along a reach of straight channel that are far enough apart so that the time the float takes to pass from one cross section to the other can be measured accurately;

ii. use a travel time of at least 20 seconds;

iii. reference the water-surface elevation to stakes along the bank at each cross section and at one or more intermediate sites (these elevations will be used at a later date, when conditions permit to survey cross sections of the measurement reach, and the end stakes will be used to obtain the length of the reach; the surveyed cross section will then be used to derive an average cross section for the reach);

iv. distribute a number of floats uniformally across the stream width and not their positions with respect to distance from the bank;

v. introduce the floats a short distance upstream from the upstream cross section so that they will be travelling at the speed of the current when they reach the upstream section. (If there is no bridge or cableway from which to introduce the floats, they will have to be tossed in from the shore.)

vi. use a stopwatch to time their travel between end cross sections;

vii. note the estimated position of each float with respect to the bank at the downstream cross section;

viii. determine the float velocity by dividing the distance between the end cross sections by the time of travel, then determine the mean velocity in the vertical by multiplying the float velocity by a coefficient of 0.85.

ix. the procedure for computing the discharge is similar to that used in computing the discharge for a conventional current-meter measurement; the discharge in each subsection of the average cross section is computed by multiplying the area of the subsection by the mean vertical velocity for that subsection, and the total discharge is equal to the sum of the discharge for all subsections.

x. if the measurement is carefully made under favorable conditions, accuracy may be to within ±10 percent, but wind may adversely affect the accuracy of the computed discharge by its effect on the float velocity, and in a nonuniform reach where only a few floats are used in the cross section, measurement results may be in error by as much as 25 percent.

(2) During periods of low flow, small discharges may be measured by several methods.

i. The volumetric measurement is used only for small discharges and is the most accurate method for measuring such flows. This method is usually used when flow is concentrated in a narrow stream or can be so concentrated to divert all of the flow into a container of known volume; sites, with a V-notch weir control and a section of natural control where a temporary earth dam can be built over a pipe through which the entire flow is directed, are examples. Where dams are constricted to divert flow-through pipes or troughs to volumetric tanks, time must be allowed for flow to stabilize.

ii. Portable weir plates are used when depths are too shallow and velocities are too low for a current-meter measurement. A 90 V-notch weir is particularly suitable because of its sensitivity at low flows. A staff gage, attached to the upstream side of the weir plate with its zero at the elevation of the bottom of the notch, is used to read the head on the notch of the weir. After installation, a pool forms on upstream side, and no readings should be recorded until the pool has risen to a stable elevation. Read the head at half-minute intervals for about 3 minutes, and the mean value of those readings should be the head used to compute discharge. Remove the weir plate after completion of the measurement.

iii. A portable Parshall flume is also used when depths are too shallow and velocities are too low for use of a current meter. When using portable Parshall flumes, the submergence ratio should not exceed 0.6. Read the gage height or upstream head on the throat of the flume in the small stilling well that is hydraulically connected to the flow. No gage-height readings should be recorded until the pool has risen to a stable level after installation of the flume. Gage height readings should be taken at half-minute intervals for about 3 minutes, and the mean value of those readings is the stage to be used to compute the discharge. Remove the flume after completion of the measurement.

9. <u>Evaluation of the Discharge Measurement</u>. After the discharge and the mean gage height of the measurement have been determined, record the data on the station data sheet in the gage shelter and plot the measurement on the field rating curve sheet. (Note: The Contractor will check the discharge rating while still at the station to determine any deviations from the trend established by previous measurements and to decide if a check discharge measurement is needed. Some experience in record computation and knowledge of station conditions are needed to properly judge when a check measurement is warranted. If one is needed, use another current meter. If the cause of the deviation is obvious, such as debris on the control, and can be confirmed by direct means, then a check measurement need not be made. If the Contractor's technician is inexperienced, he will plot the discharge measurement in the office under the guidance of the Contractor's supervisory personnel. Any deviations discovered at this point may warrant a return visit by the Contractor's technician and his supervisor to determine the causes. This information will be discussed more fully in Section 10.

10. <u>Listing Discharge Measurement (SF 9-207) in Office</u>

The Contractor's field technician should have computed all his current-meter measurements and completed the front sheet of his field notes by the time he returns from his field trip. The office supervisor shall check these measurements for conformance to USGS standards, and then they shall be listed on Standard Form 9207.

SF 9-207, when completed, is the list of discharge measurements. It is a continuing form, that is, the current year's record is started at the end of last year's tabulation without starting a new sheet. In filling out this form, the following steps should be taken in the order listed:

a. Check mathematics of the measurements and accept those that check the rating ±5 percent.

b. Arrange current discharge measurements in chronological order, including notes marked "Visits." Check against the SF 9-213 to see that all measurements are at hand.

c. Number the discharge measurements (excluding "Visit" notes and observations of no flow) consecutively.

d. Check level notes for datum corrections, and, if needed, make necessary corrections to gage heights of measurements.

e. Compare the measurements with the gage height record to check the gage height shown on the measurement sheet.

f. Copy results of discharge measurements on SF 9-207. Some general notes on copying this information are as follows:

(1) If a new sheet is started, letter or type exact station title in lower-case letters.

(2) Insert applicable statement "Beginning 1978 Water Year" or "1978 Water Year continued." Put this statement on a line by itself. Skip a line between the last measurement in one calendar year and the first in the next and insert the year on this line in the "Date" column.

(3) Fill in columns as follows:

(a) Column headed "No.": Insert measurement number.

Occasionally work is done for information obtained on a visit when no measurement is made. If this information has a bearing on computation of the record, it should be included on the 9-207 in its proper chronological place. Do not number such entries (dash "No." column), but insert information in proper spaces. This information may concern gage height of zero flow, levels to a flood peak, cleaning of control, etc. Use as many lines on the form as are needed to record all important data. Observations of no flow are listed in their proper order but are not numbered.

(b) "Date": Use the abbreviation for the month as "Oct. 14" instead of "10/14."

(c) "Made by": Show who made measurement using first and last name. If two people made measurement, last name of person who operated the meter should be listed first and the notekeeper, second. When the same person or persons made more than one measurement, "do" may be used for all consecutive measurements.

(d) "Width;" "Area;" "Mean Velocity;" "Gage Height": copy from measurement notes.

For measurements by slope-area or other indirect method, both the inside and outside gage height should be shown when gage height is obtained from recorder or crest-stage gage.

(e) "Discharge": The measured discharge should be given on the line. If the discharge has been corrected for change in storage or by Boyer method, the adjusted discharge should be shown above the measured discharge with symbol "*" designating change in storage, and symbol /—/ for Boyer (adjusted discharge inside box for Boyer). Explain correction under Remarks or at bottom of sheet.

(f) "Rating": Leave "Shift adj." and "Percent diff." columns blank until record is computed.

(g) Fill in the next six columns from information on first sheet of discharge measurements.

(h) "Remarks": Under Remarks the gage height of zero flow, condition of control or channel, place of making measurement (if not at regular station), and anything which affects the accuracy of the measurement or record should be shown. If measurement was made a considerable distance from the recorder and there was a possibility of inflow between, this fact should be noted. It is not necessary to show that a measurement was made from a bridge, cable, or by wading unless the accuracy of the measurement is affected by the method used. Measurements made by methods other than with a current meter should be identified in this column and the method of computation shown.

(4) Identification of preparer and checker: Spaces are provided on the bottom of SF 9-207 for entry of range of measurement numbers and initials. The person preparing the form should insert range of measurement numbers and his initials in the spaces provided in the bottom margin. All of the information on the form must be checked for accuracy of copying and completeness. The checker should place his initials in the space provided in the bottom margin.

(5) Significant figures: For significant figures used in SF 9-207, see sample of this form on the following page.

11. Development of Discharge Rating. The Contractor shall follow the methods and procedures of Surface Water Techniques of the United States Geological Survey, Book 1, Chapter 12, Discharge Rating at Gaging Stations, and WATSTORE User's Guide, Volume 5, Section 1-B, Data Translation/Transmission and Preparation, when a new rating curve and table is necessary. When the choice of graph paper, scales, and scale offset have been made using Chapter 12, the rating curve should be drawn by plotting the discharge as the abscissa, and the gage height as the ordinate.

a. Plotting discharge measurements. Each discharge measurement is plotted in pencil as an open circle about 3/32 of an inch in diameter, plotting from form 9-207. The guide line to the measurement is at an angle of 45° and points at the center of the circle. The guide line starts 0.2 inch from the circle and is 0.8 inch long. The number of measurements should be shown at end of the guide line and parallel to it when possible.

The rate-of-change in stage in feet per hour is shown on the guide line to all medium- and high-stage measurements, even though the change may be zero. If there is an adjustment to a discharge measurement by Boyer method, the adjusted discharge is plotted as an "X" and connected to the measured discharge by a dashed line. If a measurement is adjusted for change in storage between the gage and the measuring section, both measured and adjusted discharge are plotted, using symbol ___ for the adjusted discharge and connecting it to the measured discharge by a dashed line. The plotted points, guide lines, measurement numbers, etc., are inked by the checker and current year's measurements are blacked in with a soft pencil to distinguish them from the previous year's measurements.

b. Plotting discharge rating curve. (Note: The computation of the discharge rating is a major facet of the Contractor's responsibilities and must be performed carefully and accurately). The rating is

FORM 9-207
(Rev. 11-69)

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY (WATER RESOURCES DIVISION)
DISCHARGE MEASUREMENT SUMMARY SHEET

Station No. 06-010000

Discharge measurements of Nit Picker Creek near Careful, Montana, during the year ending Sept. 30, 1975

No.	Date	Made by—	Width	Area	Mean velocity	Gage height	Discharge	Rating No. 2 Shift adj.	Percent diff.	Method	Number meas. sections	Gage height change	Time	Meas. rated	Water Temp °C	Air Temp °C	REMARKS
			Feet	Sq ft	Fps	Feet	Cfs	Feet				Feet	Hr				
		1974 Water Year 1974 Continued															
17	Aug 5	Swift	13	5.20	0.31	1.45	3.78	0		5 & 6	21	0	½	G	11	-0.1	Control is gravel bar Clean "0" flow 1.00+ .02
18	" 31	Boss & Friend	146	1,150	2.40	7.89	2,760	-.09	-1	.2 .6 .8	24	-.18	1 2/3	F	14	0	Meas. from cable No drift. Channel control
19	Sep 28	Friend	92	584	2.14	5.37	1,250	-.03	+1	2 & 8	22	-.10	1	G	13	0	Wading 500 ft dwst. No inflow below gage channel control - clear
		Beginning Water Year 1975															
20	Oct 3	Swift	19	17.1	.85	1.68	10.1	-.12		.6	23	+.02	5/12	F	10	-.01	Moss in stream
		Gage destroyed by flood of Oct 7, 1974. Relocated 200 ft downstream of datum 2.0 ft lower Oct 10, 1974						No. 3									
21	Oct 10	Chief	37	128	1.38	1.79	199	0		2 & 8	24	-.01	3/4	G	11	-.01	Control is gravel bar No trash
22	Nov 11	do	11	17.2	.68	.59	10.9	0	-3	.6	19	0	5/12	F	1	+.01	Anchor ice in channel
23	Dec 21	do	9.1	8.41	.21	.38	6.78	0		.5	20	0	5/12	F	0	+.03	Control 90% ice covered stream open along left bank
	1975 Jan 17	Friend					0										Stream frozen solid No flow
24	Feb 21	Boss	3.7	2.54	.70	.95	1.81			.6	17	0	½	F	3	+.04	Ice on control affecting flow
25	Mar 18	Chief	1.2	.12	.5	.28	.06	+.02		Est	1	0	--	F	8	+.03	Control is gravel bar clear "0" flow 0.22+ .01
26	May 1	Moor				9.03	3,250			Slope Area				F			Slope area section 2000 ft upstream, surveyed May 5
	5	do				4.32	--	--	--	Found pen in reversal. Reset Log on control affecting flow.							~~Removed 1100 hours.~~
27	Jun 5	Less	6.0	7.60	12.5	*.71 .57	9.50	-.15 -.01		.6	20	0	⅙	G	11	+.01	Trash on control *gage-height ~~before cleaning~~
	Note: Above figures are not mathematically correct. They are used to indicate significant figures.																

Copied by............ Computed by............ Checked by............

U.S. GOVERNMENT PRINTING OFFICE : 1982 O - 386-949

Figure 1. Sample Form 9-207.

developed over the course of the water year with a new point plotted after each visit to the gaging station by the Contractor's field personnel. A separate discharge rating is kept for each station. The actual time that the rating is plotted depends on the experience level of the personnel involved. Measured discharge is plotted against concurrent stage on logarithmic graph paper to define the rating curve. The rating curve presents individual problems based on the control characteristics for the station, a knowledge of which is prerequisite for the rating analysis.

(1) Determine the rating curve by plotting the discharge as the abscissa and the gage height as the ordinate. A curve or line is fitted by eye as each point is plotted. Plotted points are tagged with their identifying measurement number.

(2) If the station is new, select scales that will accommodate the ranges of stage and discharge that are expected. If station is not new, plot all the measurements made since the analysis of the preceding year on the points of the last-used rating curve. If the "Remarks" column of SF 9-207 indicates that a measurement was made under altered control conditions, indicate that fact temporarily alongside the measurement number.

(3) If the rating deviates appreciably from the trend established by the previous measurements, a check measurement may be necessary. Check the computations of discharge and gage height of the original measurement, particularly the addition of the incremental discharges. Use the trend of previous measurements with respect to the latest curve, and not the curve itself, as the basis for judgment. Note: At a new station, many discharge measurements are needed to define the stage-discharge relation throughout the entire range of stage. Periodic measurements are needed thereafter to either confirm the permanence of the rating or to define changes (shifts) in the rating.

(4) Determine if the last-used rating ia applicable for part or all of the water year by computing percentage departures of measured discharges from the discharges for the measurment stages as indicated by the last-used rating table. Then tabulate the percentages on the list of discharge measurements.

(a) If departures are random in sign (±) and within ±5 percent, the last-used rating is kept in effect.

(b) If departures are more than 5 percent but the indicated change in rating is short-lived (less than 1 or 2 months), do not establish a new rating curve for the short period. Instead, apply gage-height shifts either to the rating in use prior to the period of shifting controls or to a new rating that is established for use starting with the period of shifting control.

c. Checking. Scales, title, notes, etc., shall be done originally in ink, but in general, everything else is done in pencil. The checker, after making any corrections, completes inking and cleans the form.

d. Review. The hydrologist-in-charge shall review each curve sheet. When satisfied that it is complete in all respects, he shall sign it in the special box to be drawn in the lower right-hand corner of the sheet.

12. Computation of Rating Table. The Contractor shall be familiar with the manual method of computing rating tables described in b. below. However, the Contractor shall be required to follow the computer-generated rating table method described in c. below whenever a new rating table is warrented.

a. If new rating is warrented:

(1) Consider the two columns headed "Rating " on SF 9-207.

(2) Draw a heavy line across the columns between the last measurement for the last-used rating and first measurement of the new rating, and above the later measurement, insert the new rating number.

(3) Compute shifts and enter them for any ice-affected measurements, but do not compute percentage differences.

(4) Add the closing date for the old rating to the rating curve plotted on graph paper, and add the starting date for the new rating curve. Tag the new curve with its identifying number.

(5) If the measurements and curves accumulated on a rating-curve sheet clutter the sheet, plot the new rating curve on a fresh sheet. Transfer old high-water and extreme low-water measurements that are needed as supporting data for the new rating curve to the new curve sheet.

b. Manual method. Basic rating curves to be used during the water year have now been defined and the next step is to transfer the ordinates of the rating curve to a rating table. This is a tabular expression of the information that is presented by the rating curve, and it provides a more convenient way of obtaining the discharge corresponding to any given stages. (Use SF 9-210.)

(1) Transfer to the rating table the identifying number of the rating and its starting date or period of appliecation.

(2) Read the discharge, starting with the low-water curve, and tabulate it at intervals of 0.1 foot of stage on the standard rating table form.

(3) On reaching the stage where the rating curve is no longer strongly curvilinear, tabulate the discharge at intervals of 1.0 foot or more. For those parts of the rating that are truly linear on a logarithmic plot, compute the discharge from the equation of the rating.

(4) Fill in blank spaces in the discharge column of the rating curve with values that are interpolated between the discharges that were entered into the table.

(5) Compute differences in discharge for each 0.1 foot of gage height and enter them in the appropriate column of the rating table. Differences should increase uniformly with stage, but this will seldom result from the discharges first entered from the rating curve.

(6) Adjustment of the rating table must be done judiciously so the recomputed discharges do not depart significantly from the original rating curve values, particularly in the vicinity of the plotted discharge measurements.

(7) If difficulty is encountered in smoothing the progression of different values while still adhering to the rating curve, compute second differences per tenth of a foot of stage. Then adjust the second differences to form a uniform progression.

(8) Recompute the first differences and recompute the discharges.

(9) To obtain discharges from the rating table for gage heights that are expressed in hundredths of a foot, compute the linear interpolation between the values shown for tenths of a foot of stage.

(10) Each rating table should be complete within itself for the entire range of stage through which it will be used so that it will not be necessary to refer to some other table that may be partially the same.

(11) Fill in the blank spaces below the rating table to indicate the data on which the rating is based, the range of discharge that was actually measured by current meter, and the basis of rating-curve extrapolation.

(12) Use the completed rating table as the basis for computing the percentage differences for discharge measurements on SF 9207 and replot rating curves in final form.

c. <u>Computer generated rating table method</u>. After the rating curve is drawn and checked, the Contractor shall use the following procedure to obtain a computer-generated rating table.

(1) Code SF 9-1873A, rating coding form , in accordance with WATSTORE manual Volume 5, Section 1-B Data Translation/Transmission and Preparation, pp. 47-48.

(2) Rating points (cols. 33-80) shall be carefully selected at the end points of straight line portions of the rating curve.

(3) Send SF 9-1873A to the USGS for processing of a computer printout of the rating table.

(4) Upon receipt of the rating table, carefully review and verify it against the rating curve.

(5) If discrepancies exist, resubmit forms to USGS with revised or additional rating points.

NOTE: The Contractor should be completely familiar with the manual computation of rating tables before using the computer generated computations method.

How these various methods are incorporated into the primary computation of records program and how the ratings are stored in the USGS rating file, will be discussed at the training seminar referred to in Part I, Article 10.

d. Shifting control adjustments. There is a certain cross-section on river and canal stations that control the relation between gage height and discharge. This may be a rock riffle, a sand or gravel bar, a natural constricted section, a dam, weir, flume, or collection of drift. It may be a stretch of the channel where only friction of bed and banks acts as control. When this section, called the control, is permanent or unchanging, there will normally be the same amount of water passing the gage for a given gage height. This seldom happens in nature. The sand bar, gravel bed, or drift pile changes during flood periods, debris is piled on rock fiffles, and aquatic vegetation, silt, and drift accumulate in channels, on and behind dams, and in flumes.

All of these control changes are reflected in the plotting of discharge measurements on the rating curve. Theoretically, a new curve should be drawn following each of these changes. However, instead of drawing new curves for each change in the state-discharge relation, a correction to the curve or table is developed, called a shifting-control correction on SF 9-207. Two columns down the center of the form were left blank when this form was made. At the top of these two columns is blank when this form was made. At the top of these two columns is "Rating ___" and the individual column headings are "Shift adj. feet" and "Percent diff." Place the rating table number in the upper blank if that table will be in use during the period when the first discharge measurement on the page was made. If a change in rating occurs between two measurements listed in the body of SF 9-207, draw a heavy line across these two columns below the last measurement applying to the prior rating table and write the number of the new table just below. Compute to hundredths of feet the gage height from the rating table which would produce the discharge shown on the measurement or as close to the measured discharge as possible. The difference between this computed gage height and the gage height of the measurement is the shift. If the computed gage height is the greater the shift is plus; if less, it is a minus. This should be checked with the curve according to the following criterion: If the plotted measurement is above or to the left of the curve, the shift is minus; if below or to the right, it is plus. Frequently errors in shift, plotting of points, and location of rating curves are picked up from this check.

It is obviously unlikely that a measurement will plot exactly on a rating curve, even if there are no shifts in the stage-discharge relations. A shift should not be computed for a measurement if that measurement plots sufficiently close to the curve to be within the percentage of the rating of the measurement. Therefore, one should compute actual percent differences without shifts before computing shifts. If all measurements are within the measurement rating and plot both plus and minus from the rating, computing shifts is unnecessary except in special cases where greater refinement is desired. On the other hand, if all measurements for a year plot within the rating and are all on the same side of the curve, one should consider shifting to all of them or drawing a new curve. When it has been decided to continue with the old rating, the analyst should compute, in pencil, percentage differences for each measurement to be used directly, placing the percentage in the second column. He should then compute the necessary shift adjustment for each measurement to be shifted to and the percentage difference after the shift adjustment has been made. The checker verifies the arithmetic of the computed shifts and percentage differences and inks them.

The checker should pay particular attention to the plus and minus signs. It is very easy to err in the sign of a shift. Too often a station record must be revised after computation because shifts have been applied in the wrong direction. A good method to check the sign of the shifts is as follows: Add the shift adjustment algebraically to the gage height of the measurement, enter the rating table at this gage height; if the computed discharge at this point equals the measured discharge, then the shift has been computed correctly.

The analyst initials and dates the proper spaces on charts and gage-height books.

e. Applying shifts. The Contractor shall apply shifts to the daily gage-height record to obtain the true discharge by:

(1) Prorating the shifts by time, i.e. from one measurement to the next.

(2) Prorating the shifts by stage, i.e. change shifts when the gage height changes.

(3) A combination of the two methods.

f. Submitting shifts. The Contractor shall provide shift information to the USGS as follows:

(1) Time prorated--list shifts on SF 9-1536.

(2) Stage prorated--provide data on SF 9-1874A as per the "Discussion of Varying Shift with Stage" in WATSTORE Users Guide, Vol. 5, Chap. 1C.

13. Transmittal of Digital Recorder Records. To facilitate the analysis and processing of surface-water data recorded by digital recorders, the Contractor shall function similar to a USGS field office wherein digital-records material shall be provided to the USGS office to be translated and submitted for computer processing of water-level records. Processing of the digital tape involves converting each field recorded value (usually represented by gage height) to a corresponding output parameter (usually discharge), obtaining daily means and extremes for print, and storing selected items in the Daily Value File on magnetic disk.

a. Digital recorder

(1) The basic data are dial readings punched at uniform time intervals by digital recorders on 16-channel tapes at the field installations. The Contractor shall transmit the digital tapes in accordance with WATSTORE User's Guide, Volume 5, Section 1-B, Data Translation/Transmission and Preparation, and as follows:

(a) The 16-channel tapes should be listed on transmittal letter SF 9-1609 for transmittal to the USGS.

(b) List the stations in downstream order and show the period of record.

(c) Indicate the rating table or conversion table (if applicable) to be used for each period and also indicate with an asterisk if the rating is in the ADP unit files or two asterisks if it is being submitted to be coded on SF 9-1873A.

(d) Submit shift corrections and datum corrections on SF 9-1874A or SF 9-1536.

(e) Submit information for the Daily Values on coding form for input, and update the Daily Values - SF 9-1841 to SF 9-1844.

(f) Submit information on the Station Header File on SF 9-1843A or SF 9-1872A. Organize the coding forms for processing digital recorder data in the order required for that particular job to insure that they will be punched and sorted in the proper sequence for entry into the computer program.

(g) Submit the supplemental data with the 16-channel tapes, i.e., in the same box, so that the USGS receives both items at the same time.

(h) Put the Contractor's name on each form to be submitted. This will help insure that the computations and forms are returned to the correct Contractor.

(2) Before transmission to the USGS, the Contractor shall examine the tapes to detect any inaccuracies in the record length, any improperly spaced feed holes or torn tape, or any clock stoppages. Special notes concerning these items shall be made on the tape leader, SF 9-176D or SF 9-176E, "Inspection of Digital Recorder," attached to the beginning of the 16-channel tape about 6 inches ahead of the punched record.

(3) The Contractor shall attach a separate tape leader to each complete and uninterrupted record. If the tape was advanced and reset in the field, the tape should be cut at this point and a new leader attached. The purposes for this are so that:

(a) The field office can precisely indicate on the tape leader their translation requirements.

(b) The translation instruction block serves to document for future reference the beginning and end of each period translated to magnetic tape for computing purposes.

(4) The block labeled "Translation Instructions" of SF 9-176D and SF 9-176E is for identifying complete uninterrupted periods of record for translation.

(5) Before each piece of 16-channel tape is translated by USGS personnel, the information in the translation instruction block is written on magnetic tape ahead of the record from the 16-channel tape. It is important that the information listed here be correct because the station number will be used by the computer program for matching the 16-channel tape record with proper conversion tables and supplemental data on punch cards.

(6) The beginning and end times listed in the translation instruction block are used to further identify the punched data that immediately follow. The beginning tape time and the ending tape time listed in the translation instruction block must agree exactly with the times on the 16-channel tapes. The computer program uses these items to divide the record into calendar days and hours. A comparison of the tape ending time and the watch ending time is used to compute time corrections. The maximum time correction that can be made by the computer program is 1 hour per day.

(7) If the clock stopped at any time, then the end dates and times listed by the person servicing the recorder in the field may have to be modified for entry in the translation instruction block. In that case, the translation instruction block should be completed in accordance with the assumptions made below.

(a) If the clock stopped and did not start again, the ending watch time should then be made to read the same as the ending tape time in the translation instruction block on the tape leader.

(b) If the clock stopped and did restart, it may be possible to make use of some of the later data if the times of stopping and restarting can be determined. In this case, the translation instructions block should be completed for the period before the clock stopped. A red pencil line should be drawn through the last punch of the first period of record on the 16-channel tape to indicate the ending tape time for this period. The first item beginning the next period of record should then be marked with a red pencil (this could be the next punch or several punches later depending on the nature of the clock stoppage). An expression for time similar to

04-15	2200 =	1530
(date)	(actual)	(on tape)

should be made on the tape to clearly mark the beginning of the next period. The date should also be indicated on the tape. The ending date and time of the tape should be labeled in a like manner to show the difference between actual and tape time. A second translation instruction block should be prepared using the actual time (not time as printed on the tape) for the second complete and uninterrupted period on the 16-channel tape.

(c) The procedure explained under paragraph b. above should also be used any time that a record exceeds the maximum number of days that are permitted on a single tape so that it has to be broken up into two or more short records.

(8) All references to time should be in terms of beginning and ending times and must be on a 24-hour basis.

(9) Mark the first automatic punch to be processed with red pencil through the middle of the row of holes. The black pencil line made in the field by drawing across the top of the punch block when the tape is in position to start recording automatically, will be through or just ahead of the last test punch, so the first automatic punch will be one punch beyond this one. For digital monitor multiple-item records, the red line must be drawn through item number one of the first complete sequence of punches after the test punches to ensure that the data on the tape are processed in proper sequence.

(10) Check to insure that the 16-channel tapes are rolled so that the beginning day of the tape will come off first as it is unwound. The inside diameter of the center of each strip of tape must also be larger than 5/8 inch to permit direct insertion on the supply spool of the translator or transmitter.

(11) A notation should also be made on the tape leader if there are any "0000" values punched. If there are more than 8 or 10

zero values punched consecutively, then the tape should be set up as explained in paragraph (7)(b) above. An effort should be made to avoid punching zero values because the magnetic tape translators and data transmitters are designed to stop automatically on each "0000" value (no holes punches) without recording the zero value on the magnetic tape.

(12) Occasionally, the punch pins in the digital recorder may stick or the paper may fail to advance which causes illegal punch combinations on the 16-channel tape. When these tapes are processed, the output from the primary computation may contain some alphabetic symbols instead of numeric data. Recorders that indicate these malfunctions should be replaced or repaired immediately. The photoelectric readers on the magnetic tape translators or data transmitters are designed to stop on illegal punch combinations, but occasionally one will pass this test.

(13) These data are transferred to magnetic tape records as described in the WATSTORE User's Guide, Volume 5, Section 1-B, Data Transmission. The addition of identification information is made at this time and includes site identification, elevation of the land-surface reference point, or reference datum, and the data corrections to the observed readings.

(14) The Contractor shall furnish the analog record, digital tapes with leaders completed, and coding forms to the USGS within 30 days after removal from the gaging station. These will become part of the associated record for each site for preliminary processing.

b. Within 20 days after the above material is received by the USGS, the primary computation sheets and computer produced stage discharge ratings for each gaging station shall be returned to the Contractor for editorial correction and review for correctness and completeness of record. The Contractor shall insure that the proper rating and appropriate shifts were applied correctly.

14. Computation of Daily Discharge. The Contractor shall determine values of mean daily discharge from the gage-height records which he collects and the stage discharge relations which he develops. The Contractor shall compute complete daily discharge records for all gaging stations specified as "continuous record stations" in Attachment 8.

The Contractor shall be responsible for insuring that his personnel have enough experience and technical understanding to compute daily discharge in strict compliance with the procedures described in the Geological Survey Technique Manuals and the WATSTORE User's Guide.

Discharge is computed from the gage-height record which may be obtained from (1) a digital recorder, (2) once-daily or more frequency readings of a non-recording gage, or (3) an analog recorder. Gage height for the first type is coded on a 16-channel paper tape at pre-selected time intervals. Computation procedures vary with the type of record and are set forth below. The second type may consist of readings obtained by a local observer, recorded in an official gage-height book (form DI-8); special forms furnished monthly by power companies or other allied organizations; or record furnished by the Weather Bureau. The third type is in the form of a graph from a water-stage recording instrument. If more than one record is available, the digital record is the primary record, the graphic record is a supplement to the primary record, and discharge should be computed from the type record in the following order; digital, analog, then non-recording. Days of no gage height from recorders or observation should be listed as such by an "a" day on the computation sheets.

a. Digital recorder. The Contractor shall review primary computation sheets produced by the USGS from digital recorder tapes submitted in accordance with paragraph 13 above. Revisions, adjustments, additions, and corrections shall be made by the Contractor including, but not limited to, the following: (1) estimated discharge for period of no gage-height record, (2) adjustments for doubtful gage-height record, (3) revisions for ice-affected periods or periods of back water, and (4) computation of peak discharge above a selected base.

The Contractor shall provide the revised and corrected primary computation sheets and Daily Values update forms to the USGS for finalized printout of daily-discharge tables.

b. Analog recorder. If the only gage-height record collected at the site is an analog record, the Contractor shall manually compute the mean daily gage heights, manually apply shifts and datum corrections on a daily basis, subdivide as required, and manually compute the mean daily discharge using the effective rating table for the period. At most stations, however, digital recorders will be used and analog recorders will only be used as a backup record in case of malfunction.

c. Non-recording gage. The Contractor shall record, in the local observer's gage-height book, all readings recorded by Contractor personnel on measurement notes. When all corrections have been noted and all extra gage readings have been recorded in the observer book, the Contractor shall compute mean daily-gage height by plotting observations on recorder paper and constructing a graph to show the variation in gage height. When the graph has been completed, it is tested in the same manner as an analog-recording gage record.

d. Hydrograph. A computer generated hydrograph of daily discharges shall be furnished to the Contractor for each station. It shall be used as a tool to estimate periods of missing or doubtfull gage-height record, and periods of ice effect. A hydrographic comparison between stations on the same streams or nearby streams shall be made by the Contractor to explain irregularities or to aid in detecting possible errors in the record which might be eliminated by re-examination of the base data.

e. Computation of daily discharge for periods of ice effect. At many gaging stations, the stage discharge relation is affected by ice during the winter, and it becomes impossible to compute the discharge in the usual manner. Several different methods can be used to estimate the discharge during ice-affected periods, depending on information that is available for a given station.

(1) If the gage-height record is complete, if regular discharge measurements are made, and if the stream has a practically complete ice cover at the beginning of the winter period that remains intact until the spring breakup, the Contractor shall use the following method:

(a) Plot temperature and precipitation record where needed from a nearby Weather Bureau station.

(b) Plot discharge measurements on hyrograph.

(c) Copy field notes on the hydrograph concerning ice conditions; write vertically on the day the note applies.

(d) With this information plotted on the hydrograph, the Contractor has a complete picture for the winter period of the available data. From this point on, the Contractor shall apply sound technical judgment in interpreting the record.

(e) The hydrograph from a nearby stream which remains open and free from ice effect most of the time--possibly because of warm springs, pollution, or because the control is covered and heated--should be used as a guide in estimating winter discharges.

(2) If there is intermittent or infrequent ice effect, the Contractor shall carefully examine the recorder chart and make appropriate adjustments for ice effect, giving consideration to the open-water part of the day.

(3) If there is no gage-height record available and no discharge measurements made, the Contractor shall estimate the discharge based on a hydrographic comparison with a nearby, preferably open-water, station and the temperature graph.

(4) All estimated discharges shall be shown on the hydrograph as a broken line.

f. Computation of discharge during periods of backwater. At many gaging stations, the stage discharge relation can be affected by backwater caused by ice, debris on the control, growth of moss or grass on the control or in the channel, etc. The Contractor shall review field notes and weather records, make a hydrographic comparison with nearby stations, and adjust the daily discharge record as necessary.

g. Estimation of discharge during periods of no gage-height record. The Contractor shall apply sound technical judgment in interpreting available data and estimating discharge during periods of no gage-height record. The Contractor shall compile all available data such as fragmentary gage-height records, weather records, inspection notes, discharge measurements, range line from graphic recorder, etc. The Contractor shall estimate the discharge based on the kinds of information mentioned above and a hydrographic comparison with a nearby station or stations.

h. Updated daily discharges. The Contractor shall submit all updated daily discharges to the USGS in accordance with WATSTORE User's Guide, Volume 5.

i. Tabulation of peak discharges. After discharge records are complete, the Contractor shall tabulate peak discharges above a selected base in accordance with the manual Preparation of Water-Resources Data Reports, pp. 38-40.

The Contractor shall return the revised and corrected computation sheets and Daily Values update forms, complete for the entire water year, to the USGS for finalized printout of daily discharge tables within 120 days after the end of the water year.

15. Preparation of station analysis. The Contractor shall prepare a station analysis for each station for each water year. This analysis covers data collected, procedures used in computing the data, and the logic upon which the computations were based. This provides a basis for review and serves as a reference in the event questions arise about the records at some future date. The analysis also includes a record of any changes in records collected, equipment, location, or other physical features. The document should be written clearly and concisely and should contain sufficient information so that those who are totally unfamiliar with the station will be able to follow the reasoning used in computing the records. The analysis should consist of:

a. Introductory paragraphs that describe the equipment and hydrologic conditions of the drainage basin above the station. (Any man-made changes in the drainage basin during the year shall be noted.)

b. The following sections outlining the quality of the base data collected and the methods used to convert those data into the final discharge figures:

(1) gage-height record
(2) datum corrections
(3) rating and shifts
(4) discharge
(5) special computations
(6) remarks
(7) recommendations

See attachment 7 for more detailed instructions.

Upon completion of the station analysis, the Contractor assembles all the deliverable items and data and information from each station report and sends it to the USGS district office for processing and storage into a computer system.

B. REQUIREMENT FOR DISCHARGE MEASUREMENTS AT DIFFERENT STAGES

Current meter measurements must be taken at significantly different stages to define adequately the relation between gage height and discharge. The Contractor shall make every reasonable effort to take current meter measurements, in addition to the regular monthly measurements during periods of high flows.

As shown in the individual station Data Collection Calendars of Attachment 2, more than one discharge measurement per month is shown for the spring season on many of the calendars. The Contractor shall acquire current meter measurements of high flows during flood season in excess of the normal monthly measurement as shown. For the several months shown where extra flood measurements are desired, the excess (over the normal one per month) flood measurements may all be made during one runoff event or a series of events without regard to the exact distribution shown in the calendar.

In planning the attempts at taking high-flow measurements, the Contractor shall consider under what conditions high flow is most likely to occur. The Contractor shall keep well informed on rainfall or snowmelt in the watershed above the gage site or in adjacent watersheds.

C. OPERATION AND MAINTENANCE OF CREST-STAGE GAGES

A crest-stage gage is used to determine the elevation of a peak stage occurring at specific location on a stream. These crest-stage gages are installed as auxiliary gages at a regular gaging station or possibly as the primary gage at a partial record station. The Contractor shall service and maintain the crest-stage gages as part of the gaging station data collection and operation, Attachment 3. For crest-stage partial record stations, discharge measurements and water-quality samples shall be obtained in accordance with Addendum 1 to Attachment 2. As soon as possible, establish the gage height for when flow breaks over the roadway.

The accuracy of peak data collected at a crest-stage station depends in part on the stability of a stage-discharge relation developed at the site. Rigid datum controls must be maintained by the Contractor at the gage site throughout the period of record. Physical changes of the site resulting from flood flows or man-made alterations must be evaluated.

The quality of peak data collected at a crest-stage station will depend primarily on the attention given to the site by the Contractor during the year. Accordingly, the Contractor shall provide the following service and maintenance at the crest-stage gage sites:

1. If the stage at time of inspection is <u>below the datum pin</u>, the procedure shall be as follows:

a. Remove the cap at the top of the gage pipe.

b. Remove the staff and if cork particles indicate a peak has occurred, mark the cork line with a pencil line, then remove all cork particles. If a cork line is found at the same elevation as the vent hole, the gage may have been topped. Always verify such a mark by outside high-water marks.

c. Enter the date of the inspection on the penciled line and measure the distance from the line to the bottom of the staff (to the nearest 1/100 foot).

d. Remove the lower cap and flush out any silt that might have collected, make sure all intake and vent holes are unobstructed.

e. Place 1 tablespoon of granulated cork in the bottom cap, and secure the cap with a pipe wrench. Caps that are easily removed are often taken by children of all ages. Make sure the intake system is positioned so that the five closely-spaced holes face upstream.

f. Replace the top cap (with a wrench), and make sure all bracket bolts and lag screws are tight.

g. Determine the present water surface at the gages (to the nearest 1/100 foot), if over-the-road flow exists.

h. Remove debris that might have collected on the gage.

i. Carefully describe and measure any debris that might have collected. Try to estiamte the location of the debris at the time of the peak flow (floating, lodged in the entrance, etc.). Draw a diagram of the obstruction. Remove the debris, and record any resultant change in the present water-surface elevation at the gage.

j. Document the outside high-water marks and any changes in channel properties. If a peak stage has not occurred since the previous visit, the cork supply in the gage may be adequate. Never assume the gage is fully charged because ants or wind will sometimes remove the cork.

2. If the present water-surface elevation is higher than the datum pin, and the stage is falling, the above procedure should be modified as follows.

a. Perform steps a to c (above) as described.

b. Carefully pour a teaspoon of cork (half of the amount used when servicing the gage from the bottom cap) into the gage pipe. Wipe the staff completely dry and lower it very slowly into the pipe. If the staff is lowered too fast, an erroneous present water-surface reading will result due to the rapid displacement of water within the gage pipe. Make it a practice to determine the present water-surface elevation by measuring outside the pipe.

c. Perform steps g to j (above) as described.

3. If the present water surface is <u>high and rising</u>, use the following procedure:

a. Remove the top cap.

b. Do not remove the staff from the gage. The removal of the staff may cause an erroneous mark if the stream is near its peak stage.

c. Determine the present water surface by measuring the distance between the top of the gage pipe and the water surface or the datum pin, if possible.

d. Indicate the rising trend of the stream on the note sheets along with the time of day.

e. Replace the top cap and try to identify the control for the present flow.

4. The USGS Technical Officer should be notified immediately if the recorded peak stage is such as to warrant an indirect determination of peak flow. Pre-flood plans should be made as to type of indirect to be made and best location for indirect.

Article III. DELIVERABLE ITEMS:

A. In the analysis and computational procedure the USGS shall be responsible only for the tape translation and computerized computation of the primary and finalized stage and discharge records.

B. The Contractor shall furnish the following as part of the associated record for each site:

1. For primary (or preliminary) record computation (digital recorders) the following items shall be furnished to the USGS within 30 days after removal from gaging stations:

a. Digital tape with tape leader and analog record for specified period.

b. Copies of discharge measurement notes (SF 9-275).

c. Coded forms showing stage and datum corrections and adjustments for furnished digital tapes.

d. Rating tables covering period of intended record computation.

e. Preliminary station analyses for the period furnished.

2. For finalized printout of daily discharge to be completed after USGS has returned computation sheets and computer-produced hydrographs of daily mean discharge for each site to Contractor for editorial correction and discharge correction or revision, the Contractor shall provide the revised and corrected computation sheet and update forms.

3. For permanent documentation for each data collection station to be a part of the permanent file of the USGS District Office, the following material shall be furnished to the USGS within 120 days after the end of the water year:

a. Original discharge measurement notes (SF 9-275). These original notes may be provided when data for primary record computation are furnished.

b. Discharge measurement listing (SF 9-207).

c. Inspection sheets for digital recorders (SF 9-176).

d. Level notes regarding datum control (SF 9-276).

e. Level summaries.

f. Station rating curves (SF 9-279).

g. Station rating tables (SF 9-210 and expanded SF 9-210a).

h. Revised manuscript station description.

i. Station analysis.

j. Discharge hydrograph (SF 9-274).

k. Computed daily gage-height and discharge:

(1) Analog recorder record.

(2) Digital record and tapes (preliminary and finalized computer printout).

(3) Correction and update form for daily values.

m. Extremes summary sheet including a tabulation of peaks above base.

n. Copies of all indirect determinations of discharge, if any, and associated forms, photographs, surveys, and computations.

p. Revised station description when any change has been made during the preceding year.

q. Data for each crest-stage site which includes: Station number, station name, station location, drainage area, period of record, date, gage height, and discharge of annual maximum.

Part III

SPECIFICATIONS FOR THE COLLECTION AND PROCESSING OF WATER QUALITY DATA

Article I. SCOPE

A. INTRODUCTION

This section of the specifications covers and defines the work to be done in the collection, processing, and field analysis of water-quality samples. The Contractor shall be responsible for furnishing all plant, labor, materials, and equipment in the performance of the water-quality data collection, except for the equipment listed in Part VI which the Government will furnish.

B. PRINCIPAL FEATURES

1. Work to be performed. The work to be done under this section by the Contractor includes the following:

a. Chemical Analysis

(1) Collection, preparation, filtering, preservation, and shipment of surface-water samples to Geological Survey Central Laboratory for analysis.

(2) Field measurements of selected chemical, physical, and biological water-quaity parameters.

(3) Operation and maintenance of water-quality monitors which record continuous pH, specific conductance, dissolved oxygen, and temperature data.

(4) Correlating field measurements of pH, specific conductance, dissolved oxygen, and temperature with corresponding monitor readings; and computation of shifts necessary to process the data.

(5) Checking and tabulation of corrected water-quality analyses.

b. Sediment Analysis

(1) Operation and maintenance of automatic sediment samplers, and

(2) Field collection and shipping of sediment samples.

2. The above general description of work to be performed does not in any way limit the responsibility of the Contractor to perform all work and furnish all plant, labor, materials, and equipment required by the contract, the specifications, and the attachments.

C. LOCATION OF SAMPLING SITES

The locations of the sites in Oklahoma where work is required under this contract are shown in Attachment 1.

D. FREQUENCY OF SAMPLING AND DATA COLLECTION REQUIREMENTS

The types and frequencies of samples to be collected and type of measurements to be made by the Contractor are shown in Attachment 2 for each site.

E. DELIVERY OF SAMPLES

The Contractor shall be responsible for mailing costs (first class required) in sending the water samples for chemical analysis to the Central Laboratory System and the sediment samples to the District Office located in Oklahoma City. If the Contractor fails to mail samples as called for in this specification, the Contractor shall be subject to termination for default of reduction of the contract price to reflect the reduced value of the service performed.

Article II. STATEMENT OF WORK

A. GENERAL

The Contractor shall preplan each visit and make all necessary preparations. He must be thoroughly familiar with the site-specific information needed, the equipment to be used, any maintenance, calibration, and repair procedures that may be required, and all the methods outlined in these specifications for field measurements, sample collection, sample preservation, and sample processing. The Contractor shall take all equipment, maps, forms, and the like that will be needed at each site.

B. OPERATIONAL PROCEDURES OF THE CONTRACTOR

1. Initial Procedures. Upon arrival at the site, the Contractor shall make a visual observation of the surrounding area and of the site itself to detect any problems which may influence his work. Such factors as weather conditions, streamflow, color of the water, condition of the site, and any other relevant observations shall be noted before proceeding.

The field notes shall indicate any special precautions to be taken. The Contractor shall remember that the colleciton and recording of data is a continuous process that follows step by step as indicated in the instructions below. To insure a satisfactory permanent record of water quality at each site, he shall use every precaution to assure adequate recording and documentation.

With completion of these initial procedures, the Contractor shall inspect, calibrate, and clean the instruments, recorders, and any other equipment that will be needed for each part of the sampling procedure and maintain a log of the calibrations for each instrument. Every piece of equipment must be in good condition (flasks, tubing, etc.) to insure successful and accurate sampling and measurements. Note any problems that arise with the equipment. For specific information on equipment maintenance, calibration, and repairs, see the service manuals furnished and the Techniques of Water-Resources Investigations manuals (TWRI) furnished by the USGS. Use TWRI Book 5, Chapter A1, Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gasses 1979 edition; TWRI Book 3, Chapter C2, Field Methods for Measurement of Fluvial Sediment; and TWRI Book 1, Chapter D1, Water Temperature-Influential Factors, Field Measurement, and Data Presentation. Appendix I and II provides a quick reference for field measurements and collection of water quality.

2. Where Field Determinations are called for in the Data Collection Requirements and Calendar, Attachment 2, the Contractor shall:

a. Make field measurements of the following paramaters and enter results on coded form provided by the Survey.

(1) Alkalinity/Acidity

(a) pH above 4.5: The Contractor shall perform field measurements for Alkalinity in strict accordance with the procedure set forth in Appendix I, "Field Measurement of Water Quality," Section 3.1.

(b). pH below 4.5: The Contractor shall perform field measurements for Acidity in strict accordance with the procedure set forth in TWRI Book 5, Chapter A1, p. 414-16, method I-1021-78.

(2) Dissolved Oxygen: The Contractor shall perform field measurement for Dissolved Oxygen in strict accordance with the procedure set forth in Quality of Water Branch Technical Memorandum 79.10.

(3) pH: The Contractor shall perform field measurement for pH in strict accordance with the procedures set forth in Appendix I, Sections 3.4 and 3.5. The Contractor shall use the glass electrode method for measuring pH.

(4) Specific Conductance: The Contractor shall perform field measurement for Specific Conductance in strict accordance with the procedures set forth in Appendix I, Sections 3.2 and 3.3.

(5) Temperature of Water: The Contractor shall perform field measurement for temperature in strict accordance with the procedures set forth in Appendix I, Section 3.7.

(6) Temperature of air.

(7) Discharge: The Contractor shall include the results of the current discharge measurements. In the event no measurement is available, a preliminary discharge figure should be entered based upon latest information.

3. Where chemical samples are called for in the Data Collection Requirements and Calendar, Attachment 2, the Contractor shall collect, prepare, and handle the water samples in accordance with the procedures set forth in Appendix II and appropriate TWRI's. The Contractor shall divide the volume of water collected into subsamples as necessary using techniques given in Attachment 5.

The volumes of the required subsamples, the types of container to be used for each, the type treatment and/or preservation, and sample designation are given in Attachment 5B.

Where the following analyses are called for in the Data Collection Requirements and Calendar, Attachment 2, the Contractor shall perform the following:

a. Collect sufficient volumes of water for the corresponding laboratory schedules using appropriate type of bottle and type of treatment as required in Attachment 5.

b. Label, package, and ship, by the most expedient methods available (priority mail preferred), the sample on the day of collection to:

U.S. Geoloigcal Survey, WRD
Central Laboratory
5293 Ward Road
Arvada, Colorado 80002

	Type of Chemical Sample Analysis	Laboratory Schedule
(1)	Major Constituents	425
(2)	Nutrients	426
(3)	Minor Constituents - dissolved	1076
(4)	Minor Constituents - total	1176
(5)	Emission Spectrograph - dissolved	1090
(6)	Bottom Material	1292
(7)	Phenols	LC0052
(8)	Cyanide	LC0023
(9)	Barium, Lithium, Strontium	427

4. Where a sediment-suspended concentration sample is called for in Attachment 2, the Contractor shall perform the following:

a. Collect sufficient volumes of water using methods and volumes presented in TWRI Book 3, Chapter C2.

b. Cap, label, and store samples in a secure location away from freezing or excessive heat and light conditions.

c. Ship collected samples monthly to the U.S. Geological Survey office designated as the area technical coordination office.

5. Where sediment-suspended size and/or bed-size data are called for in Attachment 2, the Contractor shall perform the following:

a. Collect sufficient volumes of water and bed material using methods and volumes presented in TWRI Book 3, Chapter C2.

b. Cap, label, and store samples in a secure location away from freezing or excessive heat and light conditions.

c. Ship collected samples monthly to the U.S. Geological Survey office designated as the area technical coordination office.

6. Where coal-separation analysis is called for in Attachment 2, the Contractor shall perform the following:

a. Collec sufficient volumes of bed material for analysis of parameters listed as Lab Code LC1038 in Attachment 5.

b. The samples shall be wet sieved in the field to pass a 2.00 mm sieve but not to pass a 0.06 mm sieve.

c. The volume, type of container to be used, and type of treatment code required are given in Attachment 5.

d. Label, package, and ship by most expedient methods available (priority mailing preferred) the samples on the day of collection to:

U.S. Geological Survey, WRD
Central Laboratory
6481 Peachtree-Industrial Blvd., Suite H
Atlanta, Georgia 30340

7. Where a Biological-Phytoplankton sample is called for in Attachment 2, the Contractor shall perform the following:

a. Collect sufficient volumes of water for laboratory schedule 1076 listed in Attachment 5. The sample container and preservative will be supplied by the Survey laboratory.

b. Process the sample as listed in instructions accompanying the sample container.

c. The volumes or types of sample, type of bottles to be used, and type of sample treatment required are in Attachment 5.

d. Label, package, and ship samples on the same day of collection and by the most expedient methods available to:

U.S. Geological Survey, WRD
Biolab
6481 Peachtree-Indistrial Blve., Suite H
Doraville, Georgia 30340

8. Where a Biological-Periphyton sample is called for in Attachment 2, the Contractor shall perform the following:

a. Place clear plastic strips and designated periphyton strips in the stream monitored according to instructions listed in TWRI Book 5, Chapter A4.

b. After 4 to 6 weeks, recover periphyton strips, and process per instructions supplied with periphyton strips and container and listed under laboratory schedule 1708 in Attachment 5. Put strips in empty 10-oz. wide-mouthed glass bottle and chill. No water should be placed in the bottles.

c. Label, package, and ship the samples on the same day of collection and by the most expedient methods available to:

U.S. Geological Survey, WRD
Biolab
6481 Peachtree-Industrial Blvd., Suite H
Doraville, Georgia 30340

9. Where a Radiochemical sample is called for in Attachment 2, the Contractor shall perform the following:

a. Collect sufficient volume of water for the analysis of parameters listed in Attachment 5 as schedule 1405.

b. The volume of sample, type of bottle to be used, and type of treatment are given in Attachment 5.

c. Label, package, and ship, by most expedient methods available (priority mailing preferred), the samples on the same day of collection to:

U.S. Geological Survey, WRD
Radiochemical Laboratory
5293 Ward Road
Arvada, Colorado 80002

10. Operation and maintenance of the water-quality monitor

a. Initial data collected

(1) Station name, in full

(2) Date; month (name, not number), day, and year

(3) Time; watch time using 24-hour time system

(4) Punch time on digital recorder

(5) Initial readings, and their respective converted readings from the monitor (D.O., pH, Specific Conductance, Water Temp.)

(6) Field meter readings for each of the parameters

(7) Initials of Contractor(s)

(8) Additional remarks related to station conditions

b. Servicing the QW monitor and recorder: After the initial visual checks, the Contractor proceeds to the station structure to service the water-quality monitor recorder using the following steps as a guide:

(1) Determine if the timer is running and draw a line across the tape for a guide. If tape is not removed, record time and data at the line on the tape.

(2) Switch QW monitor to manual operation.

(3) Standardize field instruments according to instructions in individual manufacturer's instrument manuals.

(4) Record monitor readings and measured field readings to detect differences.

(5) Examine and clean pump intakes, probe reservoirs and probes.

(6) Check reading of each monitor probe in a standard test solution and record on field sheet.

(7) Record monitor readings of stream with field readings.

(8) Make necessary adjustments of monitor if readings do not agree. Record readings after adjustment.

(9) Switch QW monitor back to automatic operation after recorder has been serviced.

(10) Upon completion of monitor servicing and inspection, the Contractor repeats step (1).

c. Servicing the recorder

(1) At intervals not to exceed two months, the used section of digital tape bearing the QW monitor record should be removed and

(a) Cut the tape leaving at least one full day in addition to the day of the visit on the end of the tape.

(b) Examine the tape to detect any recorder malfunction or clock stoppage since the last inspection, and record the station name, date, time, and initials of Contractor(s) on the tape.

(c) Check the amount of tape left on the supply roll and make certain that there is more than enough to last the interval between visits.

(d) Check battery voltage or anperage and record. Replace battery if no load voltage is less than 7.0 volts.

(e) Rethread the digital tape into the take-up spool, read all parameters on the monitor again, and record all data and observations on the field sheet.

(f) Record, on the unused portion of the new digital tape above the punch block, station name, station number, date, time, and initials of Contractor(s).

(g) Complete tape leader for record removed, and begin a new tape leader for the current record.

(h) Advance digital tape and timer to proper times, and make a mark along top of digital punch block across tape.

d. The Contractor shall keep in mind several additional points when servicing the station.

(1) Periodic cleaning and oiling of the recorder can reduce malfunction of recorder.

(2) Intakes and sediment traps shall be cleaned thoroughly.

(3) Humidity and temperature control reduce errors associated with paper expansion and contraction. Excessive humidity and temperatures in the gage house shall be kept to a minimum by proper ventilation.

e. The Contractor shall not leave the station without assuring himself that:

(1) The recorded monitor readings and time agree with the field readings and his watch time;

(2) That the clock is running;

(3) That all necessary valves are open;

(4) That the digital recorder is punching; and

(5) That all doors have been locked.

11. Transmittal of Digital Recorder Records - QW Monitor. To facilitate the analysis and processing of QW monitor data recorded by digital recorders, the Contrator shall function similar to a USGS field office wherein digital-records materials shall be provided to the USGS office to be translated and submitted for computer processing of QW monitor records. Processing of the digital tape involves converting each field recorded value to a corresponding output parameter obtaining daily means and extremes for print and storing selected items in the Daily Value File on magnetic disk.

The basic data are dial readings punched at uniform time intervals by digital recorders on 16-channel tapes at the field installations. Specific conductance, D.O., pH, and water temperature data are punched on a single digital recorder. These water-quality data are punched in a predetermined sequence on a 16-channel paper tape at preselected time intervals. The Contractor shall process the digital tape as follows:

a. The 16-channel tapes shall be listed on transmittal letter SF 9-1609 for transmittal to the USGS. List the stations in downstream and chronological order and show the period.

b. Indicate the conversion table to be used for each period and each parameter, and also indicate, with an asterisk, whether the conversion table is in the ADP unit files or is being submitted on Forms 9-1837A.

c. Submit shift corrections and datum corrections on SF 9-1536.

d. Submit information for the Daily Values code card on SF 9-1752A.

e. Submit information on the Station Header File on SF 9-1843A and SF 9-1872A. Organize the coding forms for processing digital recorder data in the order required for tat particular job to insure that they will be punched and sorted in the proper sequence for entry into the computer program.

f. Submit the supplemental data with the 16-channel tapes, i.e. in the same box, so that the USGS receives both items at the same time.

g. Put the Contractor's name on each form to be submitted. This will help insure that the computations are returned to the correct Contractor when the transmittal memo and supplemental data sheets are separated.

h. The Contractor shall follow instructions in WATSTORE User's Guide Vol. 5, Chapter IX, Sections A, B, and G, when preparing 16-channel tapes for transmitting to USGS.

i. These data are transferred to magnetic tape records as described in the WATSTORE User's Guide. The addition of identification information is made at this time and includes site identification, elevation of the land-surface reference point or reference datum, and the data corrections to the observed readings.

12. Automatic Sediment Collection: An automatic sediment sampler (PS-69) shall be installed in some station structures as indicated in Attachment 8. The PS-69's will be set to automatically collect samples daily and during rises. Daily samples will be collected on a timed sequence whereas samples for rises will be based on gage-height sampling. As experience is gained at each site the requirements for gage-height-change sampling may be adjusted. The technical officer will notify the Contractor when such adjustments are necessary.

After the initial visual checks, the Contractor shall proceed to the station structure to service the automatic sediment sampler (PS-69) using the following steps as a guide:

a. Initial data collected

(1) Station name in full

(2) Date; month (name, not number), day, year

(3) Time; watch time using 24-hour time system

(4) Pen time on analog recorder chart

(5) Number of event marks on analog chart

(6) Number of bottles pumped by PS-69

(7) Notes explaining the difference (if any) between items 5 and 6

(8) Time last sample was collected by PS-69 prior to ETR (equal transit rate) method sample

(9) Starting and ending time ETR was collected

(10) Time of first automatically collected sample by PS-69 after ETR method sample

b. Servicing the PS-69

(1) Check power supply for proper operation and record on service log.

(2) Check the analog record for daily sample collection to see if timing cycle is operating correctly. Time between collections should equal the time set on the timer. During periods of no flow, check the TC-76 timer by pressing red button; this should start the PS-69. If the timer is not working, replace it. Note whether or not the micro switch is in or out of the notch on the cam. If the switch is already out of the notch, proceed to step (3). If the switch is in the notch, slightly loosen the knurled nut in the center of the cam. Rotate the plastic cam counter clockwise until the switch is fully out of the notch. This will allow a condenser in the control

unit to discharge itself (after 1 minute) which is necessary before the sampler can be restarted. (Replace 1½ volt, D cell alkaline battery at 1 month intervals.)

(3) Service analog recorder: Carefully remove strip chart and count the number of event marks on the tape and record. This number should equal the number of bottles pumped by the PS-69. If there are more bottles than there are event marks, check the chart marks to see if it is possible the sampler could have been activated both by the timer and the delta-stage switch during a single 15-minute lapse of the digital recorder. If this is not possible, proceed as suggested by item 7 of the trouble-shooting procedures beginning on page 18 of the PS-69 Operations Manual. If there are less bottles than there are event marks, follow the suggestions outlined by item 8 of the trouble-shooting procedure.

(4) Remove bottles which contain samples. On each bottle write station name, the date sample was removed, and appropriate sample number. Replace them with clean bottles.

(5) Reset the swing arm in its starting position. As noted in the Operations Manual, "Some backlash exists in the gears which drive the swing arm. To eliminate the lash, start tightening the wing nut when the arm is about 2" from the starting position. Be sure the wing nut is tight!"

(6) Check to be certain that the low-flow cut-off switch, coupled to the manometer, will disconnect the pump before the water surface in the stream receeds below the sampler intake.

(7) Observe the sampler intake to be certain it is in the water and free of debris.

(8) Replace bottles 1 through 4 which are to be used each visit simply for checking.

(9) Check out sampler

(a) Manually cause the delta-stage switch to close. Note the stage at which the sampler is started. The sampler should start immediately. If the switch is found closed, it must be opened for at least 2 minutes. This is necessary to permit a condenser in the control box to discharge before the sampler can be restarted. After waiting at least two minutes, close the switch to start the sampler.

(b) If the TC-76 timer is not used, recycle and time (see (c)) the sampler by activating the time switch. Mark the cam where the micro switch is resting, then slightly loosen the holding nut at the center of the cam. Rotate the loose cam counter clockwise until the micro switch is activated. Return the time cam back to its original position.

(c) While the sampler is running, time and record both the backflush and the refill portions of the operating cycle. Excessive pumping time in either direction indicates debris, air leaks, or pump wear. These problems should be isolated and corrected. The most likely spots for air-leaks are around the hose clamps on the stream side of the pumps. These clamps should be tightened occasionally.

(d) Be certain to push drawer back to sampling position and check nozzles for correct positions over bottles. Inspect, and if necessary, clean the contacts of the power relays in the control box. Use a contact file or burnisher availabie from most electrical stores. Abrasive cloths or papers that contain conductive matallic oxides should not be used.

(e) Recycle the sampler again and check the lower float and the bottom of the flush tank for debris.

(f) Examine the bottles filled during the checkout procedure to see that they are greater than 1/2 full but not overflowing.

(g) Examine the event marker to be sure a mark was recorded for each sample pumped. Make necessary notes on the recorder chart to identify the test runs. Enter pertinent data in the sampler log book.

(h) When trouble is encountered, follow the "Flow Diagram trouble shooting guide" (see Attachment 9); if the trouble is not discovered by use of this guide, refer to the trouble-shooting procedure beginning on page 17 of the Operations Manual.

(10) After the PS-69 has operated correctly, remove the four bottles used for the check and replace with clean bottles.

Reset the swing arm to the start position

(11) Cycle the sampler to take a sample which will correspond to the manual sample set at the control. This can be done by shorting terminal C-1 to C-4 using a short piece of electrical wire. Label this bottle (should be number 1) with station name, date, time it was taken, taken by PS-69, temperature, bottle number, and initials of fieldman. Cap this bottle and replace it in the sample drawer. Be certain to push drawer back to sampling position and check nozzles for correct positions over bottles.

(12) Collect reference sample set, see IIB.13.a.

(13) As soon as possible cycle the sampler to take a sample which will correspond to the manual sample set at the control. This can be done by shorting terminal C-1 to C-4 using a short piece of electrical wire. Label this bottle (should be number 2) with station name, date, time it was taken by PS-69, temperature, bottle number, and initials of fieldman. Cap this bottle and replace it in the sampler drawer. Be certain to push drawer back to sampling position and check nozzles for correct positions over bottles.

(14) Refill (using distilled water) the samples removed from the PS-69 sampler, so that the volumes compare with the No. 1 sample which was taken on the last visit and the sample just taken.

(15) Cap all automatically and manually collected samples. Check to make sure they do not leak, and deliver to the appropriate USGS office or laboratory. Put in cases to deliver to appropriate USGS office or laboratory.

(16) Deliver samples with all appropriate field data sheets, analog record, etc. to the Oklahoma District Laboratory, Room B27, 201, N.W. 3rd Street, Oklahoma City, Oklahoma 73101.

13. Manual Sediment Sampling

a. Where sediment-concentration suspended samples are scheduled as Attachment 2, collect a reference sample set. This sample set is to be a multivertical sediment-concentration suspended sample using the ETR methods presented in TWRI Book 3, Chapter C2. Cap, label, and store samples in a secure location away from freezing or excessive heat and light conditions. A PS-69 sample (or single vertical sample if no PS-69 is installed) shall be collected prior to and after the reference sample is collected. A correlation shall be established between the daily automatically collected or single vertical samples and manually collected reference samples.

b. Where sediment-size distribution suspended and bed material data are called for in Attachment 2, the Contractor shall use methods presented in TWRI Book 3, Chapter C2. Cap, label, and ship sample to the U.S. Geological Survey Office designated by the Technical Officer.

Article III DELIVERABLE ITEMS

A. The USGS shall:

1. Within 20 days after receiving digital tape from Contractor, transmit tape to generate primary printout of each parameter;

2. Return primary printout to Contractor;

3. Update daily value file using coded data provided by Contractor;

4. Provide finalized tables for review to Contractor;

5. Make any update;

6. Furnish the Contractor the annual table of daily values for each parameter for final review;

7. Update daily values and publish;

8. Results of laboratory measurements will be given to the Contractor as soon as practicable;

9. The Survey will retrieve annual tables of laboratory results as soon as possible after the end of the water year; and

10. Update annual tables of laboratory results and publish.

B. The Contractor shall:

1. Within 30 days after removal from the recorder, furnish the following as part of the associated record for each monitor site for primary (or preliminary) record computation:

a. Digital tape for specified period

b. Original water quality monitor field notes

c. Digital tape leader covering period for associated digital tape

d. Coded forms showing shift corrections and adjustments for furnished digital tape

e. Rating tables covering period of intended record computation

f. Statement detailing reasons for shifts, action taken, etc. for the period furnished

2. Within 30 days after receiving primary printouts of daily values, Contractor shall furnish:

a. Coded forms for updating the daily values

b. Corrected primary printouts

3. Within 30 days after receiving the daily values table for the water year, review it for error and return corrected copy to USGS.

4. The Contractor shall deliver to the COR within 10 days of a field visit, copies of the field notes including coded results of field measurements and log inventory forms.

The Contractor shall be prepared to deliver any records concerning his measurements and sampling to the Survey upon request. Requests will be delivered within 15 days after receiving the submission results.

5. Upon receipt of the results of the sample analyses, the Contractor shall review the laboratory results for errors and inconsistencies and prepare coded file-update forms as needed within 30 days following receipt of the laboratory results from the Survey.

6. Upon receipt of the annual tables, the Contractor shall review and indicate needed corrections to the Survey within 30 days after their receipt from the Survey.

7. The Contractor shall deliver sediment samples to Oklahoma District Laboratory, Room B27, 215 N.W. 3rd Street, Oklahoma City, Oklahoma 73102, on a weekly basis.

8. The Contractor shall provide, along with the analog record containing the event marks for automatic sediment samples, a list showing number and type of samples collected. Type of samples shall be divided into automatic or single vertical samples and ETR multivertical samples.

9. Upon completion of this contract, the Contractor shall deliver all Government-furnished equipment, remaining supplies, keys, maps, and forms, plus all station record files, within 30 days of the contract termination.

Part IV
SPECIFICATIONS FOR COLLECTION AND PROCESSING
OF GROUND-WATER LEVEL DATA

ARTICLE I. SCOPE:

A. INTRODUCTION

This section of the specifications covers and defines the work to be done in the collection and processing of ground-water level data from a basic network of observation wells. The Contractor shall be responsible for all plant, labor, materials, and equipment in the performance of the ground-water level data collection, except for the equipment listed in Part VI, and standard forms to record data, which the Government shall furnish.

B. PRINCIPAL FEATURES

1. Work to be Performed. The work to be done under this section by the Contractor includes the following:

a. Operation and maintenance of ground-water level recording stations, including datum control.

b. Maintenance and collection of complete and accurate continuous ground-water level data (water surface elevation) at each observation well site.

c. Making tape-down readings at each observation well site.

d. Providing corrections to be applied to the record for computation of mean daily water levels.

e. Field observations of local conditions such as stage in nearby surface-water bodies; weather conditions such as heavy rainfall or high winds; construction or pumping of nearby wells; frozen ground; changes in local land surface due to construction or mining-related activities; sound of cascading water in the observation well; recent pumping of the observation well; or conditions which could have had a significant effect on the water level being measured.

2. Contractor's Responsibility. The above general outline of the principal features does not in any way limit the responsibility of the Contractor to perform all work and furnish all labor, materials, and equipment required by the contract, the specifications, and the attachments.

C LOCATION OF GROUND-WATER LEVEL STATIONS

1. Well Data. The wells from which ground-water level data are to be obtained have been selected by the U.S. Geological Survey. Attachment 1 describes the general location of the wells to be measured. Each ground-water station consists of a digital recorder housed in a steel shelter.

2. Detailed Locations and Descriptions. The appropriate USGS office shall provide the Contractor with sketch drawings that may be used to locate each well. One shows culture and land features in the vicinity of the well. Adequate details are provided to permit an observer unfamiliar with the area to locate the well relative to permanent landmarks or reference points. Another sketch provides details on location of the measuring point (MP) from which manual measurements have been made, and the relationship between the MP and land surface datum (LSD) and possibly also its relationships to other nearby permanent reference point(s) RP other than land surface and needed details on access to wells.

D. FREQUENCY OF INSPECTION AND MEASUREMENT

The Contractor shall visit each observation well site and make a tape-down water-level measurement at least once each month.

E. GAGE DATUM

The Government will run levels at each observation-well site and establish the distance of the datum mark (tape-down point) above the concrete base at ground level. The Contractor will be responsible to maintain the elevation of the datum mark or make the proper adjustments if the tape-down point is disturbed.

F. LIABILITY FOR DAMAGE TO WELLS

The Contractor shall immediately report any loss of tape, weights, or other objects into an observation well to the COR. The Contractor shall maintain the responsibility and be liable for any and all damages due to his negligence.

G. QUALITY CONTROL

At random intervals, USGS representatives will visit selected recorder stations to check that the recorders are being properly serviced and maintained and the proper procedures are being used to assure acceptably accurate water-level measurements and to minimize periods of lost record.

Article II. STATEMENT OF WORK

A. OPERATION AND MAINTENANCE OF GROUND-WATER LEVEL STATION

1. General The Contractor shall provide for the operation and routine field maintenance of a basic network of observation wells and the collection, analysis, and processing accurate hydrologic data related to ground-water levels in accordance with applicable and recommended procedures now in use by the USGS and detailed in manuals or bulletins furnished by the Geological Survey and detailed herein. During every visit to each observation well, the Contractor shall follow the procedures for taking and recording measurements and for proper and accurate accomplishment of all procedures and responsiblilies. The Contractor shall insure that his employees follow the procedures outlined below. Failure to do so shall subject the Contractor to the default provision of this contract.

2. Maintenance of Observation-Well Site. Upon arrival at the observation-well site, the Contractor shall make a visual inspection of the site and the surrounding area to determine any changes or problems which may prevent continuation of later steps, and perform maintenance of the well site.

a. Minor maintenance. The Contractor shall perform minor maintenance such as minor repairs necessary to keep the well site operational, safe, and to maintain its appearance. Such minor repairs include, but are not limited to, replacement of defective recorders and timers which cannot be repaired in the field, replacement of defective floats, and repainting and repairing the shelter as required. The Contractor shall furnish all labor and materials necessary to perform the work, with the exception of those items of equipment that duplicate, replace, or repair instrument or appurtenant fixtures that were provided by the Government. Materials such as these shall be provided to the Contractor by the COR. The Contractor shall keep the shelter clean and oil hinges, locks, and hasps. The Contractor shall maintain a neat appearance at the site by clipping weeds and grass around the shelter, removing debris, and generally keeping the area clean. Minor maintenance shall be done at no additional expense to the Government.

b. Major maintenance. Major maintenance is defined as repair or services required to make the site opertional after a period when the site was inoperative because of vandalism or damage to station due to natural or man-made causes. Such major repairs include, but are not limited to, extensive rebuilding of the shelter and complete replacement of instrumentation.

The Contractor shall within 3 days of discovery of a situation that might require major maintenance, notify the COR and inform him of the amount and costs of remedial work planned. The COR shall within 5 days after notification, advise the Contractor whether or not to proceed with the work. All work shall be completed as soon as possible after approval and in all cases shall be completed within 30 days. Contractor shall furnish all labor and materials necessary to perform the work, with the exception of those items of equipment that duplicate, replace, or repair instrument or appurtenant fixtures that were provided by the Government. Materials such as these shall be provided to the Contractor through the COR.

All costs associated with major maintenance shall be handled outside of this contract. The Contractor may or may not be requested to perform certain major maintenance, but in no event shall the Contractor be obligated to perform such maintenance under this contract, unless the need for the major maintenance is due to negligence of the Contractor. If such negligence does exist, then the Contractor shall be responsible for accomplishment of the major maintenance at no expense to the Government.

All work performed shall be subject to inspection. Government shall have the right to require the Contractor to perform the work again if the maintenance work is defective or would reduce the major maintenance price to reflect reduced value of services provided.

c. Site Security. The Contractor shall close and lock all gates or doors wherever appropriate with regard to protection of the site.

d. Maintenance and Replacement of Batteries. The Government shall furnish 7½ volt batteries to initiate operation of the equipment at each gage site.

The Contractor will be responsible for insuring continuous operation of the well sites and will be responsible for supplying and replacing the batteries. The Contractor shall replace batteries on all recorders regularly at 6-month intervals. The Contractor shall replace all recorder batteries in October and March or when the no-load voltage drops below 7.0 volts.

Unforeseen events can cause batteries to run down. Having replacement batteries on hand is the responsibility of the Contractor. Missing record because of failure to replace batteries is unacceptable performance on this contract and may subject the Contractor to a reduction in contract price, if warranted.

3. Initial Data Collected at Site. The collection of data from the well-site recorders and instruments is a continuous process that follows each step taken in the succeeding instructions; to insure a permanent record of these data, the Contractor shall use every precaution to assure adequate recording and documentation. The data and information collected initially and throughout site servicing, shall include:

a. Station name, in full;

b. Date: month (name, not number), day, and year;

c. Time: watch time using 24-hour time system;

d. Pen time of analog recorder, punch time on digital recorder;

e. Tape-down water-level readings;

f. Water level by float tape, if available;

g. Initials of Contractor(s);

h. Additional remarks related to station conditions.

4. Servicing the Water-level Recorder. After the inital visual checks and preparation of the record sheet, the Contractor shall service the recorder. The recorder shall be serviced using the following procedures as a guide:

a. Check to see if the clock and/or timer is running, and mark the recorder chart

(1) by marking the point where the pen or pencil is resting on the strip-chart recorder (adjust timer if needed or replace if timer has been malfunctioning), and

(2) by watching the instrument punch the digital tape and drawing a line across the digital tape, using the top of the punch block as the straight edge.

b. Compare tape-down water-level measurement with recorded water-level data, and check to see if there is a malfunction of the equipment such as

(1) defective float,

(2) float hung up in well, and

(3) if there are any inconsistencies between the recorded and tape-down measurements, note them so that adjustments can be made to the recorded water-level record.

c. Records shall be removed from each recorder at intervals not to exceed 2 months. Change the record from each recorder as follows:

(1) Analog recorder

(a) At the time of initial inspection, the time shall be indicated by a vertical mark of the pen or pencil. The float tape or cable should be grasped between the float and the float wheel and lifted a few hundredths and gradally released. The mark should not be made by rocking the float wheel because it places undue strain on the float wheel bearing.

(b) Advance the chart about 1 inch. Run a reversal mark and adjust if necessary.

(c) Blot the ink at the end of the recording to prevent smears.

(d) Identity the chart by printing the name of the station, date, time, water-level readings, and initials of person.

(e) Cut and remove the chart, leaving at least 1 full day in addition to the day of the visit on the end of the chart to provide ample room for joining the pieces in the office.

(f) Wind clock or negator spring.

(g) Check the amount of paper left on the supply roll, and make certain that there is more than enough to last the interval between visits.

(h) Rethread the chart into take-up rolls and run reversals, read all gages again, and record all data and observations on the chart.

(i) Reset pen to agree with the water level indicated by the tape-down measurements, and advance chart to agree with watch time and make a vertical mark. Be certain that pen is not in reversal.

(j) Check the ink supply of the pen and replenish it if necessary.

(k) Unroll and examine the chart in an effort to detect any recorder malfunction or clock stoppage since the last visit, and, if found, note range line.

(2) Digital recorder. When arriving at a station, look at the face of the timer to see if a punch would occur in about the next 5 minutes, the time it would take to remove the punched record and reset the tape. If so, it is better to wait until the punch has occurred before starting the tape removal procedure. When ready to remove the punched record, follow the steps listed below.

(a) Cut the tape leaving at least one full day in addition to the day of the visit on the end of the tape.

(b) Examine the tape to detect any recorder malfunction or clock stoppage since the last inspection, and record the station name, date, time and initials of Contractor(s) on the tape.

(c) Check the amount of tape left on the supply roll, and make certain that there is more than enough to last the interval between visits.

(d) Check battery voltage or amperage and record. Replace battery if no load voltage is less than 7.0 volts.

(e) Rethread the digital tape into the take-up spool and record all data and observations on the field sheet.

(f) Record, on the unused portion of the new digital tape above the punch block, the station name, station number, date, time, and initals of Contractor(s).

(g) Complete tape leader for record removed, and begin a new tape leader for the current record.

(h) Advance digital tape and timer to proper times, and make a mark along top of digital punch block across tape.

5. Making the Tape-down Water-level Measurement. The Contractor shall measure the water level by following the steps listed below:

a. Coat the lower portion of the steel tape with blue chalk or some other substance that exhibits a marked color change when wetted.

b. Feed the tape into well until the lower portion is below water level.

c. Record the tape reading when held at the datum mark.

d. Withdraw the tape and record the tape reading at the wetted line.

e. Subtract the wet-line reading from the datum-mark reading to obtain the tape-down measurement.

Tape readings and subsequent subtraction should be placed on inspection slip for subsequent checks.

6. Recording Field Visits. The Contractor shall maintain a field-visit log and keep it in the shelter. The log shall consist of a chronological listing of the visits, the tape-down measurements, and remarks. Remarks should include any item that would effect the record. Examples of information to be recorded are; (1) nearby creek is dry, (2) significant changes in weather such as heavy rainfall or very high winds prior to or during measurement, (3) construction of nearby wells or pumping nearby wells, (4) pools of standing water or snow banks near observation wells, (5) frozen ground, (6) significant changes in kinds of crops nearby, (7) nearby changes in land surface due to construction or mining-related activities, (8) sound of cascading water in a non-pumping well, (9) recent pumping of measured well, etc. For changes that may have a significant effect on the measured water levels, such as development of an operating well nearby or destruction of the well or the reference point or MP, the Contractor shall notify the COR in writing within 10 days of such changes.

7. Completion of Observation Well Servicing. The Contractor shall not leave the well site without assuring himself that:

a. The recorded water level agrees with the tape-down measurement;

b. That the timer is running and punch set to agree with watch time;

c. That the digital recorder is punching; and

d. All latches on instruments are fastened.

8. Transmittal of Digital Recorder Records. To facilitate the analysis and processing of water-level data recorded by digital recorders, the Contractor shall function similar to a USGS field office wherein digital-records material shall be provided to the USGS office to be translated and submitted for computer processing of water-level records. Processing of

the digital tape involves converting each field recorded value (usually represented by gage height) to a corresponding output parameter (usually discharge), obtaining daily means and extremes for print, and storing selected items in the Daily Value File on magnetic disk.

a. Digital recorder

(1) The basic data are dial readings punched at uniform time intervals by digital recorders on 16-channel tapes at the field installations. The Contractor shall transmit the digital tapes in accordance with WATSTORE User's Guide, Volume 5, Section 1-B, Data Translation/Transmission and Preparation, and as follows:

(a) The 16-channel tapes should be listed on transmittal letter SF 9-1609 for transmittal to the USGS.

(b) Submit shift corrections and datum corrections on SF 9-1874A or SF 9-1536.

(c) Submit information for the Daily Values on coding form for input, and update the Daily ValuesSF 9-1841 to SF 9-1844.

(d) Submit information on the Station Header File on SF 9-1843A or SF 91872A. Organize the coding forms for processing digital recorder data in the order required for that particular job to insure that they will be punched and sorted in the proper sequence for entry into the computer program.

(e) Submit the supplemental data with the 16-channel tapes, i.e., in the same box, so that the USGS receives both items at the same time.

(2) Before transmission to the USGS, the Contractor shall examine the tapes to detect any inaccuracies in the record length, any improperly spaced feed holes or torn tape, or any clock stoppages. Special notes concerning these items shall be made on the tape leader, SF 9-176D or SF 9-176E, "Inspection of Digital Recorder," attached to the beginning of the 16-channel tape about 6 inches ahead of the punched record.

(3) The Contractor shall attach a separate tape leader to each complete and uninterrupted record. If the tape was advanced and reset in the field, the tape should be cut at this point and a new leader attached. The purposes for this are so that:

(a) The field office can precisely indicate on the tape leader their translation requirements.

(b) The translation instruction block serves to document for future reference the beginning and end of each period translated to magnetic tape for computing purposes.

(4) The block labeled "Translation Instructions" of SF 9-176D and SF 9-176E is for identifying complete uninterrupted periods of record for translation.

(5) Before each piece of 16-channel tape is translated by USGS personnel, the information in the translation instruction block is written on magnetic tape ahead of the record from the 16-channel tape. It is important that the information listed here be correct because the station number will be used by the computer program for matching the 16-channel tape record with proper conversion tables and supplemental data on punch cards.

(6) The beginning and end times listed in the translation instruction block are used to further identify the punched data that immediately follow. The beginning tape time and the ending tape time listed in the translation instruction block must agree exactly with the times on the 16-channel tapes. The computer program uses these itmes to divide the record into calendar days and hours. A comparison of the tape ending time and the watch ending time is used to compute time corrections. The maximum time correction that can be made by the computer program is 1 hour per day.

(7) If the clock stopped at any time, then the end dates and times listed by the person servicing the recorder in the field may have to be modified for entry in the translation instruction block. In that case, the translation instruction block should be completed in accordance with the assumptions made below.

(a) If the clock stopped and did not start again, the ending watch time should then be made to read the same as the ending tape time in the translation instruction block on the tape leader.

(b) If the clock stopped and did restart, it may be possible to make use of some of the later data if the times of stopping and restarting can be determined. In this case, the translation instructions block should be completed for the period before the clock stopped. A red pencil line should be drawn through the last punch of the first period of record on the 16-channel tape to indicate the ending tape time for this period. The first item beginning the next period of record should then be marked with a red pencil (this could be the next punch or several punches later depending on the nature of the clock stoppage). An expression for time similar to

04-15	2200 =	1530
(date)	(actual)	(on tape)

should be made on the tape to clearly mark the beginning of the next period. The date should also be indicated on the tape. The ending date and time of the tape should be labeled in a like manner to show the difference between actual and tape time. A second translation instruction block should be prepared using the actual time (not time as printed on the tape) for the second complete and uninterrupted period on the 16-channel tape.

(c) The procedure explained under paragraph b above should also be used any time that a record exceeds the maximum number of days that are permitted on a single tape so that it has to be broken up into two or more short records.

(8) All references to time should be in terms of beginning and ending times and must be on a 24-hour basis.

(9) Mark the first automatic punch to be processed with red pencil through the middle of the row of holes. The black pencil line made in the field by drawing across the top of the punch block when the tape is in position to start recording automatically, will be through or just ahead of the last test punch, so the first automatic punch will be one punch beyond this one. For digital monitor multiple-item records, the red line must be drawn through item number one of the first complete sequence of punches after the test punches to insure that the data on the tape are processed in proper sequence.

(10) Check to insure that the 16-channel tapes are rolled so that the beginning day of the tape will come off first as it is unwound. The inside diameter of the center of each strip of tape must also be larger than 5/8 inch to permit direct insertion on the supply spool of the tranlator or transmitter.

(11) A notation should also be made on the tape leader if there are any "0000" values punched. If there are more than 8 or 10 zero values punched consecutively, then the tape should be set up as explained in paragraph (7)(b) above. An effort should be made to avoid punching zero values because the magnetic tape translators and data transmitters are designed to stop automatically on each "0000" value (no holes punched) without recording the zero value on the magnetic tape.

(12) Occasionally, the punch pins in the digital recorder may stick or the paper may fail to advance which causes illegal punch combinations on the 16-channel tape. When these tapes are processed, the output from the primary computation may contain some alphabetic symbols instead of numeric data. Recorders that indicate these malfunctions should be replaced or repaired immediately. The photoelectric readers on the magnetic tape translators or data transmitters are designed to stop on illegal punch combinations, but occasionally one will pass this test.

(13) These data are transferred to magnetic tape records as described in the <u>WATSTORE User's Guide</u>, Volume 5, Section 1-B, Data Transmission. The addition of identification information is made at this time and includes site identification, elevation of the land-surface reference point, or reference datum, and the data corrections to the observed readings.

(14) The Contractor shall furnish the analog record, digital tapes with leaders completed, and coding forms to the USGS within 30 days after removal from the gaging station. These will become part of the associated record for each site for preliminary processing.

b. Within 20 days after the above material is received by the USGS, the primary computation sheets for each well site shall be returned to the Contractor for editorial correction and review for correctness and completeness of record.

9. Computation of Water-level Records. The Contractor shall review primary computation sheets produced by the USGS from digital recorder tapes submitted in accordance with paragraph 8 above. Revisions, adjustments, additions, and corrections shall be made by the Contractor as necessary.

The Contractor shall provide the revised and corrected primary computation sheets and Daily Values update forms to the USGS for finalized printout of daily water-level tables within 120 days after the end of the water year.

Article III. DELIVERABLE ITEMS:

A. In the analysis and computational procedure, the USGS shall be responsible only for the tape translation and computerized computation of the primary and finalized water level.

B. The Contractor shall furnsih the following as part of the associated record for each site:

1. For primary (or preliminary) record computation (digital recorders) the following items shall be furnished to the USGS within 30 days after removal from well site:

a. Manual water-level measurement.

b. Digital tape with tape leader for specified period.

c. Coded forms showing water level and datum corrections and adjustments for furnished digital tapes.

2. For finalized printout of daily water level to be completed after USGS has returned computation sheets for each site to Contractor for editirial correction and discharge correction or revision, the Contractor shall provide the revised and corrected computation sheet and update forms.

3. For permanent documentation for each data collection well site to be part of the permanent file of the USGS district office, the following material shall be furnsihed to the USGS within 120 days after the end of the water year:

a. Inspection sheets for digital recorders (SF 9-176).

b. Level notes regarding datum control (SF 9-276).

c. Computed daily water-level record and discharge:

(1) Digital record and tapes (preliminary and finalized computer printout).

(2) Correction and update form for daily values.

Part V
SPECIFICATIONS FOR COLLECTION AND
PROCESSING OF PRECIPITATION DATA

ARTICLE I. SCOPE:

A. INTRODUCTION

This section of the specifications covers and defines the work to be done in the collection and processing of precipitation records. The Contractor shall be responsible for all plant, labor, materials, and equipment in the performance of the precipitation-data collection, except for the equipment listed in Part VI, which the Government shall furnish.

B. PRINCIPAL FEATURES

1. Work to be Performed. The work to be done under this section by the Contractor includes the following:

a. Operation and maintenance of precipitation recording stations.

b. Maintenance and collection of complete and accurate continuous precipitation data at each observation site.

c. Providing corrections to be applied to the record for computation of the precipitation data.

2. Contractor's Responsibility. The above general outline of the principal features does not in any way limit the responsibility of the Contractor to perform all work and furnish all labor, materials, and equipment required by the contract, the specifications, and the attachments.

C. LOCATION OF PRECIPITATION STATIONS

The location of precipitation stations in Oklahoma where work is required under this contract is shown in Attachment 1. Each station consists of a recorder housed in a steel shelter.

D. FREQUENCY OF INSPECTION

The Contractor shall visit each precipitation site equipped with a digital recorder at least twice each month and each site equipped with a graphic chart recorder once each week.

Article II. STATEMENT OF WORK

A. OPERATION AND MAINTENANCE OF PRECIPITATION STATION

1. General. The Contractor shall provide for the operation and routine field maintenance of precipitation gages and the collection, analysis, and processing of accurate hydrologic data related to precipitation in accordance with applicable and recommended procedures now in use by the USGS and detailed in manuals or bulletins furnished by the Geological Survey and detailed herein. During every visit to each station, the Contractor shall follow the procedures for taking and recording measurements and for proper and accurate accomplishment of all procedures and responsiblilies. The Contractor shall insure that his employees follow the procedures outlined below. Failure to do so shall subject the Contractor to the default provision of this contract.

2. Maintenance. Upon arrival at the station, the Contractor shall make a visual inspection of the site and the surrounding area to determine any changes or problems which may prevent continuation of later steps, and perform maintenance of the site.

a. Minor maintenance. The Contractor shall perform minor maintenance such as minor repairs necessary to keep the well site operational, safe, and to maintain its appearance. Such minor repairs include, but are not limited to, replacement of defective recorders and timers which cannot be repaired in the field, replacement of defective floats, and repainting and repairing the shelter as required. The Contractor shall furnish all labor and materials necessary to perform the work, with the exception of those items of equipment that duplicate, replace, or repair instrument or appurtenant fixtures that were provided by the Government. Materials such as these shall be provided to the Contractor by the COR. The Contractor shall keep the shelter clean and oil hinges, locks, and hasps. The Contractor shall maintain a neat appearance at the site by clipping weeds and grass around the shelter, removing debris, and generally keeping the area clean. Minor maintenance shall be done at no additional expense to the Government.

b. Major maintenance. Major maintenance is defined as repair or services required to make the site opertional after a period when the site was inoperative because of vandalism or damage to station due to natural or man-made causes. Such major repairs include, but are not limited to, extensive rebuilding of the shelter and complete replacement of instrumentation.

The Contractor shall within 3 days of discovery of a situation that might require major maintenance, notify the COR and inform him of the amount and costs of remedial work planned. The COR shall within 5 days after notification, advise the Contractor whether or not to proceed with the work. All work shall be completed as soon as possible after approval and in all cases shall be completed within 30 days. Contractor shall furnish all labor and materials necessary to perform the work, with the exception of those items of equipment that duplicate, replace, or repair instrument or appurtenant fixtures that were provided by the Government. Materials such as these shall be provided to the Contractor through the COR.

All costs associated with major maintenance shall be handled outside of this contract. The Contractor may or may not be requested to perform certain major maintenance, but in no event shall the Contractor be obligated to perform such maintenance under this contract, unless the need for the major maintenance is due to negligence of the Contractor. If such negligence does exist, then the Contractor shall be responsible for accomplishment of the major maintenance at no expense to the Government.

All work performed shall be subject to inspection. Government shall have the right to require the Contractor to perform the work again if the maintenance work is defective or would reduce the major maintenance price to reflect reduced value of services provided.

c. Site Security. The Contractor shall close and lock all gates or doors wherever appropriate with regard to protection of the site.

d. Maintenance and Replacement of Batteries. The Government shall furnish 7½ volt batteries to initiate operation of the equipment at each gage site.

The Contractor will be responsible for insuring continuous operation of the well sites and will be responsible for supplying and replacing the batteries. The Contractor shall replace batteries on all recorders regularly at 2-month intervals, or when the no-load voltage drops below 7.0 volts.

Unforeseen events can cause batteries to run down. Having replacement batteries on hand is the responsibility of the Contractor. Missing record because of failure to replace batteries is unacceptable performance on this contract and may subject the Contractor to a reduction in contract price, if warranted.

3. Initial Data Collected at Site. The collection of data from the precipitation recorders and instruments is a continuous process that follows each step taken in the succeeding instructions; to insure a permanent record of these data, the Contractor shall use every precaution to assure adequate recording and documentation. The data and information collected initially and throughout site servicing, shall include:

a. Station name, in full;

b. Date: month (name, not number), day, and year;

c. Time: watch time using 24-hour time system;

d. Pen time of analog recorder, punch time on digital recorder;

e. Gage reading;

f. Initials of Contractor(s);

g. Additional remarks related to station conditions.

4. Servicing the Precipitation Recorder. After the inital visual checks and preparation of the record sheet, the Contractor shall service the recorder. The recorder shall be serviced using the following procedures as a guide:

a. Empty the catchment.

b. Check to see if the clock and/or timer is running, and mark the recorder chart;

(1) by marking the point where the pen or pencil is resting on the strip-chart recorder (adjust timer if needed or replace if timer has been malfunctioning), and

(2) by watching the instrument punch the digital tape and drawing a line across the digital tape, using the top of the punch block as the straight edge.

c. The interval for record removal depends upon the type of precipitation-recording gage. This interval, along with instructions for changing the record, follows:

(1) Analog (chart) recorder: The Contractor shall remove each analog recorder record each week. The following steps shall be taken:

(a) Remove the drum containing the analog and examine the record. Remove the analog from the cylinder and make any remarks pertinent to the record on the chart. Write the date, time, and initials of field person on the chart.

(b) Install the chart onto the drum. Feed the trailing edge of the chart and install the spring clip so that the folded edge is under the clip and the chart passes over the clip.

(c) Replace the drum so that the record will begin at the proper time on the first day of the chart. Write the station name, date, time, and initials of the field person on the chart.

(d) Check the ink supply of the pen and replenish it if necessary.

(2) Digital recorder: The Contractor shall remove each digital recorder record at intervals not to exceed 7,800 punches. For a 5-minute punch, this computes to 27 days. If the record is not removed within 7,800 punches, the record must be cut and additional tape leader (inspection slip) attached. It is recommended, therefore; that the record on the 5-minute digital punch recorder be removed at 3- or 4-week intervals. When the station is first reached, wait until the next punch occurs (for 5-minute punch, this wait will always be less than 5 minutes). Fill in the removal block of the inspection slip. As soon as the next punch occurs, remove the punched record by following the steps listed below:

(a) Cut the tape leaving at least one full day in addition to the day of the visit on the end of the tape.

(b) Examine the tape to detect any recorder malfunction or clock stoppage since the last inspection, and record the station name, date, time, precipitation and initials of Contractor(s) on the tape.

(c) Check the amount of tape left on the supply roll, and make certain that there is more than enough to last the interval between visits.

(d) Check battery voltage or amperage and record. Replace battery if no load voltage is less than 7.0 volts.

(e) Rethread the digital tape into the take-up spool and record all data and observations on the field sheet.

(f) Record, on the unused portion of the new digital tape above the punch block, the station name, station number, date, time, and initals of Contractor(s).

(g) Complete tape leader for record removed, and begin a new tape leader for the current record.

(h) Advance digital tape and timer to proper times, and make a mark along top of digital punch block across tape.

5. Completion of Station Servicing.

a. The Contractor shall not leave the station without assuring himself that:

(1) The recorded gage reading is 1.10;

(2) That the timer is running and pen or punch is set to agree with watch time

(3) That the digital recorder is punching or the pen is marking; and

(4) That all all latches on instruments are fastened and that all doors are locked.

6. Transmittal of Digital Recorder Records. To facilitate the analysis and processing of precipitation data recorded by digital recorders, the Contractor shall function similar to a USGS field office wherein digital-records material shall be provided to the USGS office to be translated and submitted for computer processing of precipitation records. Processing of the digital tape involves converting each field recorded value (usually represented by gage height) to a corresponding parameter (usually discharge), obtaining daily means and extremes for print, and storing selected items in the Daily Value File on magnetic disk.

a. Digital recorder

(1) The basic data are dial readings punched at uniform time intervals by digital recordres on 16-channel tapes at the field installations. The Contractor shall transmit the digital tapes in accordance with WATSTORE User's Guide, Volume 5, Section 1-B, Data Translation/Transmission and Preparation, and as follows:

(a) The 16-channel tapes should be listed on transmittal letter SF 9-1609 for transmittal to the USGS.

(b) Submit shift corrections and datum corrections on SF 9-1874A or SF 9-1536.

(c) Submit the supplemental data with the 16-channel tapes, i.e., in the same box, so that the USGS receives both items at the same time.

(2) Before transmission to the USGS, the Contractor shall examine the tapes to detect any inaccuracies in the record length, any improperly spaced feed holes or torn tape, or any clock stoppages. Special notes concerning these items shall be made on the tape leader, SF 9-176D or SF 9-176E, "Inspection of Digital Recorder," attached to the beginning of the 16-channel tape about 6 inches ahead of the punched record.

(3) The Contractor shall attach a separate tape leader to each complete and uninterrupted record. If the tape was advanced and reset in the field, the tape should be cut at this point and a new leader attached. The purposes for this are so that:

(a) The field office can precisely indicate on the tape leader their translation requirements.

(b) The translation instruction block serves to document for future reference the beginning and end of each period translated to magetic tape for computing purposes.

(4) The block labeled "Translation Instructions" of SF 9-176D and SF 9-176E is for identifying complete uninterrupted periods of record for translation. For precipitation records, the "Translation Instructions" shall be completed by USGS personnel.

(5) If the clock stopped at any time, then the end dates and times listed by the person servicing the recorder in the field may have to be modified for entry in the translation instruction block. In that case, the translation instruction block should be completed in accordance with the assumptions made below.

(a) If the clock stopped and did not start again, the ending watch time should then be made to read the same as the ending tape time in the translation instruction block on the tape leader.

(b) If the clock stopped and did restart, it may be possible to make use of some of the later data if the times of stopping and restarting can be determined. In this case, the translation instructions block should be completed for the period before the clock stopped. A red pencil line should be drawn through the last punch of the first period of record on the 16-channel tape to indicate the ending tape time for this period. The first item beginning the next period of record should then be marked with a red pencil (this could be the next punch or several punches later depending on the nature of the clock stoppage). An expression for time similar to

04-15	2200 = 1530
(date)	(actual) (on tape)

should be made on the tape to clearly mark the beginning of the next period. The date should also be indicated on the tape. The ending date and time of the tape should be labeled in a like manner to show the difference between actual and tape time. A second translation instruction block should be prepared using the actual time (not time as printed on the tape) for the second complete and uninterrupted period on the 16-channel tape.

(c) The procedure explained under paragraph b above should also be used any time that a record exceeds the maximum number of days that are permitted on a single tape so that it has to be broken up into two or more short records.

(6) All references to time should be in terms of beginning and ending times and must be on a 24-hour basis.

(7) Check to insure that the 16-channel tapes are rolled so that the beginning day of the tape will come off first as it is unwound. The inside diameter of the center of each strip of tape must also be larger than 5/8 inch to permit direct insertion on the supply spool of the translator or transmitter.

(8) The Contractor shall furnish tha analog record, digital tapes with leaders completed, and coding forms to the USGS within 30 days after removal from the gaging station. These will become part of the associated record for each site for preliminary processing.

b. The primary computation sheets will not be returned to the Contractor. Finalized printout and review of precipitation data shall be the responsibility of the USGS.

Article III. DELIVERABLE ITEMS:

A. In the analysis and computational procedure, the USGS shall be responsible only for the tape translation and computerized computation of the primary and finalized precipitation record.

B. The Contractor shall furnish the following as part of the associated record for each site:

1. For primary (or preliminary) record computation (digital recorders) the following items shall be furnished to the USGS within 30 days after removal from stations:

a. Digital tape with tape leader for specified period.

b. Coded forms showing adjustments for furnished digital tapes.

2. Finalized printout and review of precipitation data shall be the responsibility of the USGS.

3. Analog recorder: Weekly charts with sufficient notes to allow for proper corrections and computations.

PART VI

Government Furnished Materials and Equipment

The contractor shall sign for and be fully responsible for the following materials and equipment to be furnished within 60 calendar days of the effective data of the contract. The exact quantities and identification of said equipment will be made at this time based on workload and a physical count respectively. The U.S. Geological Survey will provide at its expense all replacements and repairs incurred as a result of reasonable usage or losses and damages not the fault of the contractor.

A. Permanent Station Equipment

1. Digital Stage Recorders
2. Analog Stage Recorders, A-71
3. Manometers (Bubble Gages)
4. Automatic Sediment Samplers (P-69's or comparable)
5. Water Quality Monitors
6. Precipitation Gages (with Digital Recorders)
7. Wire Weight Gages
8. Permanently Mounted Suspended Sediment Samplers (B-reals with P-69 Sampler)
9. Miscellaneous: Timers, Nitrogen Tanks, Orifices, Floats, Tapes, and Counterweights

B. Individual Field and Laboratory Equipment

Surface Water

10. A-reel
11. B-reel with 125 ft. of 1/8" cable
12. B-reel Power Unit
13. Truck, 4-wheel base
14. Crane, Type A
15. Counter weights
16. Handline
17. Bridgeboard
18. Weights--30, 50, 75, and 100 lb.
19. Hanger bars
20. Hanger bar pins
21. Wading rod
22. Wading rod, sectional
23. Tag line, Paklon, 300 foot
24. 500 foot Lee Au Tag line
25. Tape (50 foot)
26. Shore Rods
27. Standard AA meter
28. Meter box
29. Pigmy meter
30. Ice meters
31. Stop watch

80. P-61 sediment sampler
81. BMH-53 (piston type)
82. BM-54 (reel type)
83. BMH-60 (hand line)
84. Sediment bottles, case of 20
85. Wire basket, wading type
86. Bed material containers
87. Heating & stirring plate
88. Peristaltic pump

<u>Ground Water</u>

89. 100' steel tape
90. 300' steel tape
91. 500' steel tape
92. 300' steel tape (refill)
93. 500' steel tape (refill)
94. Lead weights for steel tapes
95. Altimeter, surveying

C. In addition to the above, the U.S. Geological will furnish the following expendable items as needed:

1. Bottle meter oil
2. Mercury
3. Digital (16 channel) tape rolls
4. A-35 chart rolls
5. Bacteria filters (0.7 m, 47 mm diameter) box of 200
6. Petri dishes (47 mm) box of 200
7. Growth media--MFC Agar, kits
8. M-Enterococcus Agar, kits
9. Bufferred dilution water, liters
10. Filters (0.45 m, 142 mm diameter) box of 50
11. Silver filters for DOC (0.45 m, 47 mm diameter) box of 50
12. Standard solution conductivity (sets of 50, 500, 5,000 mhos)
13. Standard buffers (pH 4, 7, 10 set)
14. Nitric acid ampules (2 m200)
15. Standardized sulfuric acid ltrs
16. Box carpenter chalk (blue)
17. Binders for field notes
18. Forms

D. The Contractor shall be furnished two (2) copies of each of the following technical references:

1. The following U.S. Geological Survey Techniques of Water-Resources Investigations will be furnished as references to be used in the collection and processing of surface water data:

General procedure for gaging streams, by R. W. Carter and Jacob Davidian: USGS--TWRI Book 3, Chapter A6, 1968, 13 pages.

Stage measurements at gaging stations, by T. J. Buchanan and W. P. Somers: USGS--TWRI Book 3, Chapter A7, 1968, 28 pages.

Discharge measurements at gaging stations, by T. J. Buchanan and W. P. Somers: USGS--TWRI Book 3, Chapter A8, 1969, 65 pages.

Low-flow investigations, by H. C. Riggs: USGS--TWRI Book 4, Chapter B1, 1972, 18 pages.

Calibration and maintenance of vertical-axis type current meters, by G. F. Smoot and C. E. Novak: USGS--TWRI Book 8, Chapter B2, 1968, 15 pages.

The following additional references will also be provided:

Use of flumes in measuring discharge at gaging stations, by F. A. Kilpatrick: USGS--Surface Water Techniques Book 1, Chapter 16, 1965, 27 pages.

Discharge ratings at gaging stations, by R. W. Carter and Jacob Davidian: USGS--Surface Water Techniques Book 1, Chapter 12, 1965, 36 pages.

WATSTORE User's Guide, volume 5 (WRD), chapter 1, by W. L. Isherwood, N. E. Hutchison and N. G. Stuthman: USGS--Instructions for Processing Digital Recorder Data, 1976, 143 pages.

2. The following U.S. Geological Survey Techniques of Water-Resources Investigations are furnished to be used as references in the collection and processing of Water Quality Data:

Water temperature-influential factors, field measurement, and data presentation, by H. H. Stevens, Jr., J. F. Ficke, and G. F. Smoot: USGS--TWRI Book 1, Chapter D1, 1976, 65 pages, $1.60.

Guidelines for collection and field analysis of ground-water samples for selected unstable constituents, by W. W. Wood: USGS--TWRI Book 1, Chapter D2, 1976, 24 pages, $ .85.

Field methods for measurement of fluvial sediment, by H. P. Guy and V. W. Norman: USGS--TWRI Book 3, Chapter C2, 1970, 59 pages, $2.50.

Methods for collection and analysis of water samples for dissolved minerals and gases, by Eugene Brown, M. W. Skougstad, and M. J. Fishman: USGS--TWRI Book 5, Chapter A1, 1970, 160 pages, $2.40.

Determination of minor elements in water by emission spectroscopy, by P. R. Barnett and E. C. Mallory, Jr.: USGS--TWRI Book 5, Chapter A2, 1971, 31 pages, $ .80.

Methods for analysis of organic substances in water, by D. F. Goerlitz and Eugene Brown: USGS--TWRI Book 5, Chapter A3, 1972, 40 pages, $ .90.

Methods for collection and analysis of aquatic biological and microbiological samples, by P. E. Greeson and others (ed.): USGS--TWRI Book 5, Chapter A4, 1977, 332 pages, $2.85.

The following additional references will also be provided:

WATSTORE Instruction Manuals

- Vol. 3, Chapter I - General Information
- Vol. 3, Chapter IIA - Instructions for the Entry of Water-Quality Data, Processing QW Data
- Vol. 3, Chapter IIB - Instructions for the Entry of Water-Quality Data, Free Field Input
- Vol. 3, Chapter III - Instructions for the Retrieval of Data from the Water-Quality File
- Vol. 3, Chapter IV, Section A - Identification Codes for the Storage and Retrieval of Water Data
- Quality of Water Branch Technical Memorandums

No. 71.05	No. 76.17
No. 72.04	No. 76.24-T
No. 72.09	No. 77.01
No. 73.02	No. 79.10
No. 74.11	No. 79.69
No. 75.25	

Part VII
INSPECTION OF SERVICES

Article I. SCOPE:

All services (which term throughout this clause includes services performed, material and equipment furnished or utilized in the performance of services, and workmanship in the performance of services) shall be subject to inspection and test by the Government, to the extent practicable at all times and places during the term of the contract. All streamflow and QW instruments shall be brought to USGS offices for routine inspection once each quarter. All inspections by the Government shall be made in such a manner as not to unduly delay the work.

Article II. REDRESS:

If any services performed hereunder are not in conformity with the requirements of this contract, the Government shall have the right to require the Contractor to perform the services again in conformity with the requirements of the contract at no additional increase in total contract amount. When the services to be performed are of such a nature that the defect cannot be corrected by reperformance of the services such as missing a measurement or sample at the time specified in this contract, the Government shall have the right to:

A. Require the Contractor to immediately take all necessary steps to insure future performance of the services in conformity with the requirements of the contract; and

B. Reduce the contract price to reflect the reduced value of the services performed. In the event the Contractor fails promptly to perform the services again or to take necessary steps to insure future performance of the services in conformity with the requirements of the contract, the Government shall have the right to either,

1. have the services performed in conformity with the contract requirement and charge to the Contractor any cost occasioned to the Government that is directly related to the performance of such services, or

2. terminate this contract for default as provided in the clause of this contract entitled "Default."

Article III. CONTRACTOR INSPECTION SYSTEM:

The Contractor shall provide and maintain an inspection system acceptable to the Government covering the services to be performed. Records of all inspection work by the Contractor shall be kept complete and available to the Government during the term of this contract and for any longer period as may be specified elsewhere in this contract.

Article IV. GOVERNMENT INSPECTION SYSTEM:

The Government reserves the right to periodically inspect all phases of the work while such work is in progress or after completion of the whole or any part to insure that the work is being performed in compliance with the terms of the contract. All work and related records shall be available at all times for examination by the COR. The Contractor shall provide full facility for such inspections during working hours. It shall be expressly understood, except as otherwise provided in these specifications, that such inspection shall not constitute acceptance by the Government of any part of the work but will be for the purpose of coordination and assistance in interpretation of specifications and technical requirements.

A. FIELD DATA COLLECTION

A COR, assisted by other WRD employees as appropriate to the skills and experience required, will accompany and observe each member of the Contractor's staff in the performance of his/her field duties for a minimum of 1 day each fiscal year or portion of a fiscal year in which the contract is in effect.

The details, as appropriate to the contract, that are to be observed and documented will include but are not limited to the following:

1. Condition, calibration, care, and use of portable and fixed instruments and equipment.

2. Procedures for collection and handling of streams and ground-water samples.

3. Streamflow and water-level measuring techniques, equipment, and notes.

4. Field measurement of water-quality parameters.

5. Adequacy of field notes.

Immediately following each trip for observation of Contractor performance, the COR will prepare a memorandum to the Regional Contract Coordinator that records the details of his observations, impressions, and as appropriate, his recommendations.

B. EQUIPMENT

The COR shall assure that instruments furnished to the Contractor are checked, calibrated, replaced, or repaired under conditions at least as rigid as those applicable to WRD-used instruments.

Contractor personnel are to participate in the Field Service Laboratory tests for pH and specific conductance in accordance with the provisions of WRD Memorandum No. 79.69.

C. INDEPENDENT CHECK OBSERVATIONS

An independent check observation will be obtained to assess and document the reliability of Contractor-provided data. The COR will be responsible for scheduling at unannounced times during each year and without the Contractor's knowledge at least supplemental and independent streamflow measurement and water sample at each Contractor-operated streamflow water-quality station and one water-level measurement and sample at each observation well operated by the Contractor. The check measurements are to be obtained only under carefully selected and documented conditions.

1. Check-measurement information will not be available to the Contractor for routine record computation, although the data may be used for recomputation or revisions of records as required in subsequent reviews.

2. The discharge measurement notes and the analysis of the sample, each supplemented by notes adequately describing field or other conditions relevant to the results, are considered to be adequate documentation. The results conveyed to the Regional Contract Coordinator are to be filed with current station material at district level.

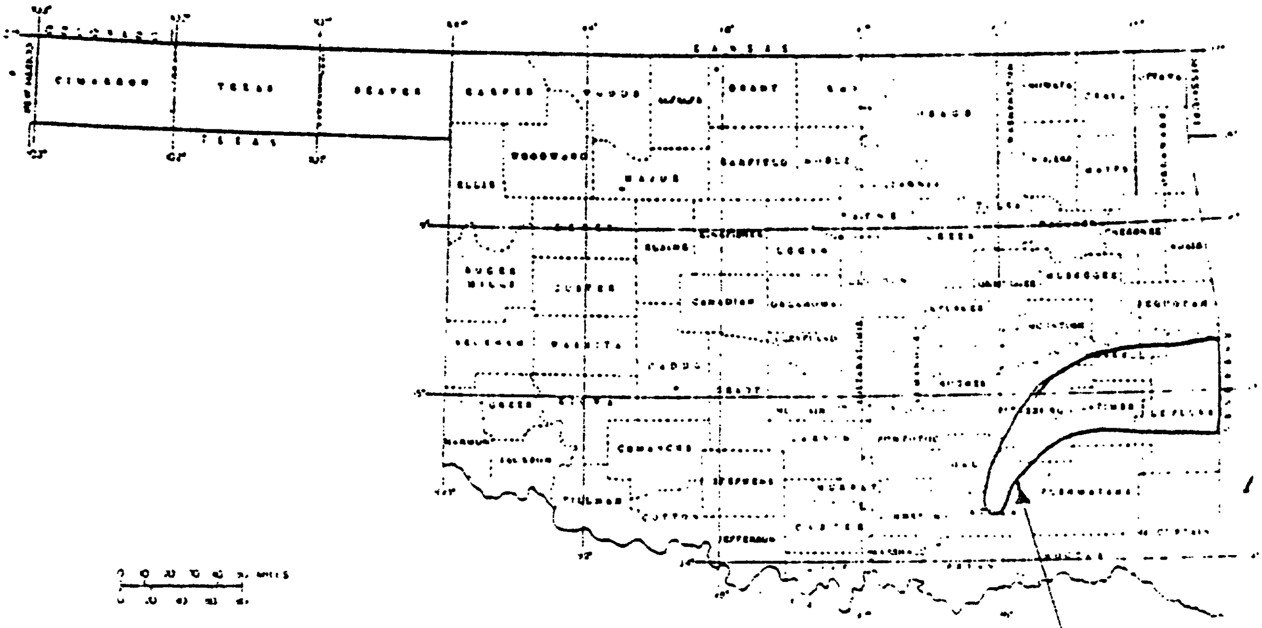
D. REVIEW OF DAILY RECORDS

The COR will either personally review or insure that each record receives an appropriate review. He will certify review by signing and dating each document of the computation, and he will add to the station analysis a short statement assessing the adequacy of the record including a reference to the independent check observations.

The COR review will be coordinated with the subsequent and independent district review to minimize the likelihood of requiring multiple recomputation and revision by the Contractor.

Attachment 1

STUDY AREA LOCATION
WATER RESOURCES DATA COLLECTION - OKLAHOMA



Study area.--see "Job Locations" and "Location Maps" included in this attachment for location details.

07232010 Blue Creek near Blocker, OK, Lat 34°02'26", long 95°34'21", in SW ¼, NW ¼, sec. 36, T.7N., R.16E., Pittsburg County, Hydrologic Unit 11090204, on right bank at downstream side of bridge on State Highway 31, 1.5 mi south of Blocker, and at mile 3.9.

07232008 Blue Creek Tributary near Blocker, OK, Lat 35°02'25", long 95°34'15", NE ¼, NW ¼, sec. 36, T.7N., R.16E., Pittsburg County, Hydrologic Unit 11090204, approximately 400 feet east of State Highway 31 bridge along Blue Creek, 1.5 mi south of Blocker, and at mouth.

07249073 Brazil Creek near Lodi, OK, Lat 34°59'28", long 95°00'24", in NE ¼, SW ¼, sec. 17, T.6N., R.22E., Latimer County, Hydrologic Unit 11110105, at gas well 1½ mi (2.42 km) east and 1¼ mi (2.01 km) south of Lodi.

07249080 Brazil Creek near Walls, OK, Lat 35°01'21", long 94°56'39", in SW ¼, NW ¼, sec. 1, T.6 N., R.22 E., Latimer County, Hydrologic Unit 11110105, at county road bridge, 2.2 mi southwest of Walls, and at mile 32.2.

07249060 Brazil Creek near Red Oak, OK, Lat 34°59'03", long 95°07'06", on north line SW ¼, sec. 17, T.6N., R.21E., Latimer County, Hydrologic Unit 11110105, on county road bridge, 3.3 mi northwest of Red Oak, and at mile 49.2.

07231975 Brushy Creek near Haileyville, OK, Lat 34°48'05", long 95°39'16", in NE ¼, SE ¼, sec. 19, T.4N., R.16E., Pittsburg County, Hydrologic Unit 11090204, on downstream left bank at county road bridge 0.9 mi (1.4 km) south of junction of State Highway 63 and county road, 1.2 mi (1.9 km) northeast of Arch and 6.3 mi (10.1 km) southwest of Haileyville, and at mile 14.3 (23.0 km)

07248600 Caston Creek at Wister, OK, Lat 34°57'27", long 94°44'18", SW ¼, SE ¼, sec. 26, T.6N., R.24E., LeFlore County, Hydrologic Unit 11110105, at pier on right downstream side of county road bridge 0.15 mi (.24 km) downstream from Mountain Creek, and 0.8 mi (1.3 km) along county road southwest of intersection with U.S. Highway 270 in Wister, and at mile 2.4 (3.9 km).

07246615 Coal Creek near Spiro, OK, Lat 35°15'11", long 94°45'18", on south edge SW ¼, sec. 11, T.9N., R.24E., LeFlore County, Hydrologic Unit 11110104, on downstream side of bridge on State Highway 9, 0.4 mi (0.6 km) south-east of junction of with U.S. Highway 59 and 8 mi (12.9 km) west of Spiro, and at mi 4.4 (7.1 km).

JOB LOCATIONS
Groundwater-Level Stations

Blocker area:

350241095341101, local number 07N-16E-25C CDC1, Hydrologic Unit 11090204, Pitsburg County, 0.35 mi north of streamflow gage on State Highway 31 and 1.15 mi south of Blocker, in borrow ditch on west side of highway.

Panama area:

351122094403901, local number 08N-25E-04 CDC1, Hydrologic Unit 11110105, LeFlore County, on State Highway 31 0.3 mi west of junction of State Highway 31 with U.S. Highway 59 and 271 and one mi north of Panama, about 50 feet south of road.

Red Oak area:

345908095013001, local number 06N-22E-18 DCC1, Hydrologic Unit 11110105, Latimer County, along Walls county road 2.3 mi from its junction with U.S. Highway 270 0.9 mi east of downtown Red Oak, in pasture 100 feet north of road.

Spiro area:

351002094314401, local number 08N-26E-14 ACC1, Hydrologic Unit 11110105, LeFlore County, on county road 0.35 mi west of its junction with old State Highway 112, and 1 mi east of Williams, about 50 feet north of road.

Stigler area:

352006095080101, local number 10N-20E-13 DDD1, Hydrologic Unit, 11090204, along county road 5.5 mi north of its junction with State Highway 9 in Stigler, about 400 feet west of road.

JOB LOCATIONS
Precipitation Stations

Blue Creek Watershed:

350218095315301, local number 07N-17E-32 ACA1, Hydrologic Unit 11090204, Pittsburg County, 0.6 mi south out of Blocker along State Highway 31 and 2.6 mi east along dirt road; about 75 feet east of gas well.

350306095340101, local number 07N-16E-25 ACA1, Hydrologic Unit 11090204, Pittsburg County, 0.6 mi south out of Blocker along State High 31 and 0.1 mi east along dirt road; about 50 feet on north side of road.

350429095333601, local number 07N-17E-18 CCB1, Hydrologic Unit 11090204,Pittsburg County, 0.9 mi north out of Blocker along State Highway 31 and 0.15 mi north along private road; about 75 feet northwest of farm house.

Holi-Tuska Creek Watershed:

351247094432301, local number 09N-24E-36 BCA1, Hydrologic Unit 11110105, LeFlore County, 0.75 mi north of streamflow gage near Panama on U.S. Highway 59; follow county road west 1.0 mi, south 0.5 mi, west 2.0 mi, south 0.25 mi then east 0.15 mi on private road; between farm house and barn.

351259094412301, local number 09N-25E-32 BBB1, Hydrologic Unit 11110105, LeFlore County, 0.75 mi north of streamflow gage near Panama on U.S. Highway 59; follow county road west 1.0 mi, and south 0.5 mi; in pasture about 200 feet left of road.

Morris Creek Watershed:

345447094341901, local number 05N-26E-16 BBB1, Hydrologic Unit 11110105, LeFlore County; follow old U.S. Highway 59 2.4 mi south of streamflow gage at Howe; follow county road 1.4 mi east, 1.0 mi south, and 1.0 mi east; about 75 feet east of farm house.

345452094321901, local number 05N-26E-11 CCC1, Hydrologic Unit 11110105, LeFlore County, in pasture on left of road; follow old U.S. Highway 59 2.4 mi south of streamflow gage at Howe; follow county road 1.4 mi east, 1.0 mi north, and follow winding logging road about 5 mi.

345606094362001, local number 05N-26E-06 BDC1, Hydrologic Unit 11110105, LeFlore County; follow old U.S. Highway 59 1.2 mi south of streamflow gage at Howe; follow county road 1.25 mi east, 0.5 mi south; 75 feet south of farm house at junction of county roads.

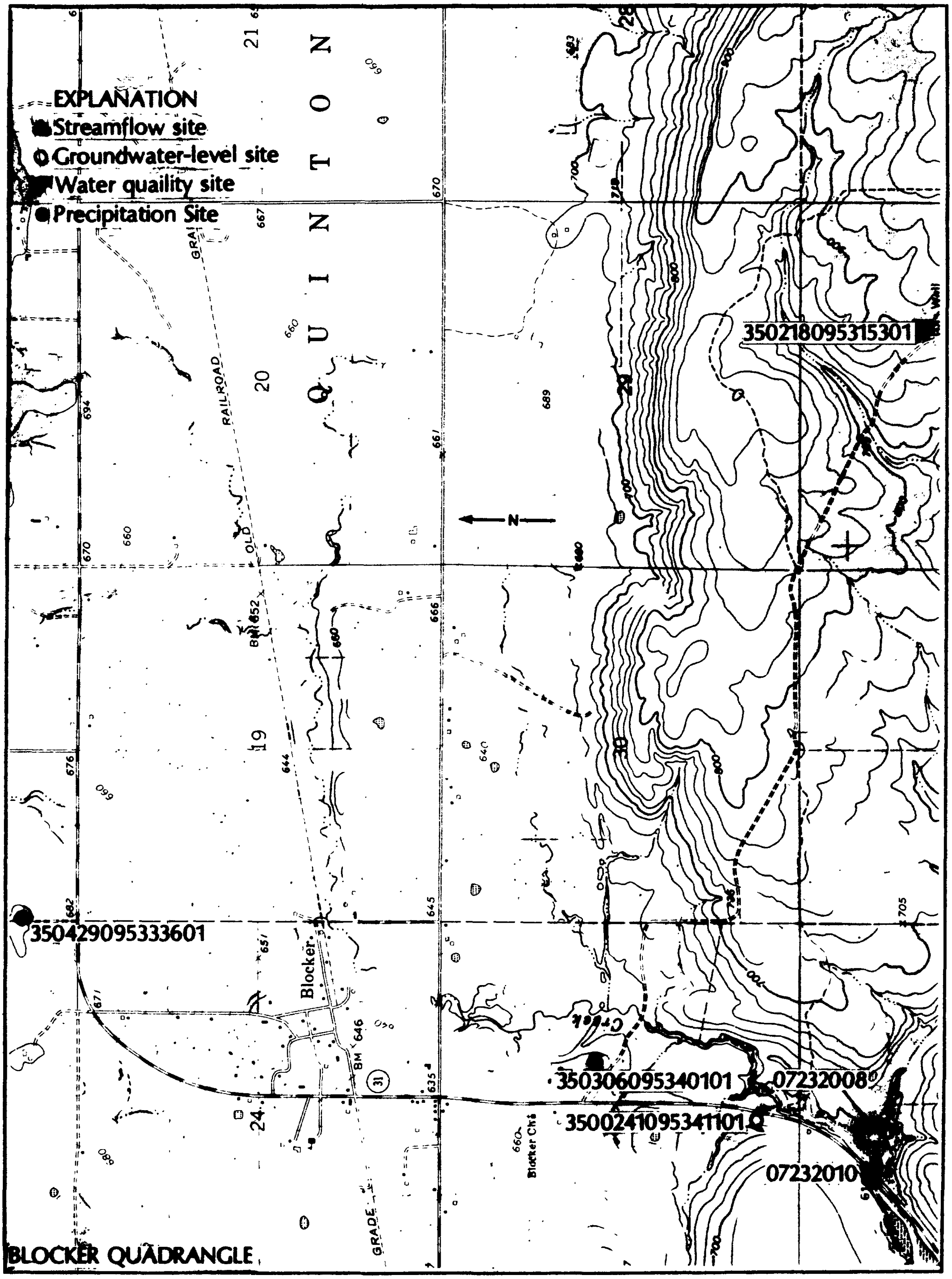
FORM 9 - 213C
(Rev. Nov. 69)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File ____________

Location Map
07232010

BLUE CREEK nr BLOCKER, OK.



Sheet No. .... of .... Sheets. Prepared by .... Date .... Checked by .... Date ....

U.S. GOVERNMENT PRINTING OFFICE

Attachment 1. Location maps as necessary for all work.

ATTACHMENT 3 DATA COLLECTION REQUIREMENTS AND CALENDAR FOR Oklahoma

The contractor shall collect the data required at the gage sites identified below by station numbers in accordance with the indicated schedule.

STATIONS: 07246615
07247550

Data Required	Laboratory Schedule	Frequency – Month O	N	D	J	F	M	A	M	J	J	A	S	Remarks
1. Station Inspection		2	2	2	2	2	2	←	8	→	2	2	2	
2. Discharge Measurement		1	1	1	1	1	1	←	8	→	1	1	2	
3. Digital Tape Removal		1	1	1	1	1	1	1	1	1	1	1	1	
4. Field Determinations: a. Water and Air Temperature b. Specific Conductance c. pH and Dissolved Oxygen d. Alkalinity/Acidity[b]		←					d						→	
5. Chemical: a. Major Constituents	425	1	1	1	1	1	1	1	1	1	1	1	1	
b. Nutrients	426	1		1		1		1		1		1		
c. Minor Constituents – Dissolved	1076	1		1		1		1		1		1		
d. Minor Constituents – Total	1176	1		1		1		1		1		1		
e. Emission Spectrograph – Dissolved	1090					NONE								
f. Bottom Material	1292				ONCE A YEAR @ LOW FLOW									
g. Phenols	LC0052					NONE								
h. Cyanide	LC0023					NONE								
i. Barium, Lithium, Strontium	427	1						1						
6. Sediment: a. Suspended, Concentration		←					d						→	a
b. Suspended, Size c. Bed Size									2				1	f
d. Coal Separation[b]	LC1038				ONCE A YEAR @ LOW FLOW									
7. Biological: a. Phytoplankton	1706		1			1			1			1		
b. Periphyton	1708		1			1			1			1		
8. Radiochemical	1405				ONCE A YEAR @ LOW FLOW									

General: Discharge measurements will be made using current-meter or other acceptable direct methods; number indicates number of measurements required for period shown; observence of zero flow constitutes a measurement. Where more than one measurement or sample is indicated per period it is desired that to the best of the contractor's ability these be made during a flood or above average runoff. These frequencies shown are based on the Survey's best estimate of the months when major runoff may be expected. When it is impossible to estimate when major runoff may be expected the additional visits shown under "Remarks" are to be made in an effort to define the relation of discharge to stage, sediment and chemical quality throughout the range of discharge during the year. Frequencies shown will apply for succeeding years unless otherwise modified.

[a] Acidity should be determined only when field measured pH of a sample is less than 7.0

[b] On bottom material at low flow only. Samples are to be wet sieved in the field to pass a 2.00 mm sieve but not to pass a 0.06 mm sieve.

[c] Water Quality Field Determinations will be made at the time of each discharge measurement as well as samples obtained for sediment concentration.

[d] Three samples during period – one at high flow caused by snowmelt, one at high flow caused by rainfall, and one at low flow – each concurrent with other highflow, major, and suspended concentration samples.

[e] Two samples during period – 1 at high flow caused by snowmelt and 1 when runoff is due to rainfall concurrent with sampling for minor constituents.

[f] If no flow, obtain samples during remaining part of year to provide at least ___ per year.

[g] Automatic sediment sampler (PS-69) installed requiring servicing by the contractor once every ___ days during normal flow conditions and after each runoff exceeding ___ hours duration.

Attachment 2. As many as necessary for all work.

mployee number: (1) ____________ (2) ____________ (3) ____________ (4) ____________

(5) ____________ (6) ____________ (7) ____________ (8) ____________

____
(month) (year)

tation Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1.																															
2.																															
3.																															
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8.																															
9.																															
0.																															

Number on day indicates person who will visit site ○ around number indicates tape change ◇ around number indicates chemical sampling

M by number indicates current meter measurement scheduled

ATTACHMENT 3

Monthly work schedule

ATTACHMENT 4

List personnel proposed for use in this project. Qualifications, education and experience of these and administrative personnel should be furnished on other than this form.

PERSONNEL

Position#	Employed*	Name	Experience in This Position, in years
Project Chief	______	______	______
Supervisor	______	______	______
Supervisor	______	______	______
Supervisor	______	______	______
Hydrologist	______	______	______
Hydrologist	______	______	______
Hydrologist	______	______	______
Hydrologist	______	______	______
Technician	______	______	______
Technician	______	______	______
Technician	______	______	______
Technician	______	______	______
Technician	______	______	______
Technician	______	______	______

#Contractor may choose to use and list more, less or none in any of the position categories shown, but must list all personnel to be employeed on this project.

*1.--By proposing firm. *2.--By Subcontractor. *3.--Other (explain).

____
Contractor or Authorized Agent
(signature)

Laboratory Schedule or Laboratory Code	Volume Required	Size and Type Container	Treatment and/or Preservation	Sample Designation
425	250 mL	500 mL polyethylene, jet rinsed.	Filter through 0.45 micron filter. Acidify with HNO_3 to pH<2.	FA (Filtered, Acidified)
	250 mL	500 mL polyethylene, jet rinsed.	Filter through 0.45 micron filter.	FU (Filtered Untreated)
	100 mL	500 mL polyethylene, jet rinsed.	Acidify with HNO_3 to pH<2.	RA (raw acidified)
426	250 mL	250 mL polyethylene, field rinsed.	Filter through 0.45 micron filter. Chill and maintain at 4° C.	FC (Filtered, Chilled)
	250 mL	250 mL polyethylene, field rinsed.	Chill and maintain at 4° C.	RC (Raw, Chilled)
	100 mL	4 oz. glass bottle, by Central Lab, baked at 350° C prior to use.	Filter using silver filter Chill and maintain at 4° C.	LC0113
	1 Filter	0.45 μ silver filter shipped in petrie dish.	Retain sample on silver filter. Chill and maintain at 4° C. Record volume filtered.	LC0305
1076	500 mL	500 mL polyethylene, jet rinsed.	Filter through 0.45 micron filter. Acidify with HNO_3 to pH<2.	FA

Laboratory Schedule or Laboratory Code	Volume Required	Size and Type Container	Treatment and/or Preservation	Sample Designation
1176	500 mL	500 mL polyethylene, jet rinsed.	Acidify with HNO_3 to pH<2.	RA (Raw, Acidified)
1090	100 mL	500 mL polyethylene, jet rinsed.	Filter through 0.45 micron filter. Acidify with HNO_3 to pH<2.	FA
1292	100 g	1-pint plastic freezer carton.	Wet-sieved in field to pass a 2.00 mm sieve, but not to pass a 0.06 mm sieve, untreated.	CU (Carton, Untreated)
LC0052	1 L	Glass bottle, by Central Lab, baked at 350° C prior to use.	Add 1 g $CuSO_4$ and 1 mL H_3PO_4 (to pH 4) per liter, chill and maintain at 4° C.	LC0052
LC0023	500 mL	500 mL polyethylene, jet rinsed.	Add NaOH to pH 12. Chill and maintain at 4° C.	LC0023
427	100 mL	250 mL polyethylene, jet rinsed.	Filter through 0.45 micron filter. Acidify with HNO_3 to pH<2.	FA
	100 mL	500 mL polyethylene, jet rinsed.	Acidify with HNO_3 to pH<2.	RA
LC1038	50 g	1-pint plastic freezer carton.	Wet-sieved in field to pass a 2.00 mm sieve, but not to pass a 0.06 mm sieve, untreated.	CU

Laboratory Schedule or Laboratory Code	Volume Required	Size and Type Container	Treatment and/or Preservation	Sample Designation
1706	1 L	Plastic bottle.	Add 40 mL formalin-$CuSO_4$ solution plus 4 mL detergent per liter of sample.	PHY
1708		Strips in wide-mouth glass jar.	Chill and maintain at 4° C. Keep in dark.	CHE
1405	2 L	2 L polyethylene, acid washed - "Rad-Chem".	Untreated.	RUC

Procedures for Subsampling Water-Sediment Mixtures (14-Litre Churn Splitter)

General: The water-quality laboratory may require 4 to 16 subsamples of a representative cross-section sample of the water-sediment mixture (streamflow) for water-quality analyses. The cross-section sample is collected in 1-pint or 1-quart bottles using suspended-sediment samplers at no fewer than 3 and preferably 8 to 10 verticals (ETR or EDT techniques). These samples are composited into one single representative cross-section sample of the streamflow. This composited sample can then be split, using the churn splitter, into the required 4 to 16 representative subsamples as explained under Procedure. Samples collected for organic analyses (e.g. organic carbon, pesticides) should not be composited in this container because of the possibility of contamination from the plastics.

Fourteen-Litre Churn Splitter: The churn splitter is a 1/4-inch thick polyethylene cylinder, 10 inches in diameter and 12 inches deep with a lid. It has been manufactured for the Survey by a commercial manufacturer. The valve and spout are polypropylene. The stirring disc is a 3/8-inch thick polyethylene disk, 9 15/16 inches in diameter with 16 holes, 8 as scallops in the outer edge and 8 in an inner circle. The handle, a 1-inch diameter by 18-inches polyethylene rod, is welded perpendicular to the center of the disk and supported by four ribs. A small "lip" on the disc alines with the valve, and a guide notch and rib are provided to maintain the correct alinement. Replacement valves and spouts are availble from the Branch of Quality of Water.

Procedure: This procedure requires a total sample volume of 8 to 14 litres, of which 4 to 10 litres are suitable for water-sediment mixture subsamples. The remaining 4 or more litres may be used for filtered subsamples if required by the analytical schedule. If not, they may be discarded. This size churn splitter does not reliably produce representative water-sediment mixture subsamples when it contains less than about 4 litres.

Before starting to collect the representative sample of the streamflow, label all the subsample containers to be used and determine the total sample volume needed. Add to this sample volume at least 10 percent to cover filter losses and spillage. It is less frustrating to throw away a small amount of sample than to have to go back and collect another cross-section sample.

Collect approximately 1 litre of water and thoroughly rinse the churn splitter.

Representative samples of the streamflow are collected by using standard EDI or ETR sampling techniques as described in "Field Methods for Measurement of Fluvial Sediment" TWRI Book 5, Chapter C2. Specific sample volumes cannot be obtained with sediment samplers, but properly collected pint bottles (approximately 2/3 full) will yield about 1/3 litre each. Only one sediment sample bottle is used over and over again in collecting the cross-section samples in order to minimize the amount of sediment lost in transferring samples from the bottles to the churn splitter. Each time the bottle is filled, the sample is poured into the splitter and the bottle is used again so that each succeeding sample washes the sediment left from the previous one into the splitter. Remember that the volume to be used for water-sediment mixture subsamples must be of "on top of" the 4 litres of samples in the tank from which representative water-sediment mixture subsamples cannot be obtained.

Suspended-sediment concentration should always be determined whenever a sample is analyzed for total concentrations of chemical constituents. The sample for determination of suspended-sediment concentration can be collected (1) as a separate cross-section sample as if no other sampling were required (if concentration less than about 1000 mg/l) or (2) it can be obtained as a subsample of the composited sample from the churn splitter (if concentrations greater than about 1000 mg/l).

When the required volume plus 10 percent for waste is in the churn splitter, place all water-sediment mixture subsample containers within easy reach, so that once started the stirring can be continuous. The sample should be stirred at a uniform rate of approximately 9 inches per second. As the volume of sample in the tank decreases, the round trip frequency should increase so that the churning disc velocity remains the same. The disc should touch the bottom of the tank on every stroke, and the stroke length should be as long as possible without breaking the water surface. Before using the sample splitter for the first time, practice this stroke using tap water. Observe that, as the stroke length and/or disc velocity is increased beyond the recommended rate, there is a sudden change of excessive air into the moisture. The introduction of excessive air into the sample is undesirable because it may tend to change the dissolved gasses, bicarbonate, pH, and other characteristics. On the other hand, inadequate stirring may result in non-representative subsamples.

The sample in the splitter should be stirred at the uniform churning rate for about 10 strokes prior to the first withdrawal to establish the desired stirring rate of 9 inches per second and to assure uniform dispersion of the suspended matter. The churning must be continuous during the withdrawals; therefore, if a break in withdrawals is necessary, the stirring rate must be reestablished before continuing the withdrawals.

When all of the required water-sediment mixture subsamples have been obtained, the remaining portion of the sample is used as necessary for the filtered samples. It will be advantageous to allow the sediment to settle out in the mixing tank for a few minutes before pouring the sample into the filter apparatus. When all of the necessary filtered subsamples have been obtained, the mixing thank, churning disc, and filter water will not remove all of the residue; clean by using a small amount of a detergent such as Alconox, rinse with a weak acid solution (4 ml of nitric acid per litre of water), rinse repeatedly with tap water, and then rinse with deionized water.

Equipment not Furnished:

1. A stand to support the mixing tank that will allow the subsample containers to be placed under the spout.

2. Small supports to hold various sizes of subsample containers such that the top or opening is at or near the mixing tank spout.

NOTE: When used in compositing samples collected from a bridge or roadway, the lid should be kept on at all times, except when pouring sample, in order to protect sample from dust contaminations.

STATION ANALYSIS

A complete analysis of data collected, procedures used in processing the data, and the logic upon which the computations were based must be recorded for each year of record to provide a basis for review and serve as a reference in the event that questions arise about the records at some figure date. Such a report is called the "Station Analysis." A record of any changes in records collected, equipment, location, or other physical features should be included. It should be written clearly and concisely and contain sufficient information so that those who are totally unfamiliar with the station will be able to follow the reasoning used in computing the records. A station analysis should be prepared for each station, including those for which records are furnished by other agencies.

Most districts carry forward a chronological visit by visit summary of information relative to the operation of the gaging station. This summary contains special notes by observer or engineers, results of levels, and other pertinent data. At the end of the water year a complete report is made on the analysis of all the station data. This report will be headed "Station analysis." It may contain in addition to the information discussed herein, the chronological summary of station operation. The station analysis will be divided into parts as indicated below. In preparing this analysis remember that many times an additional sentence or a brief discussion of any out-of-the-ordinary procedure may save time both in the field and the office.

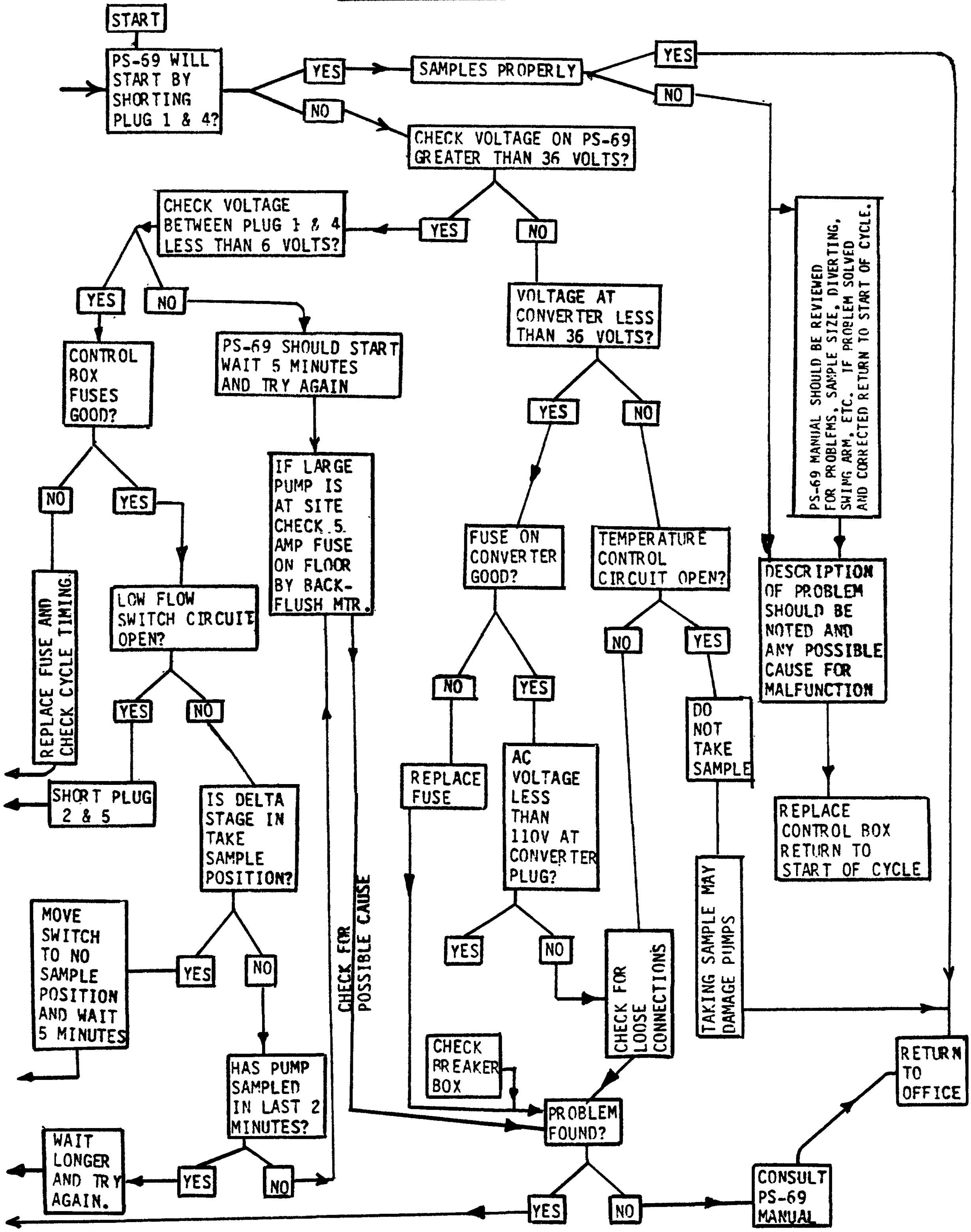
Records.--One short sentence or statement listing each of the parameters recorded at the site.

Equipment.--Provide a short statement which describes the equipment at the site. Designate type of gage (stilling well or manometer), type of recorder used, measuring facilities, artificial control, if any. Describe installed sediment sampling equipment, and indicate location of fixed installation on the bridge. Indicate type of thermograph or raingage equipment and location of sensors (probes or rain collector) relative to the gage. Report any changes in equipment which may affect accuracy of the records. Review the station description, revise it if necessary, and include statement that "Equipment conforms to station description dated...."

Hydrologic conditions.--A brief description of the hydrologic characteristics of the basin should either be carried forward in the station analysis from year to year or be included in the station description. Review this paragraph and briefly describe any changes that might affect the runoff regime. These changes may be as a result of fire (give date and percentage of basin area affected) or urban development (describe type and extent of development and give approximate dates) or of logging or road building operations. Usually several years elapse before the effects of these hydrologic changes become stabilized. Therefore, even if no changes occur in the current year, this paragraph should carry a statement referring to changes in the recent past such as: "No changes since the fire of August 21, 1961, which burned 6,000 acres of woodland;" or "No increase in urban development since September 1962."

PS-69 FLOW DIAGRAM

TROUBLE SHOOTING GUIDE



Attachment 6

Gage-height record--Tabulate periods of faulty or missing gage-height record and reasons for these problems. Discuss briefly any large instrument errors that affect the accuracy of the gage-height record. If portions of the gage-height record have been synthesized or adjusted on the basis of observers' readings and other data, this should be explained. Do not discuss in this paragraph how discharge was computed during missing periods. This should be explained in the "Special Computations" paragraph.

Datum corrections--Confusion frequently exists as to what should be included in this paragraph. Datum errors may result from leaky floats, from settlement of gages, from movement of bubble gage orifices. Too often these errors are lumped with shift corrections, and erroneous rating analysis results. Care should be taken, particularly with manometer and digital recorder combinations, to differentiate between datum corrections and shift corrections. If datum corrections are necessary, the reasons should be explained and corrections listed in tabular form, such as:

Period	Correction Applied
Oct. 1 - Jan. 15	+0.04
Jan. 16 - Apr. 15	+0.05
Apr. 16 - Aug. 3	+0.06
Aug. 4 - Sept. 30	0

If applicable, use a simple statement such as "None applied; last levels run on ____________."

Rating--Start this section with a description of the channel and the control, providing sufficient detail to give anyone unfamiliar with the site a fair picture of the dominant features. Items discussed should include the size of the channel, composition of the bed (sand, gravel, boulders, or bedrock), location of the gage relative to the control, and the approximate elevation incised in the flood plain. Bed material is predominantly sand and gravel. The low water control is generally a gravel riffle which moves up and down the channel in response to flood flows. At bank full stage (about 21 feet), the channel is about 150 feet wide. At higher stages, it spreads out rapidly to a width of about 300 feet at a stage of 25 feet.

The balance of the rating paragraph should be a chronological narrative of what occurred, hydraulically, during the year. Begin with a statement as to the number of measurements made and how they plot in relation to the rating curve in use at the end of last year. If new ratings are required, explain how this conclusion was reached and what caused the shift from one rating to the other. State exact time and date when rating changes were made. If ratings are modified during periods of significant flow by use of the shifting control method, document these rating changes with shift tables or shift curves. These are rating changes, too, and require the same explanations as a new table does. Because the reviewer does not always have access to the basic data, it is most important that the distribution of shifts be explained in detail, particularly any unusual methods used. The statement "Shifts were distributed on basis of stage and (or) time" does not constitute a detailed explanation. The reviewer needs sufficient detail so that he can at least determine if a shift must be applied to the maximum and secondary peak stages and know its magnitude. For example, discharge measurements were obtained before and after a peak of 12.55 ft.; the measurement preceeding the peak shows a shift of -0.26 ft. at gage height 2.56, and the one following the peak shows a shift of -0.06 ft. at gage height 9.63 ft. One might reason that the rise scoured out the channel gradually, and the shift was zero at the peak. In the analysis, one might state "It was assumed that the shift of -0.26 ft. indicated by measurement No. xx was gradually reduced during rise, and there was no shift at the peak; therefore, the shift between measurements No. xx and xxx was distributed on basis of stage." Or one might have basis for this statement: "On basis of shifts indicated by measurement No. xx and xxx and succeeding measurements, shift distribution was made on the assumption that the shift varied during the rise from -0.26 ft. at gage heights 2.50 ft. to -0.06 ft. at the peak and remained" would indicate to the reviewer the shift needed for the peak stage and give him a better idea of the distribution that was made. If a shift distribution were made on the basis of time, the statement "Shifts were distributed on basis of time" is sufficient, providing the shift used for peak occuring within the period is given. Discuss, also, the adequacy of the high-water rating. Is it defined by this year's measurements to within 50 percent of this year's maximum? If the extension is based on slope-area or old measurements, state when they were made and whether or not significant channel changes could possibly occur within the intervening period.

Discharge--This paragraph is a summary of how the State records and rating data were combined to produce the discharge record. It should explain the origin of figures shown on the primary computations as well as on the final SF 9-211M. Thus, information is needed to show what was done on the primary run and how this may have been modified in subsequent updatings of the record. Documentation received on updating runs should accordingly be preserved and referred to in this paragraph.

Special computation--Describe the methods used for determining discharges during periods of no gage-height record, ice effect, backwater, variable slope, or other special conditions. Explain any unusual method for determining shifts. If daily discharges were estimated on the basis of hydrographic comparison with records for nearby stations, state the name of the stations used and how closely the stations compared. If weather records were used in the analysis, give the name or names of the weather stations used.

Remarks--Give a statement on the general accuracy of the daily records with special statements regarding periods of ice effect, no gage-height record, high water, low water, backwater, shifting control, or other unusual conditions. A statement should be made here indicating that a hydrographic comparison was made. Identify station or stations used for comparison and how well the hydrographs compared. In general, this section will cover the statements to be included in the "Remarks" paragraph of the manuscript station description. Preparation of the statement on accuracy at the time the station analysis is written has the advantage of getting down in black and white, while the work is fresh, the statements that will later be entered for publication under "Remarks" in the manuscript station description. Any additional remarks pertinent to the analysis of the records should be included.

MONITOR RECORD

Record--This paragraph is the counterpart of the gage-height paragraph in the surface-water discharge analysis. Tabulate periods of faulty or missing record and nature of problems related thereto.

Calibration--The discussion here again parallels the surface-water analysis. If proper attention is given to operating procedures, sufficient data will be collected over the year to verify the calibration of the monitor. If unusual corrections are necessary, explain nature of corrections and tabulate periods involved.

Computations--State how the record was computed. Anomalies of more than 2% should be explained.

Remarks--Evaluate quality of record.

SEDIMENT RECORD

Record--This paragraph is the counterpart of the gage-height paragraph in the surface-water discharge analysis. Tabulate periods of missing records and nature of problem related thereto.

Data provided--Show number of samples shipped to the USGS. Subdivide these samples as to how they were collected, (i.e., observer, automatic sampler, contractor) to be used for reference sample sets.

SUMMARY OF EQUIPMENT INSTALLATION AT STATIONS

Station Number		Continuous Stage Recorders		Bubble Gage w/ Mano-Meter	Water Quality Continuous Monitor	Sediment Collection		Outside Gages		
		Digital	Analog			Auto.	Observer	Crest-Stage (No.)	Wire weight	Staff
07231975	Brushy Creek near Haileyville	X	X	X		X		4	X	
07248600	Caston Creek near Wister	X	X	X			X	2	X	
07246615	Coal Creek near Spiro	X	X	X	X	X		2		X
07247500	Fourche Maline near Red Oak	X	X	X 1/					X	
07247450	Fourche Maline near Wilburton	X	X	X		X		0	X	
07249422	Holi-Tuska Creek near Panama	X	X	X		X		1		X
07248620	Morris Creek at Howe	X	X	X		X		0	X	
07332950	Muddy Boggy Creek at Atoka	X	X	X			X	0	X	
07249100	Owl Creek near McCurtain	X	X	X		X		4	X	
07231990	Peaceable Creek near Haileyville	X	X	X		X		2	X	
07247550	Red Oak Creek near Red Oak	X	X	X	X	X		2	X	
07248700	Sugarloaf Creek near Monroe	X	X	X		X		2	X	
07231965	Ti Creek near Blanco	X	X	X		X			X	

1/ Float gage

Watershed	Number and Type of Precipitation Gages	
	Digital	Analog
Blue Creek	2	1
Holi-Tuska	2	
Morris Creek	3	
Red Oak Creek		3
Ti Creek		1

One groundwater well with digital recorder in each of the following 5 areas:

Blocker, Panama, Red Oak, Rock Island, and Stigler

SUMMARY OF EQUIPMENT INSTALLATION AT STATIONS

Station Number	Station	Continuous Stage Recorders: Digital	Continuous Stage Recorders: Analog	Float Gage	Manometer	Outside Gages: Crest-Stage (No.)	Outside Gages: Wire Weight	Outside Gages: Staff
07232010	Blue Creek nr Blocker	X	X		X	1		X
07232008	Blue Creek Trib. nr Blocker							X
07249073	Brazil Creek nr Lodi	no gage--only a tape-down point.						
07249060	Brazil Creek nr Red Oak					2		X
07249080	Brazil Creek nr Walls	X	X		X	2**	X	
07245040	Jackson Creek nr Stigler	no gage--only a tape-down point.						
07249400	James Fork nr Hackett, AR***	X					X	
07249410	James Fork nr Williams					1*		X
07232029	Mathuldy Creek nr Crowder					2**		X
07249070	Rock Creek nr Red Oak					2**	X	
07245020	Taloka Creek at Stigler					2	X	
07245030	Taloka Creek nr Stigler	X	X	X		1	X	
07245025	Taloka Creek Trib. nr Stigler	no gage--only a tape-down point.						

* A set of crest-stage gages is installed so that the range-in-stage can be determined. Only one gage will record the peak of any one flood.

** Downstream and upstream gages. Upstream will have more than one to record range-in-stage.

*** Collect QW and gage-height only. Arkansas District services station and computes discharge.