ANALYSIS OF THE FEASIBILITY OF MULTI-PERSON FIELD TRIPS FOR ROUTINE DATA COLLECTION BY THE U.S. GEOLOGICAL SURVEY IN MISSISSIPPI

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By Michael S. Runner, Michael L. Plunkett, and B. Allen Roberts

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ABSTRACT

The Mississippi District of the U.S. Geological Survey initiated a Process Action Team in September 1993 as part of its Total Quality Management program to study the feasibility of converting the routine, single-person, surface-water data collection field trips to multi-person field trips. This was done primarily to address quality control and safety. The team reviewed the field-trip process in Mississippi to determine which factors would be affected by having an additional person on the field trip. The study indicated that multi-person field trips would increase the manpower requirements to operate the streamflow gaging network by 4 percent. The team concluded that the improved quality control, personnel safety, and field training more than offset the additional costs.

INTRODUCTION

The process of routine surface-water data collection and gage maintenance in the Mississippi District of the U.S. Geological Survey has historically consisted of a number of streamflow gaging trips run on 6-week intervals by a single field person. During the 1993 water year, the data-collection network consisted of 139 continuous and partial-record gaging stations distributed between nine single-person field trips. Quality control and safety concerns led to the creation of a Process Action Team (PAT) to study the feasibility of multi-person field trips for the purpose of routine data collection. The study was undertaken as part of the Mississippi District's Total Quality Management program.

The final report of the PAT is included in the report's original form. The report reflects the independent thinking, procedures, and conclusions of the PAT, and as such the report was not prepared using U.S. Geological Survey editorial guidelines and has not undergone the editorial review of a typical U.S. Geological Survey report. The following paragraphs contain a brief synopsis of the report. For the complete analysis refer to the original report.

To gather data for the study, the PAT temporarily implemented multi-person field trips for the existing streamflow gaging network and reduced the number of streamflow gaging trips from nine to seven. Information on the restructured trips was recorded on trip logs and given to the PAT. Data for the single-person trips were obtained from questionnaires distributed to the field personnel, review of old trip logs and measurement notes, and personal communication with the field personnel.

A list of factors affected by the addition of a second person to the field trip was developed. This list was divided into tangible and intangible factors. Tangible factors are those that can have a quantative cost or manpower number attached to them, and intangible are those that cannot. The final list of factors included manpower, travel costs, equipment costs, vehicle costs, quality control, safety, and on-the-job training. The effect on these factors was analyzed using the data obtained from the trip logs, questionnaires, and communications.

The results from the analysis showed that there would be an increase in the manpower required to run the routine trips for the gage network. However, the study also showed a decrease in the manpower required for maintenance trips, estimating missing record, and personnel training. The net increase in manpower was determined to be approximately 700 hours per year. Comparing this to the total hours required to run the gage network (nine full-time employees), the net increase is only 4 percent. The PAT concluded that the benefits of improved quality control, personnel safety, and field training more than offset the additional costs. It should be noted that the results from the study are specific to the Mississippi District and may be different for other districts.

ANALYSIS OF THE FEASIBILITY OF MULTI-PERSON FIELD TRIPS FOR ROUTINE DATA COLLECTION

Final Report of the Mississippi District's
Surface Water Process Action Team

Jim Alvis
Coleman Leach
Mike Manning
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September 1994

ANALYSIS OF THE FEASIBILITY OF MULTI-PERSON FIELD TRIPS FOR ROUTINE DATA COLLECTION

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ANALYSIS OF THE FEASIBILITY OF MULTI-PERSON FIELD TRIPS FOR ROUTINE DATA COLLECTION

EXECUTIVE SUMMARY

The Mississippi District of the U. S. Geological Survey initiated a Process Action Team to analyze the feasibility of multi-person teams for routine surface-water trips as an alternative to the standard single person field trips. The multi-person field trip was expected to eliminate many of the unscheduled maintenance trips by allowing many problems at gaged sites to be corrected at the time of discovery rather than having to make a return trip specifically for that problem. In addition to eliminating a significant amount of missing record, the expense and inconvenience of many unscheduled field trips can be avoided. Potential improvements in quality control, safety, and training for field personnel were also major concerns for consideration of the multi-person trips. The team was charged with analyzing the additional costs incurred by multi-person field trips, and weighing those costs against the benefits derived from having an extra person along on the trip. During the 1993 water year (WY) the Mississippi District's surface-water data collection network consisted of 139 continuous and partial record sites. These sites were divided up among eight full trips and one short trip consisting of some partial record sites and the lock and dam sites at Aberdeen and Columbus. The full trips were initially set up to take four to four-and-a-half days to complete. To gather data on two-person field trips, the trip network was rearranged to take advantage of an expected efficiency increase. The trip network was restructured to have seven full two-person trips, eliminating one full trip and the lock and dam trip. A list of factors affected by the extra person was made and divided into two sub lists, tangible and intangible factors. Tangible factors are those factors that can have a dollar or manpower figure attached, and intangible factors are those that cannot. The final list of factors consisted of manpower, travel costs, equipment costs, vehicle costs, quality control, safety, and on-the-job training. Data was collected from trip

logs, questionnaires distributed to field personnel, and contact with field personnel. The increase in the hours required to run the two-person routine field trips combined with a decrease in hours required for avoidable maintenance trips, estimating avoidable missing record, and training resulted in a net increase in 713 hours. When considering the total manpower required to operate the District's network of surface-water sites, including data collection and analysis (about 9 full time employees), the increase in manpower due to two-person field trips is only about 4 percent. Analysis of the costs associated with travel, equipment, and vehicles showed that switching from one-person to two-person trips would have no significant effect, with the increase in travel and equipment costs being offset by a savings in vehicle costs. After reviewing the results of the analysis, the Process Action Team deemed that the increase in hours was more than offset by the benefits in quality control, safety, and improved training. Therefore, it is the recommendation of the Process Action Team that for the purpose of running the routine field trips for measurements and gage maintenance multi-person field trips be implemented on a regular basis.

PURPOSE

The purpose of this study was to analyze the economic and logistical feasibility of multi-person field trips for the Mississippi District's routine surface-water data collection trips. This analysis was accomplished by a comparison between the current one-person trip network and a revised two-person trip network.

INTRODUCTION:

The Quality Council for the Mississippi District created a Process Action Team (PAT) to perform a study of the feasibility of the multi-person field trips for the routine data-collection trips. It was thought that multi-person field trips would provide the ability to eliminate a significant amount of missing record and improve safety, data quality and training procedures. The PAT consisted of seven members of the District all of whom are associated with field work in some way. The PAT roster is as follows: Jim Alvis, Coleman Leach, Allen Roberts, Mike Manning, Mickey Plunkett, Ron Durr, and Mike Runner.

The Mississippi District's surface-water data collection network consisted of 77 continuous record sites as well as 62 partial record and crest-stage gages (CSG's) during the 1993 WY. The operation of this network, including data collection, analysis, and publication, requires the efforts of about nine full time employees. The 1993 network for routine field trips consisted of nine trips--eight trips with an average of nine continuous gages and six CSG's, and one trip which incorporated the Columbus and Aberdeen lock and dam's and eight CSG's. The trips were run once every six weeks and took approximately four to four-and-a-half days to complete, except for the lock and dam trip which was a two day trip.

Missing record and record of questionable accuracy for continuous gaging stations is a continuing problem and concern for all Districts in the U.S. Geological Survey, and the Mississippi District is no exception. This concern was a major factor in the consideration of

multi-person field trips in the Mississippi District. Often, there will be weeks of questionable or missing record that must be estimated to complete the WY's record for a given station. Estimated data is considerably less accurate than recorded and measured data and is always rated poor. Record often must be estimated for the extreme high- and low-discharge periods of a given water year. Questionable and estimated record can have repercussions far beyond the annual report; for instance, it will effect any work done which relies on this data such as flood frequency and low flow studies.

The question of record integrity within the Geological Survey has risen several times in the recent past, both nationally and on the district levels. A recent memo from the Office of Surface Water (OSW) (Appendix E) urged the implementation of quality-control procedures to ensure data integrity. The suggestions are aimed at making sure that proper techniques are used during the data collection process. It was recognized that the suggestions made in this OSW memo could be addressed through the implementation of multi-person field trips.

Safety concerns for field personnel were also a major factor in the implementation of the study. The pursuit of data often takes field personnel to remote areas of the State where communications with civilization are difficult if not non-existent. An accident in a remote area could prove serious or fatal if assistance is not available and cannot be summoned. The purchase of cellular phones in 1993 for emergency situations alleviated some problems, but an incomplete coverage by the phone service limits the use of the phones. In addition, many measurements are made from bridges with less than desirable traffic conditions that produce hazardous situations. The level of risk in these situations is related to traffic volume, effectiveness of traffic control, amount of time spent on the bridge, and other factors. The District has recently developed a bridge safety plan which specifies lane and shoulder closure procedures following Federal Highway Administration guidelines. This plan will become effective October 1, 1994 and will

require one or two extra persons to make a bridge measurement in some situations.

In the regular measurement and maintenance of the continuous record gage network, many scenarios already exist requiring more than one person to be present. Any maintenance that requires a person to enter a stilling well for whatever reason currently requires adherence to confined space guidelines as outlined in Water Resources Division Memorandum 94.30, dated May 9, 1994 (Appendix E). Flood measurements and boat measurements also require more than one person be present, as stated in the Mississippi District's Flood Operations Plan and the regulations governing boat safety for personnel of the U.S. Geological Survey.

These factors and others can be addressed by a multi-person field trip. The goal of this Process Action Team was to perform a comparison analysis between the single person field trip and multi-person field trip to test the economic and logistic feasibility of implementing the multi-person trip on a permanent basis.

ANALYSIS PLAN

The first step in the Multi-person Field Trip Feasibility Study was to set up an analysis plan to act as a guide for the project. The basic analysis plan decided upon was a three step plan.

1) Generate a list of affected factors

2) Gather data necessary to evaluate each factor

3) Analyze the data

The first step in the plan was to generate a list of factors that would be affected by adding an additional person to the field trip. A broad list of factors was created initially and then after several reviews and much discussion, trimmed down to those factors deemed relevant to the analysis. The list was divided into two sub lists, tangible and intangible factors. A tangible factor

is a factor that can have a dollar or manpower figure attached directly to it. An example of a tangible factor is vehicle costs. An intangible factor is a factor that although it cannot have a dollar or manpower figure attached to it is still important to the analysis and would play a substantial role in making a final decision. The final list of factors is as follows:

-Tangible Factors: Manpower, travel costs, equipment costs, and vehicle costs.

-Intangible Factors: Quality control, safety, and improved training techniques.

One of the tools used to establish these factors was the development of a flow chart detailing the steps involved in running a field trip (Appendix D). The flow chart was broken down into three phases; the pre-trip phase, the actual on site phase, and the post-trip phase. Each of the flow charts looks at the steps required in each phase and puts them into chronological order as well as possible. The flow chart gave a good idea of where the time was being spent for the field trips and where time might be saved with a multi-person trip.

The second step in the analysis was data collection. Information was needed on things such as sites per trip, length of trips (time), miles per trip, extra maintenance trips, amount of missing record for each station, time spent estimating record, and the amount of missing record and field trips that could have been avoided had personnel and equipment necessary to make a repair (within reason) been available at the time the problem was discovered.

The information required was gathered by means of trip logs and questionnaires. The trip logs are filled out during each trip and document the date and time of each site visit, total mileage for the trip, and location of field crews each night (for per diem purposes). Two questionnaires were distributed to the field personnel in the office. One questionnaire dealt with missing record and the other with time spent in the field on routine and extra field trips. Copies of a trip log and the questionnaires are included in Appendix B.

The third step in the analysis plan was the data analysis. The tangible factors list was divided up for analysis purposes as follows:

Manpower

-Routine Trips

-Avoidable Maintenance Trips

-Estimation of Avoidable Missing Record

-Training

Travel Costs

Equipment Costs

Vehicle Costs

-Vehicle Rent

-Mileage

In order to make a viable comparison between the one-person and the two-person field trips, it was necessary to gather data on the two-person trips. For the purpose of gathering data during the 1994 WY, the field trip network used for the 1993 WY was rearranged to facilitate the two-person trips. In anticipation of increased efficiency of two-person trips, two of the field trips were eliminated and their sites divided up among the remaining field trips. The realignment of the field trips was done without regard for the effect of the impending Traffic Control Safety Plan. The intention was to isolate and analyze the effects of two-person field trips.

TANGIBLE FACTORS

Manpower

A major factor in the multi-person field trip analysis is the manpower requirements. The total effort to operate the District's surface-water network includes routine field trips, maintenance or construction trips, flood and low-flow measurement trips, training of new employees, and the office work required for data analysis and publication. This effort currently

requires about 9 full time employees. It was determined that the implementation of the two-person routine field trips would have an impact on the manpower required to (1) run the routine trips, (2) run the maintenance trips (specifically those deemed avoidable), (3) estimate avoidable missing record, and (4) provide on the job training.

The trip network as it stood during the 1993 WY consisted of nine field trips, including the lock and dam trip. The field trips were designed so that a single person could complete the trip in four-and-one-half days. For the implementation of the two-person trips during the 1994 WY, the assumption of increased efficiency led to the elimination of two field trips with their sites being distributed among the remaining seven trips. It was expected that, even with the additional sites on each trip, the increased efficiency of the two-person field trips would allow the field trips to be completed in less than a week.

Routine Trips

Routine trips are defined for this report as the trips that are scheduled to be run on a six week interval for the purpose of inspecting and servicing instruments and making discharge measurements in a designated area of the State. Manpower requirements for routine trips is defined for this report as the time required, in hours, to complete a given routine field trip, disregarding extra trips for maintenance and flood work. To calculate the manpower required to operate the routine gaging trip network, the trip logs for the 1993 WY and the available logs for the 1994 WY were analyzed, along with data collected by personal contact with the field personnel.

From the trip logs it was determined that for one-person field trips during the 1993 WY, it took about 2,920 hours (365 days) to complete each trip 9 times (one year's worth of routine trips). For the 1994 WY and the implementation of the seven two-person trips, it was determined that about 4,480 hours (560 days) were required to complete each trip 9 times. The

change from one-person to two-person trips yields an increase of approximately 1,560 hours (195 days).

Avoidable Maintenance Trips

Maintenance trips are trips made outside the scope of the routine field trips specifically for the purpose of fixing some problem at a gage. For the purpose of this study, an avoidable maintenance trip is a trip that could have been avoided if at the time of the discovery of the problem (assuming discovery occurs on a routine trip) the problem could have been corrected had the proper equipment and a second person been available. To obtain these figures, the District's field personnel were asked to review their inspection sheets from maintenance trips and to determine which of these trips could have been avoided. Estimates of the hours to complete the work and miles driven to the site were also given. Results were put onto questionnaires made up by the Process Action Team for reviewing purposes. Results from the survey indicate that a total of about 559 hours (70 days) were spent on avoidable maintenance trips during the 1993 WY.

Estimation Of Avoidable Missing Record

Avoidable missing record, for the purpose of this study, was defined as missing record that could have been avoided had personnel and equipment necessary to make a repair (within reason) been available at the time the problem was discovered (assuming discovery occurs on a routine trip). An example of avoidable missing record is when a person on a one-person field trip arrives at a sight and discovers a well is silted. In this case the lone person is generally unable to resolve this problem and must return later with another person and extra equipment to pump the silt out of the well. Had there been another person and pump with them originally the problem could have been resolved immediately. The avoidable missing record is between the time of the discovery of the problem and the time of the eventual repair.

To establish the amount of avoidable missing record for the 1993 WY a second survey was taken of the District's field personnel. This survey had the field personnel look at all missing record periods for each gaging station and determine how much of it was avoidable according to the definition given above. They were also asked to determine how much time was required to estimate the avoidable missing record for the preparation of the annual report.

For the 1993 WY the Mississippi District had a total of 2,107 days of missing record for all the continuous stations, with 646 days (31 percent) deemed avoidable missing record. The estimation of the avoidable missing record took about 75 hours (9 days).

Training

With two-person trips the problem of on the job training for new employees can be addressed. In the past it has been customary to send a senior tech to the field for two or three field trips to conduct training of the new hire. After the three week training period, the new person was then required to run the field trip alone. This method of on the job training has several inherent shortcomings. First, after only a three field trip training period, the new employee is likely to have seen only a small portion of the possible problems that can occur during a field trip. Second, when a problem that cannot be solved arises, it usually means a return trip to the field with a more experienced person to fix the problem. In the mean time, the stage record for that time period is likely to be unusable. Third, during the training period the senior tech is pulled off whatever project the senior tech may be working on at the time to train the new employee on a field trip with which the senior tech may not be familiar. Finally, in the event that the regular field person cannot run a routine trip, another person must be assigned and briefed on the field trip, interrupting the work that person may have been doing at the time.

The two-person field trip can address each of these problems. By assigning the new employee as the second person on a field trip the new employee learns about the trip from

someone that is already familiar with all aspects of the field trip. In addition, the ongoing situation of working with a more experienced person will expose the new employee continually to a broad range of problems and solutions that occur during a field trip without the usual loss of record associated with inexperienced field people. Then too, since the new hire will be involved in two routine trips, the opportunity for more frequent training and training responsibilities shared between two experienced technicians are added benefits. More importantly, the senior tech is not pulled off of assigned duties to do the training. The new person will soon become familiar with the field trip and will be prepared to accept primary responsibility should something happen to the other field person assigned to the trip.

The Mississippi District of the USGS has trained the equivalent of 16 technicians over the past 12 years, or 1.33 techs per year. It is conservatively estimated that each trainee requires 4 weeks of field training by a senior technician resulting in an annual cost of about 213 hours (27 days).

A final comparison between the 1993 WY and the 1994 WY shows that, when considering only the routine field trips, the change from one-person to two-person field trips resulted in an increase of 1,560 hours (Table 1). However, when considering the reduction in hours required for avoidable maintenance trips, the estimation of avoidable missing record, and training the net increase in hours is only 713. When considering the total manpower required to operate the network of surface-water sites, including data collection and analysis (about 9 full time employees or 18,720 hours), the net increase of 713 hours represents only a 4-percent increase in total manpower.

Table 1: Manpower

	1993 Hours	1994 Hours	Change Hours
Routine Trips	2920	4480	+1560
Avoidable Maintenance Trips	559	0	-559
Estimating Avoidable Missing Record	75	0	-75
Training	213	0	-213
Total	3767	4480	+713

Travel Costs

Travel costs, for this study, were defined as the dollar amounts for subsistence (per diem) and lodging required to run routine field trips. These costs are directly affected by any significant change in field operations, and they can have a reasonably accurate dollar amount attached to them. For analysis purposes, the 1993 WY per diem figures and the 1994 WY per diem figures were converted to the amount typically required to run one cycle of field trips. A comparison was then made between the 1993 WY and 1994 WY to show the effect of implementation of the two-person field trips.

Records were taken from trip logs when available, otherwise, the information was taken from travel vouchers and personal contact with the field personnel. The results from the comparison show an increase in both subsistence and lodging when changing from one-person to two-person field trips (Table 2).

Table 2: Travel Costs

Item	1993	1994
Lodging, Nights/$ per WY	208 / $8,320	245 / $9,800
Subsistence, Days/$ per WY	266 / $6,920	307/ $7,980
Totals	$15,240	$17,780

An increase of 37 extra nights of lodging and 41 extra days of subsistence occurs due to the additional person on the field trips. In dollar figures that converts to an increase of approximately $1,480 for lodging and $1,060 for subsistence (assuming $40 per night at a hotel and $26 per day in per diem).

It should be noted that the avoidable field trips are usually one-day trips that don't generate travel expense and as such don't affect this cost comparison significantly.

Equipment Costs

A major benefit of two-person field trips is that with the additional person along on the trip many maintenance tasks can be performed at the time of the discovery of the problem rather than having to go back at a later date. To accomplish this, it is necessary to have enough equipment available so that a crew can take everything it would need for anticipated problems.

Having seven field trips in each six week cycle requires that two trips be run simultaneously at least one week out of the cycle. With the additional possibility of construction and emergency maintenance crews requiring the same equipment, it was determined that the District would need three of each commonly used piece of maintenance equipment. For this analysis the cost of the additional equipment needed to provide this capability was estimated. Much of the equipment needed is already in the District, but a considerable amount needs to be procured (TABLE 3).

Table 3: Equipment Costs

Item	Quantity	Total Cost
Pumps and Hoses	1set	$300
Ladders	2	$400
Cordless Drills	1	$200
Hammer Drill	2	$500
Cutting Torch (small)	1	$500
Sprayer (herbicide)	3	$75
Extension Cords (50 ft)	6	$150
Total		$2125

An initial capital investment of approximately $2,125 is required to purchase the equipment necessary to provide full time two-person field trip capability. There will be additional costs incurred in the future for equipment maintenance and replacement, but these costs are probably insignificant.

Vehicle Costs

Vehicle costs are incurred in two ways; through monthly rent of $200 on each vehicle, which is a fixed cost per vehicle regardless of how much it is used, and through a mileage charge of 19.5 cents per mile. Our vehicle cost analysis was focused on the number of vehicles required for data collection purposes and the number of miles driven to operate the network of surface-water sites.

The 1993 field trip network consisted of nine separate trips and required eight vehicles (the lock and dam trip did not require a separate vehicle). The 1994 field trip network consisted of seven trips and required seven vehicles. The expected increased efficiency of the two-person field trips allowed the restructuring of the trips by putting more sites on each trip and eliminating two

trips altogether. The elimination of one vehicle from the fleet resulted in an immediate savings of $200 per month ($2400 per year).

The vehicle mileage required to operate the network is a combination of the mileage from the routine trips plus the mileage required for unscheduled maintenance trips. The mileage required for the routine trips was evaluated based on mileages reported on trip logs (Appendix B). In 1993 the mileage required to run each trip 9 times was about 56,450 miles. At 19.5 cents per mile, the total mileage cost for the 1993 WY was $11,000. In 1994 the mileage required to run each trip 9 times was about was 50,540 miles. At 19.5 cents per mile the total mileage cost for the 1994 WY was $9,860. In addition, questionnaires distributed to the field personnel indicated an estimated total of 14,680 miles driven for unscheduled trips in the 1993 WY. Of this amount, about 7,900 miles at a cost of $1,550 (Table 4) could have been avoided if sufficient personnel and equipment had been available during the routine trips.

Table 4: Vehicle Costs

Cost Item	1993	1994
Vehicle Rent	$19,200	$16,800
Routine trip mileage (cost)	56,450 ($11,000)	50,540 ($9,860)
Avoidable unscheduled trip mileage (cost)	7,900 ($1,540)	0 ($0)
Total vehicle cost	$31,740	$26,660

Summary of Tangible Factors

The analysis of the tangible factors shows that changing from one-person to two-person field trips resulted in an increase in hours of 713. When considering the total manpower required to operate the network of surface-water sites, including data collection and analysis (about 9 full time employees), the increase of 713 hours represents only a 4-percent increase in total manpower. The increase in travel and equipment costs are offset by savings in vehicle expenses.

Table 5: Summary of Tangible Factors

Item	1993	1994	Change
Manpower	3767 hrs	4480 hrs	+713 hrs
Travel Costs	$15,240	$17,780	
Equipment Costs	0	$2,125	
Vehicle Costs	$31,740	$26,660	
Total ($)	$46,980	$46,565	-$415

INTANGIBLE FACTORS

The implementation of the two-person field trips brings with it several improvements to the data collection process which cannot have a dollar amount attached to them. Quality control in the form of increased accuracy and record integrity, safety, and improved personnel training are some of the improvements.

Quality Control

The consistently high quality of data collected by this agency has been a significant factor in establishing our reputation as the nation's premier earth science agency. The importance of monitoring the quality and integrity of our surface-water data collection efforts is continually emphasized at Project, District, Region, and Headquarters levels utilizing efforts as simple as a review of field notes and as complex as an OSW lead surface-water program review. These efforts at the District/Project level were recently emphasized through an OSW memo suggesting that the following quality-control procedures be considered (Appendix E).

- At least annually, someone other than the field person who has responsibility for a specific trip should either take the field trip or accompany the usual field person on the trip and perform the measurements at each site.

- •Field trips should be rotated to different personnel at least every three years and, preferably, more frequently.
- •Trip reviews be conducted to provide the mechanism for sharing the responsibility for overall operations and give an early opportunity to correct misunderstandings related to either technique or equipment.
- •Measurements should be scanned for erasures and checked to the extent recommended in TWRI, Book 3, Chapter A13.

Virtually all of these suggestions can be addressed to an even greater extent than that recommended through proper implementation of two-person filed trips. The training, review, and cross checking of techniques and results become built in and are therefore conducted on a continuing basis, rather than in a spot-check mode, by pairing experienced technicians with less experienced technicians and by involving each technician in two field trips coupled with a different person on each trip. Misunderstandings related to techniques or equipment can be eliminated immediately with no interruption in quality or efficiency. The rotation of field trips, which was previously an awkward process as technicians struggled to maintain efficiency while becoming accustomed to new sites and new territory, is a relatively painless process with two-person field trips. The District plan is to rotate one person off of a particular trip every other year; but, since the second person will continue to run that trip with a new partner, there will be no interruption in familiarity and no loss in efficiency. However, the advantages of bringing a new person into the trip territory still remain.

It should be noted that, while the quality-control procedures recommended by OSW do have some cost associated with them that will be eliminated through the use of two-person field trips, these savings were not included in this cost comparison exercise. Some further discussion of improvements in data quality is included in the training benefits section below.

Safety

The work conducted by our field personnel routinely involves strenuous physical labor, unfavorable weather conditions, and operation of power tools and other machinery. In addition, this work is typically in remote locations and in proximity to highway traffic, bridges, and waterways, resulting in an inherently dangerous work environment. Steps toward improving the safety in the field have already been taken in the form of purchases of cellular phones, improved emergency lights, high visibility jackets and vests, and a new traffic control safety plan. New regulations covering worker safety in confined spaces and on boats are another step toward ensuring worker safety.

No amount of rules and regulations will remove all the chances of accidents and injuries occurring in the field, however, risks can be minimized. The additional person provided by two-person field trips can assist in traffic control, watch for traffic hazards, reduce the amount of time spent on the bridge during a data collection effort, and provide assistance for wading measurements, minor maintenance, driving, map reading and other common activities, resulting in an inherently safer work environment. A second person at the site could also help with first aid and get help if it is needed should an accident occur. This could prove to be the difference between a minor and severe or fatal accident.

Training

Training was discussed previously in terms of dollars and cents. It should also be noted that improvements in the quality and efficiency of on the job training is a significant benefit of the two-person field trip.

The training routine in the past consisted of having a senior technician take a new hire out two or three times before sending the new hire out alone on a routine field trip. Not only does this method result in lost data when problems occur that the new person cannot fix alone, but also

compromises the quality of all data collected due to the fact that there is a steep learning curve associated with our current data collection activities. The rapid rate at which instrumentation is evolving and the current mix between old and new technology makes it likely that the trainee will be faced with a significant number of different data collection devices. Learning the proper way to service and maintain these instruments is an extensive process and cannot be completed in the two or three field trips of the standard training routine. Also, there are many aspects of running a field trip and keeping complete and accurate field records that are only learned through experience. In the short term, this lack of experience can make the difference between good, fair, or poor stage record and discharge measurements.

There is no simple way to quantify how much the record at a gaging station suffers when a new person takes over a field trip; however, there can be no doubt that quality is compromised. Two-person field trips provide continuous training and information exchange between senior and less experienced technicians and provide a smooth transition when an experienced member of the team is replaced by a new hire. The end result is that the learning curve is flattened, data quality remains consistent, and the overall quality of the data collection and analysis program is improved. Since data collection is one of the primary missions of this organization, any means possible to improve upon the efficiency and quality of the data collection process should be given careful consideration.

CONCLUSION

The analysis of the feasibility of the multi-person field trip as a viable alternative to the standard one-person field trip led to an in depth look at the data collection process, the steps that make up that process, and the factors effected by changes made to the process. The data received from the analysis of the 1993 WY was compared to data collected from a trial run of two-person field trips initiated at the beginning of the 1994 WY. The factors affected were broken down into

tangible and intangible subsets as follows:

Tangible factors;

- Manpower
- Travel costs
- Equipment costs
- Vehicle costs

Intangible factors;

- Quality Control
- Safety
- Training

The effect of implementing two-person field trips on each of these factors was analyzed. The analysis indicated that the increase in hours required to run the routine field trips, combined with a decrease in hours required for avoidable maintenance trips, estimating avoidable missing record, and training resulted in a net increase of 713 hours. When considering the total effort required to operate the District's surface-water data collection and analysis program (about 9 full time employees), the increase in manpower required by two-person field trips is only about 4 percent. Analysis of costs associated with travel, equipment, and vehicles indicated that increased travel and equipment costs will be offset by savings in vehicle costs, resulting in an insignificant net change. It is evident that quality control, safety, and training will all be significantly improved through the implementation of two-person field trips.

It is the opinion of the Process Action Team that, for the purpose of running the routine field trips for measurement and gage maintenance in the Mississippi District, the benefits afforded by the two-person teams outweigh the cost of the additional hours accrued. Therefore, the Process Action Team recommends the implementation of the two-person field trips on a regular and

permanent basis.

RECOMMENDATIONS FOR FURTHER STUDY

To observe further the effect of the two-person field trip on the factors involved, several steps should be taken at both the District and national level.

District Level

The field trip logs have been modified so that the hours worked in the field each day will be recorded on the trip logs, along with the other information already given. This will give a more accurate representation of exactly how many hours are being spent on a field trip as opposed to estimating the length of each day based on site visit times indicated on current trip logs. This will improve the accuracy of the estimates used in this study.

A review of the final record for the 1994 WY will determine how much missing record occurred compared to the 1993 WY. Using the same questionnaires as before, a review of all missing record in the 1994 WY and the circumstances surrounding it will determine if the assumption holds true that under the two-person system the amount of avoidable missing record approaches zero. These questionnaires will also provide data on the nature and number of extra field trips made during the 1994 WY to see if the number decreased significantly as expected. The questionnaires will be filled out during the 1994 WY station analysis and the data will be available for review April 1, 1995.

A planned meeting at the end of the WY of all personnel involved in the two-person field trips should prove valuable in sharing lessons learned and in gathering ideas for further improvements in quality and efficiency. This meeting will be held by October 31, 1994.

The full effect of the District's traffic safety plan is yet to be established. As this plan is implemented during the 1995 WY, its impact will be better understood, and a possible

reorganization of the field trips will be investigated.

These tasks will be carried out under the supervision of the Process Owner and persons of his choice. The process owner for this study is Mickey Plunkett, Supervisory Hydrologist, U.S. Geological Survey, Water Resources Division, Mississippi District.

National Level

There has been a great interest expressed on the National level in the results and recommendations of this report. The report will no doubt be scrutinized by many people. The comments by those that take the time to read the report should be compiled and reviewed for ideas and suggestions.

With the overall recommendation of this report being in favor of two-person field trips, there is the likelihood that other districts will initiate them, if only on a trial basis. When asked for, assistance should be given based on our experience with respect to monitoring the field trips and exchanging successes, failures, problems, and suggestions. Also, any findings by other districts should be reviewed for possible application in our own District.

SURFACE WATER PROCESS ACTION TEAM COST SUMMARY

The Surface Water PAT members spent approximately 350 hours performing tasks related to the completion of the project. Of this 350 hours, 140 hours were spent in team meetings, and 210 spent working outside the meetings. Outside work consisted of data collection, data analysis, TQM related activities (e.g. skills training), and report writing and review. The hours were taken from time sheets completed by the team members. The figures do not reflect any hours worked after August 25, 1994 or the hours of the team facilitators. This represents a total cost to the District of $7,800.

APPENDIX A

Process Action Team Documents

Charter

Ground Rules

Strategic Plan

CHARTER BETWEEN THE SURFACE-WATER FIELD TRIPS PROCESS ACTION TEAM AND THE MISSISSIPPI DISTRICT QUALITY COUNCIL

TITLE: Surface-Water Field Trips

TEAM MEMBERS: Jim Alvis, Ron Durr, Coleman Leach, Mike Manning, Mickey Plunkett, Allen Roberts, Mike Runner

FACILITATOR: Karl Winters

BACKGROUND INFORMATION:
We have chosen each of you with careful consideration regarding your valued input for this team. Take your duties seriously; your acceptance as a team member is contingent on you remaining and participating through the completion of the team mission.

We recognize that you have all the duties you had before becoming a Process Action Team member, but please understand that this is now to be considered one of your priority duties. If you experience problems with time, talk with the Total Quality Management Coordinator or your supervisor. Your supervisor is also supporting this team effort and will work with you to prioritize your duties.

The Council will support all reasonable requests from you in order to ensure your success in accomplishing this mission.

PROBLEM STATEMENT: Increased concern for safety and data integrity, coupled with the advent of new technology for data collection, has created a need to reassess existing field-trip procedures.

ISSUES INCLUDE (but are not limited to):

- Cost analysis of current and proposed field trips
- Field equipment
- Field procedures
- Available District funding (current and future)

SUGGESTED INFORMATION RESOURCES:

- District Safety Officer
- District personnel with surface-water experience
- Southeast Region Senior Technician Committee

- Southeast Region Surface-Water Specialist
- Office of Surface Water (Ernie Hubbard, Will Cobb, Bill Kirby, or Bill Boning)

OBJECTIVE: Analyze the feasibility of a multi-personnel field trip to collect surface-water records versus current procedures and implement the best plan.

LENGTH OF PROJECT: 8 months, with 16 hours training.

FINAL REPORT: Upon completion of your team's mission, we request that you submit a written report of actions taken to analyze the feasibility of a multi-personnel field trip to collect surface-water records versus current procedures and to implement the best plan. The report should also include specific recommendations for measuring the improvement.

This report will include a minimum of:

- **CHARTER** -- revised, if appropriate.
- **EXECUTIVE SUMMARY** -- a short overview of the report including PAT membership
- **STRATEGIC PLAN**--current and future
- **FINDINGS, CONCLUSIONS, AND LESSONS LEARNED BY THE TEAM**-- data, including statistics, to substantiate your interpretations and actions.
- **APPENDIXES** -- including data-collection tools, analysis tools, process workflows and surveys, and root cause analysis results.

COUNCIL RESPONSIBILITIES:

1. Provide adequate training for team leaders, members, and facilitators.
2. Appoint team members and facilitators if vacancies occur on the team.
3. Provide adequate support to ensure the team has the necessary resources to accomplish its mission.
4. Provide recognition of team effort upon completion of the project.

TEAM RESPONSIBILITIES:

1. Review charter for understanding of team objectives and propose any changes.
2. Develop plan for meeting team objectives and obtain Council consensus.
3. Develop ground rules and operating procedures.
4. Identify who the customers are and what their needs are.
5. Meet a minimum of 8 hours per month. Additional meetings may be scheduled as needed.
6. Ensure a facilitator is present at all meetings.
7. Seek consensus and support from the Council for any surveys, interviews, or

sampling procedures the team intends to use.

8. Keep records of the team's process and progress. A copy of meeting minutes and agenda should be provided to the District TQM Coordinator after each meeting.
9. Keep a record of the team's time and expenditures.
10. Obtain consensus of the Council before testing or implementing any solutions that it proposes.
11. Provide monthly updates by team leader or representative of team activities to the Council.
12. Brief Council of project highlights and provide draft report prior to finalizing.

GROUND RULES

1. MAKE DECISIONS BY CONSENSUS.
2. EXPLAIN THE REASONS BEHIND YOUR STATEMENTS, QUESTIONS AND ACTIONS.
3. TEST PERSONAL ASSUMPTIONS AND INFERENCES.
4. FINISH TOPIC BEFORE STARTING ANOTHER OR AGREE TO MOVE ON.
5. SHARE ONLY APPROPRIATE INFORMATION WITH NON-GROUP MEMBERS.
6. NO MEETING WITHOUT 5 MEMBERS PRESENT.
7. AIM FOR WIN-WIN SOLUTION.
8. NOTIFY MIKE RUNNER IF YOU CAN'T ATTEND A MEETING.
9. PLAN FOR 2 1/2 HOUR WEEKLY MEETING WITH 15 MINUTE BREAKS.
10. MAINTAIN AGENDA BANK.
11. DON'T INTERRUPT ANOTHER SPEAKER; NO SIDE DISCUSSIONS.
12. SAVE LAST 15 MINUTES TO CHECK OUT AND PLAN MEETING AGENDA.
13. RESPECT TEAM MEMBERS OPINIONS.
14. GROUND RULES CAN BE REVISED AS NEEDED.
15. USE OUTSIDE MEETING ROOM.
16. NO OUTSIDE INTERRUPTIONS EXCEPT PERSONAL EMERGENCIES (50 MI. RULE).
17. MAKE SURE EVERYONE UNDERSTANDS ISSUES AND SHARE ALL RELEVANT INFORMATION.
18. BE PROMPT, PREPARED, AND COMPLETE ASSIGNMENTS.

Strategic Plan

The strategic plan for the Surface Water Process Action Team was set up as a timetable for the expected or desired completion dates for various tasks required for the gathering, analyzing, and compilation of the data needed for this report. The original completion dates were revised during the process as necessary. The dates shown below represent the actual completion dates and suggested dates for monitoring and measuring.

September 1993	-First PAT Team Meeting
November 1993	-Implement Trial 2-Person Field Trips
January 1994	-Questionnaires Distributed to Field Personnel
February 1994	-Milage Comparison Completion
	-Training Costs Analyzed -Equipment Costs Analyzed -Vehicle Cost Analyzed
April 1994	-Questionnaires Returned
June 1994	-Questionnaires Analyzed
July 1994	-Data compiled and analyzed
August 1994	-Report to QC for review (rough draft)
September 1994	-Final Report Presented
October 1994	-Full Implementation of 2-Person Field Trips -Meeting of 2-Person Field Trip Personnel
April 1995	-Review 1994 WY Questionnaires

APPENDIX B

Data Collection Forms

Field Trip Log

Missing Record Questionnaire

Field Trip Questionnaire

TRIP NATCHEZ
PARTY_____
DATE_____
SPEEDOMETER: LEFT_____
RETURN _____

STAYED:_____
MONDAY _____
TUESDAY _____
WEDNESDAY_____
THURSDAY _____

Station	Type	Acct	Time	Date	Remarks
02488500 Pearl River at Monticello	G	00100			
02488700 Whitesand Cr nr Oakvale	G	00100			
02489030 Elmers Draw nr Columbia	CSG	00100			
02490500 Bogue Chitto nr Tylertown	G	00100			
07290650 Bayou Pierre nr Willows	G	00100			
07290690 Clark Cr nr Pattison	CSG	00100			
07290830 Little Cr nr Fayette	CSG	00100			
07290870 Coles Cr. nr Fayette	CSG	00100			
07291000 Homochitto R nr Eddiceton	G	00100			
07291250 McCall Cr nr Lucien	CSG	00100			
07292500 Homochitto R nr Rosetta	G	00100			
07295000 Buffalo R nr Woodville	G	00100			
07373550 Moore's Branch nr Woodville	CSG	00100			

SURFACE WATER P.A.T.

How many continuous records sites (including stage-only) do you operate?_____

Please provide the following summary of missing/estimated redcord for the 1993 WY.

STATION NUMBER	*PERIOD MISSING/ESTIMATED*	*REASON RECORD WAS MISSING OF ESTIMATION WAS REQUIRED*	*WAS MISSING RECORD AVOIDABLE**	*TIME SPENT ESTIMATING RECORD*

** Could missing records have been avoided if assistance & proper equipment had been available on routine trip?*

SURFACE WATER P.A.T.
Questionnaire on Field Trips

DATES	*PARTY*	*TOTAL TRIP HOURS*	*ESTIMATED MILEAGE*	*COULD HAVE BEEN AVOIDED?* YES OR NO*	*PURPOSE OF TRIPS/COMMENTS*

** Could trip have been avoided if assistance & proper equipment had been available on routine trip?*

APPENDIX C

Summary of Data Collected

Results From Questionnaires

Vehicle Miles For Gaging Trips

Hours Worked on Gaging Trips

Results of Questionaires

TRIP	Total Field Man-Hours	Total Milage	Total Field Hours Avoidable	Total Milage Avoidable	Total Days Missing Record	Total Days Avoidable Missing Record	Total Hours Estimating Avoidable Missing Record
MERRILL	828	14,281	48	1,355	250	112	14.5
JACKSON	394	4,960	8	110	57	0	0
GREENWOOD	419	9,725	16	100	206	52	5
COLUMBUS	633	7,569	56	1,130	286	233	20
NORTHEAST	658	7,356	167	2,068	510	89	12
MERIDIAN	687	9,096	135	1,190	413	97	10
LAUREL	658	7,100	73	900	193	29	4.5
NATCHEZ	608	11,044	56	1,050	192	34	9
TOTAL	4,885	71,131	559	7,903	2,107	646	75

VEHICLE MILES FOR GAGING TRIPS
(BOLDFACE NUMBERS INDICATE AVERAGE MILES PER TRIP)

1993 WATER YEAR

Meridian	Merrill	Laurel	Northeast	Natchez	Columbus	Greenwood	Jackson	Lock & Dam
638	1090	-----	584	-----	637	1095	455	
557	-----	725	692	869	682	1140	506	
421	-----	580	749	890	717	914	487	
352	-----	-----	838	793	585	1052	455	
-----	1237	477	792	780	723	1048	435	
-----	938	444	686	902	600	1028	529	
-----	1185	721	728	740	588	758	652	
414	1066	594	887	800	492	-----	540	
-----	1052	639	-----	-----	-----	-----	458	
476	**1095**	**597**	**744**	**825**	**628**	**1005**	**502**	***400**

1994 WATER YEAR

Meridian	Merrill	Laurel	Northeast	Natchez	Columbus	Greenwood
-----	-----	474	730	-----	-----	1009
593	738	-----	866	980	1158	-----
600	-----	-----	865	529	1240	1145
876	821	-----	735	-----	-----	952
617	852	650	722	700	663	995
811	1008	596	-----	-----	943	919
620	1013	466	711	637	-----	-----
-----	-----	453	855	-----	-----	-----
-----	864	607	838	-----	-----	-----
686	**883**	**541**	**790**	**712**	**1000**	**1004**

* Approximately

HOURS WORKED ON GAGING TRIPS

(BOLDFACE NUMBERS INDICATE AVERAGE HOURS PER TRIP)

("*" inicates hours obtained orally from field personel)

1993 WATER YEAR

Meridian	Merrill	Laurel	Northeast	Natchez	Columbus	Greenwood*	Jackson	Lock & Dam*
35	54.5	50	37	35	32.5		25	
38.5	66.5	35	34	38	36.5		31	
35	59.5	39	37	31	36.5		28	
37	60.5	31	35.5	29	32		25	
36.5	60.5	39	36.5	33	31.5		25	
31	49	43.5	34.5	32.5	41		28	
40.5	68	39	41	26	33.5		24.5	
31	50	35	34	35	32		29	
	58			39				
36	**58**	**39**	**36**	**33**	**34**	**44**	**27**	**18**

1994 WATER YEAR

Meridian	Merrill	Laurel	Northeast	Natchez	Columbus	Greenwood
	65	65	73			84
67	81	60	71	82.5	64	73
57	66		71	56	75	116
70	64		72	83.5	78	88
64	66		74	68	64	72
62	74	63	96	73	74	88
58	73	50.5	75		72	
65	62	52	75	73		
68	71	54.5	73			
64	**69**	**58**	**76**	**73**	**71**	**87**

APPENDIX D

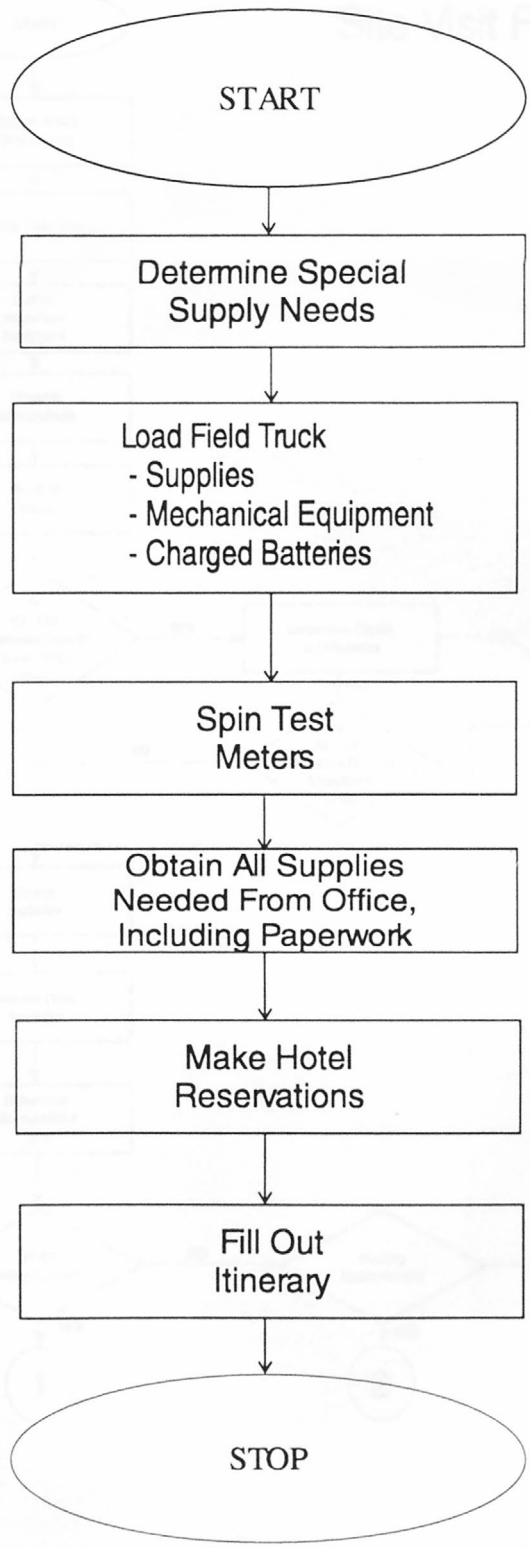
Field Trip Flow Charts

Pre-Trip Flow Chart

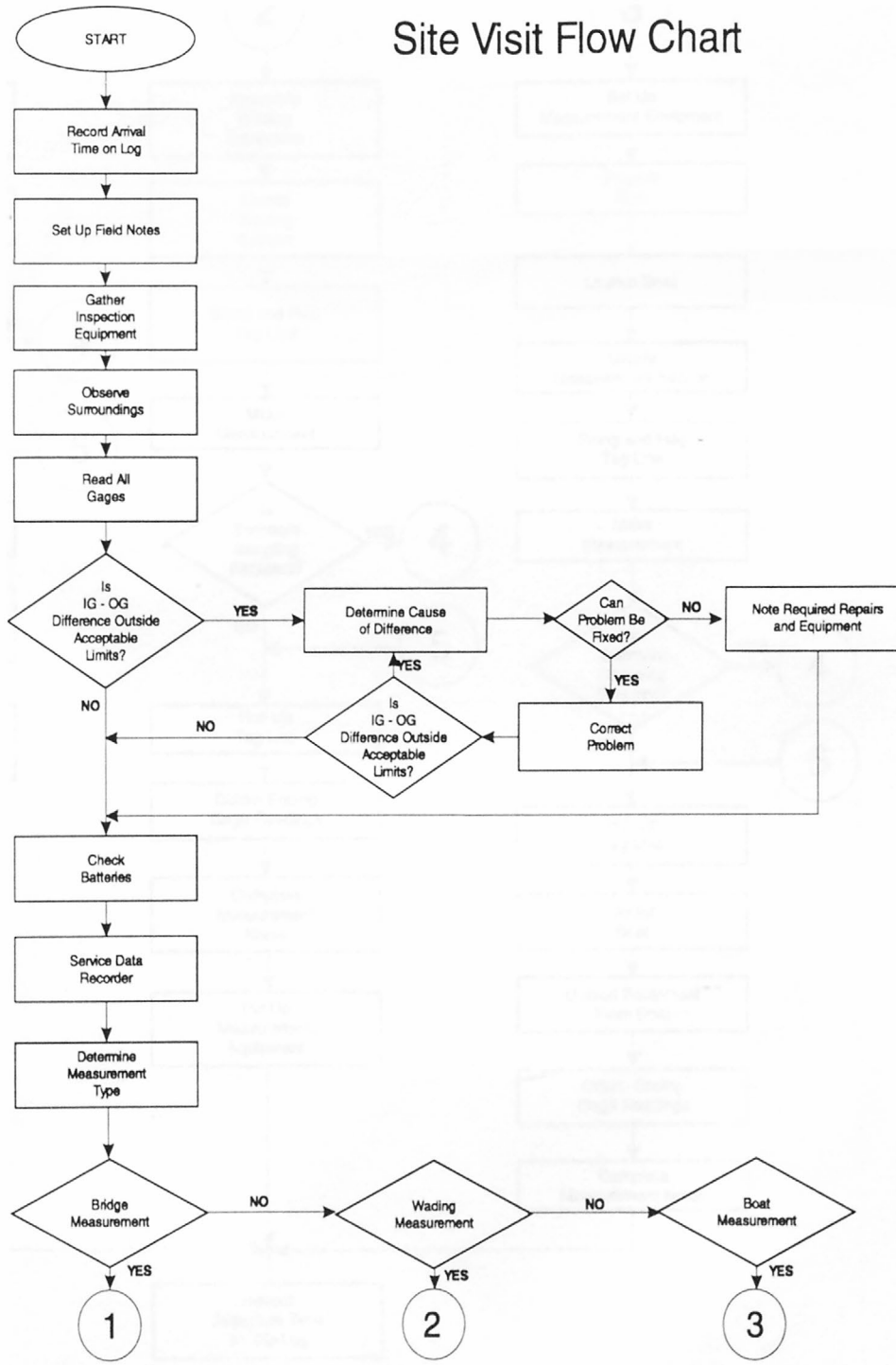
Site Visit Flow Chart

Post-Trip Flow Chart

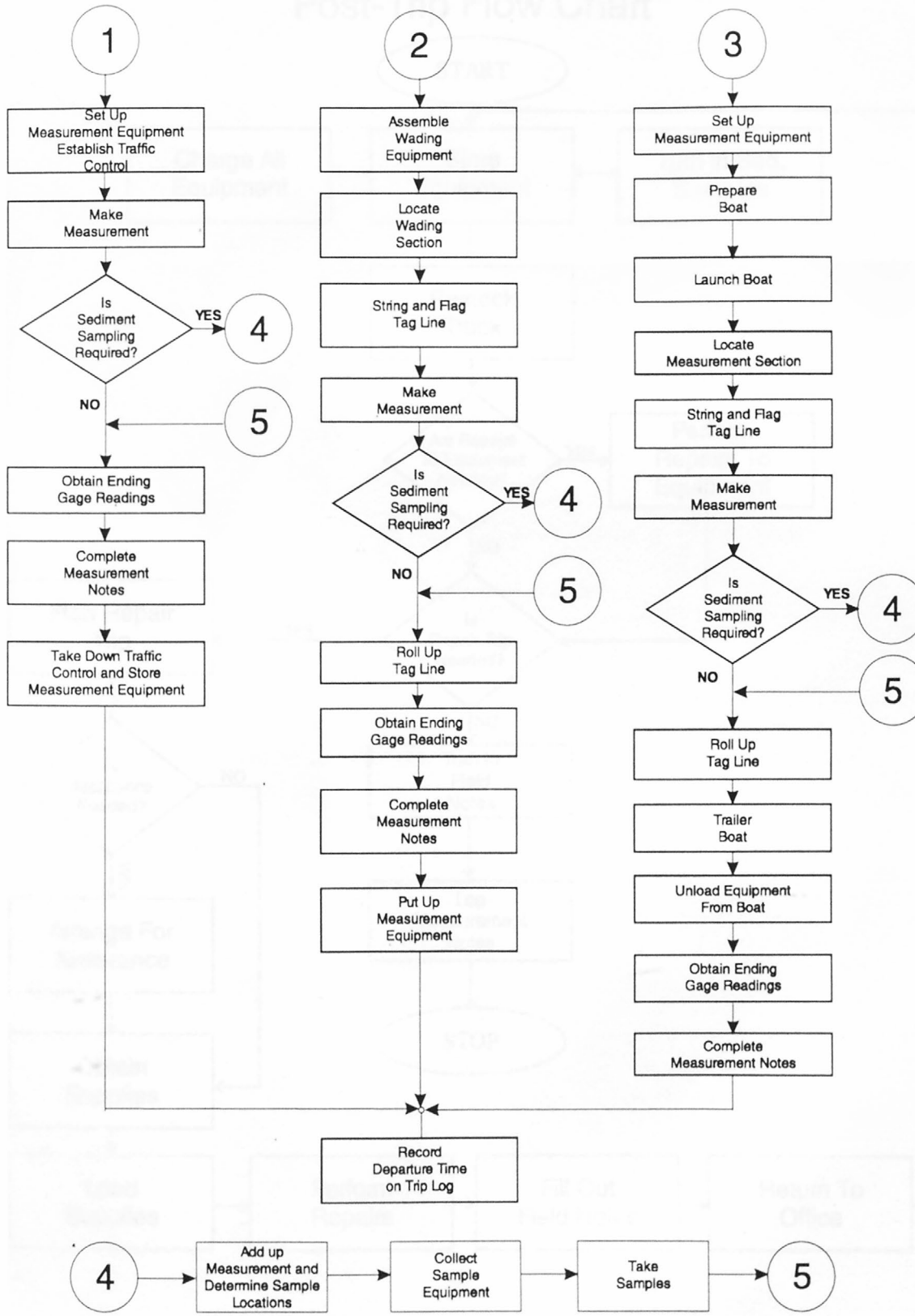
Pre-Trip Flow Chart



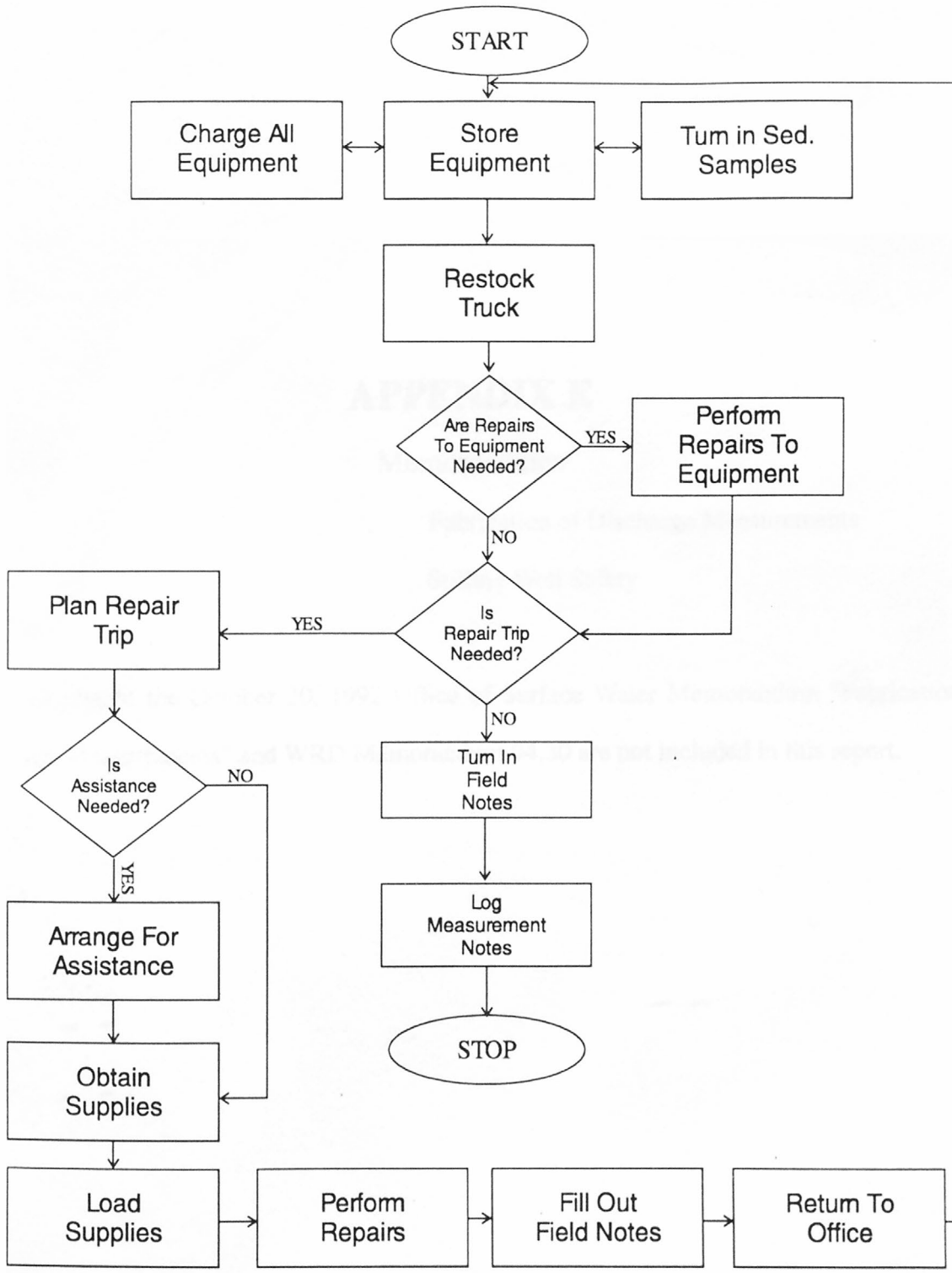
Site Visit Flow Chart



Site Visit Flow Chart (continued)



Post-Trip Flow Chart



APPENDIX E

Memorandums

Fabrication of Discharge Measurements

Stilling Well Safety

Copies of the October 20, 1992 Office of Surface Water Memorandum "Fabrication of Discharge Measurements" and WRD Memorandum 94.30 are not included in this report.