APPENDIX D -- PART B

DETAILED PROCEDURES FOR MONITORING STATION OPERATION

- Procedure B-1: Configuring and Programming the ISCO Model 3700 Sampler and ISCO Model 3230 Flow Meter
- Procedure B-2: Procedures for Grab Sample Collection for NPDES Ongoing Monitoring Program (Full Suite of Pollutants)
- Procedure B-3: Standard Operating Procedures for Field Measurement of Stream Discharge in Open Channels and Closed Conduits
- Procedure B-4: Laptop Data Interrogation and ASCII File Creation Procedure
- Procedure B-5: Sample Compositing Scheme From FLOWLINK ASCII File
- Procedure B-6: Procedures for Composite Sample Collection for Ongoing Monitoring Program
- Procedure B-7: Maintenance Procedure for the NPDES Monitoring Station Rain Gage

Procedure B-1

CONFIGURING AND PROGRAMMING THE ISCO MODEL 3700 SAMPLER AND ISCO MODEL 3230 FLOW METER

Preparing the flow meter and sampler requires two steps:

1. Configuring the flow meter and sampler; and
2. Programming the flow meter and sampler.

While each requires a number of detailed steps, you should only need to conduct the procedure once for each unit. If changes are necessary during the course of the program, they can be made easily at any time once each unit has been prepared. Programming the flow meter and configuring and programming the sampler are done through the key pad on each unit. In order to utilize the flow meter's memory capabilities as well as take advantage of the variety of sampler enable/disable functions, the FLOWLINK program is used. This appendix will outline the steps necessary for both procedures. It is organized in the following manner:

PART I: Configuring/programming the Flow Meter and Sampler Through the Key Pad

PART II: Programming the Flow Meter and Sampler Through FLOWLINK

PART I: CONFIGURING/PROGRAMMING THE FLOW METER AND SAMPLER THROUGH THE KEY PAD

A. FLOW METER

These steps detail the programming necessary to operate the flow meter in LEVEL mode. For other programming options, see the user's manual. To enter a selection at a particular step press the corresponding number key, enter a value using the number keys, or use the left/right arrow keys. Press ENTER to accept the selection.

1. Turn flow meter on.

2. Press GO TO PROGRAM STEP key. The message "Enter Program Step Number 1-12" will appear.

3. Select a mode of operation. Selecting "LEVEL ONL Y will result in a request for the units of measure (feet or meters).

4. Select sampler control. Select ENABLE BY LEVEL.

5. Enter level at which to enable sampler.

6. Select DISABLE BELOW X.XX FT. This programs the sampler to stop sampling once the level falls below what was programmed in step 5.

7. Select plotter ON/OFF with sampler enable.

8. Select plotter mode of operation (OFF OR LEVEL).

9. Enter the plotter ful1-scale reading (100% LEVEL = XX/XXX FT).

10. Select plotter chart speed. The slower the chart speed, the less paper used and less power used.

11. Set the year, month, day, hour, and minute. This sets the correct time and date for the flow meter.

12. Enter the site identification number. .

13. Select the auto purge frequency.

14. Adjust the level. Set this value to the actual level in the stream/conduit.

15. Reset the flow totalizer (YES or NO).

16. All report generation (ON or OFF). If OFF is selected, skip to step 21.

17. Clear report data after print (YES or NO). If YES is chosen the minimum, maximum, and average levels and the volume for the period would be cleared.

18. Set the report interval (hourly, daily, or monthly).

19. Enter the report interval (print a report every XX hours, days, or months).

20. Enter interval start time. This sets the beginning time of the report.

21. Enable program lock (YES or NO). If the lock is enabled, that the user must supply a password before any changes to the program can be made. The password is "3230."

B. SAMPLER

These steps detail the programming necessary to configure and program the sampler operation. For other programming options, see the user's manual. To enter a selection at a particular step press the corresponding number key, enter a value using the number keys, or use the left/right arrow keys. Press ENTER/PROGRAM to accept the selection. To obtain more information about a particular step, press and hold the STOP key. The display will show the page number of the users manual which you can consult for detailed information.

CONFIGURE SAMPLER

NOTE: The Sampler only needs to be configured once at each location.

1. Turn on Sampler.

2. Access the configure sequence by selecting CONFIGURE. Select CONFIGURE by pressing the Right Arrow key once. When CONFIGURE blinks, accept the selection by pressing Enter/Program.

3. Press the Left Arrow or Right Arrow key to scroll through the Configure options.

4. The first option displayed when the Right Arrow key is pressed is the Set Clock configure option. If the time displayed on the LCD in the standby message is not current, reset the time with the Set Clock configure option. Access the Set Clock display by pressing Enter/Program.

   Pressing the Right Arrow or Enter/Program key on the last entry will store the values and advance to the next display.

5. To verify the Bottles and Sizes settings, press the Enter/Program key.

6. Because the Model 3700 is a portable sampler, select PORTABLE by using the Arrow keys. Accept the selection by pressing the Enter/Program key.

7. This sampler has 4 bottles, so select 4. Press the arrow keys until 4 blinks, then press the Enter/Program key.

8. Enter the bottle size here. press 3-8-0-0 (for the 1 gallon bottles). Press the Enter/Program key.

9. Press the Enter/Program key at this display to access the Intake Line input displays discussed in Steps 11 -13.

10. The tubing has a 3/8 inch inside diameter. Select 3/8. Press the Enter/Program key to accept the entry and advance to the next step.

11. Select teflon and press the Enter/Program key to accept the selection.

12. Enter the length of the intake line. The length should not include the tube coupling or the strainer. Press the numbers and the press the Enter/Program key to accept the entry and move to step 14. If this is a change from the suction line settings already in the sampler, the following message will appear for a short time.

13. Press the Enter/Program key at this display to access the Liquid Detector input displays discussed in Steps 14 -17.

14. Select ENABLE. Press Enter/Program to accept the selection.

15. Enter the number of rinse cycles and press Enter/Program. Rinse cycles condition the intake line to reduce cross contamination.

16. This setting determines whether the suction head will be entered manually during programming or computed by the sampler program. Select YES or NO, and press Enter/Program to accept the selection.

17. This setting determines the number of times the sampler will try to detect the presence of liquid for each sample event. Press Enter/Program to accept the entry.

18. This setting determines the programming mode of the sampler. Press Enter/Program. You must select EXTENDED to access the STORM program. Choose a mode, and press Enter/program to accept the choice.

19. Press Enter/Program to access sampler calibration options.

20. Select ENABLE. Press Enter/Program to accept the selection.

21. Press Enter/Program to access time delay options.

22. Enter a number of minutes to delay the sampler after it has been initially triggered. Typically, no delay is necessary, so a setting of 0 minutes should be entered. Press Enter/Program to accept the entry.

23. Press Enter/Program to access the ENABLE PIN options.

24. Select "NO" at the Master/Slave mode screen. Press Enter/Program to accept entry.

25. Select "NO" at the Sample Upon DISABLE screen. Press Enter/Program to accept entry.

26. Select "NO" at the Sample upon ENABLE screen. Press Enter/Program to accept entry.

27. Select "YES" at the RESET SAMPLER INTERVAL screen. Press Enter/Program to accept entry .

28. The next steps define the type event mark the sampler will use. Press Enter/Program to access options.

29. Select PULSE. Press Enter/Program to accept entry.

30. Select FWD PUMPING. Press Enter/Program to accept entry.

31. The next steps configure the pump counter (used for tracking the pump tubing life). Press Enter/Program to access options.

32. Enter the number of pre-sample counts. Press Enter/Program to accept entry.

33. Enter the number of post sample counts. Press Enter/Program to accept entry .

34. Press Enter/Program key to enter the tubing life options.

35. This screen will show the number of pump counts. Press Enter/Program to continue.

36. Select "NO" to when prompted to reset the pump counter. Press the Enter/Program key.

37. Set the number of pump counts at which a warning to change the pump tubing will be given. Press Enter/Program to accept entry.

38. Press Enter/Program to enter the program lock options.

39. Select Disable. Press Enter/Program to accept entry.

40. Press Enter/Program to enter the sampler identification options.

41. Enter the identification number of the sampler (site specific). Press Enter/Program to accept entry.

This screen completes the Configure section of the sampler. Leave the Configure sequence by pressing the Exit Program key. The sampler will return to the standby mode shown in the next display.

PROGRAM SAMPLER

The steps needed to program the sampler in the BASIC mode follow the procedure outlined below.

1. Turn the sampler on with the ON/OFF key. The "STANDBY" message will appear, or if the sampler were turned off while running a routine, the "PROGRAM HAL TED" message will be displayed.

2. Press the ENTER/PROGRAM key to access the interactive state. Select the program sequence. If you want to return to a previous display, press the EXIT PROGRAM key. The sampler will return to standby and you can repeat steps 1 and 2. Then press the ENTER/PROGRAM key to scroll through the settings until you locate the display in question.

3. Enter the Sample Pacing settings. The sampler will prompt you to select either time- or flow-pacing.

4. Enter the Sample Distribution settings. The settings in the Sample Distribution section allow you to perform sequential or multiplexed sampling.

   If you want to use bottles-per-sample or samples-per-bottle multiplexing, select "YES". The next display will prompt you to select either "BOTTLES PER SAMPLE" or "SAMPLES PER BOTTLE".

5. Enter the Sample Volume settings. The Sample Volume program section will always contain prompts for the sample volume. Depending on the selections made in the configure sequence, it may contain prompts for the intake head and for calibrating the sampler .

6. Enter the Key Times settings. In the basic programming mode, you will be asked if you want to enter a start time for the routine. If you select "YES", you will be prompted to enter a specific start time and date. If you select "NO", the sampler will use the start time delay.

7. The sampler will automatically return to standby.

8. From standby, start the routine by pressing the START SAMPLING key. This places the sampler into the run state.

Other programming features are discussed in Chapter 4 of the Sampler Manual.

PART II:

PROGRAMMING THE FLOW METER AND SAMPLER THROUGH FLOWLINK

A. FLOW METER

Preparing the flow meter for the first time requires a number of detailed steps that should only be conducted once for each unit. Changes to the flow meter can be made at any time once it has been prepared. The flow meter's I.D., Clock, and Name will change with each new sampling site. Refer to Step 6 for programming sequence. The flow meter's partition(s) will remain the same regardless of site location. Refer to Step 7 for programming procedures. The procedures below describe programming the flow meter from a remote location using a modem and the module TELEFLOW. On-site programming using a laptop computer and using the module LAPCOMM varies only slightly from these instructions. LAPCOMM procedures can be found in the FLOWLINK User's Manual.

1. Make sure that a phone line is connected to the computer's modem connection and the line is free.

2. Be sure the flow meter is on.

3. Turn on the computer and enter FLOWLINK by typing FL from the DOS prompt (C:\>).

4. Select TELEFLOW from the main menu. Select Phonebook from the Base Menu.

    a. If the phone number for the site has not been created, select NEW from the Phonebook Menu. Type the phone number for the site. If a "9" or similar number is needed to get to an outside line from an office, be sure to include it in the phone number. The new phone number will be added to the phonebook listing.

    b. If the site's phone number has been created, highlight the phone number using the arrow keys. Proceed to step 5.

5. Select Connect from the Base Menu. TELEFLOW will contact the flow meter and present the Connect Menu.

6. Select Adjust from the Connect menu. TELEFLOW will present the Adjust Menu. The Adjust Menu allows you to establish a site ID number; set the clock; enter a site name; calibrate the level for the 3230 flow meter, and set the unit password.

a. Select ID from the Adjust Menu. TELEFLOW will prompt you for a number; you can enter up to three digits.

b. Select Clock from the Adjust Menu to synchronize the flow meter's clock with the computer's clock. The computer's current time appears in the upper right corner of TELEFLOW's screens. The flow meter's time appears in the status display.

c. Select Name to enter text for the Site Name. You can enter up to 17 characters. The site name serves as a short description of the site; the flow meter's address is a typical entry.

d. To calibrate the flow meter's level readings, select Level. TELEFLOW will prompt you to enter a new level reading.

e. Select Quit or press Escape to return to the Connect Menu.

7. Select Partition from the Connect Menu. TELEFLOW will present the Partition Menu.

a. To create a new partition, select New from the partition Menu. TELEFLOW will display the Data Type Menu. The Data Type Menu allows to you specify the type of data stored in a partition. The menu will contain Level, Rainfall, and Sampler as options.

b. Select the menu option corresponding to the type of data you want to store in the partition. If you select Level, Flow or Rainfall, TELEFLOW will present the New Partition Menu and the specification box. The box contains the specification fields required to define a new partition: Memory Type/Recording Mode, Size (Readings), Data Interval, and Partition Name.

c. Creating a level, flow, or rainfall partition requires five steps: i) select rollover or slate memory mode; ii) determine the number of readings stored in the partition; iii) select the reading interval; iv) enter a name for the partition; and v) instruct TELEFLOW to create and initialize the partition in the flow meter. To create a level, flow, or rainfall partition, follow steps i through v, below.

Creating a sampler partition requires three steps: determine the partition size, name the partition, and instruct TELEFLOW to create and initialize and partition in the flow meter. To create a sampler partition, follow steps ii, iv, and v, below.

Note: Sampler partitions are available in rollover mode only; you cannot use slate mode memory for sampler partitions. The Mode Menu is therefore not available for sample partitions. Because sampler data is event driven rather than time driven, you cannot set a time interval for the data.

i. Select Mode from the Partition Menu. TELEFLOW will present the Mode Menu. The menu contains six options: No Slate, Slate, Level, Flow, Rainfall, and Time. Select the option which corresponds to the type of memory you need for the partition. After you select the memory type, TELEFLOW will prompt you for a set point. When you complete the set point entries, select Quit to return to the Partition Menu.

ii. Select Readings from the Partition Menu. TELEFLOW will prompt you for the number of readings. The minimum is 64; the maximum is the amount of memory not already committed to other partitions. TELEFLOW will round you entries up to the nearest multiple of 64 and recalculate the amount of time needed to fill the partition.

iii. Select Interval to set the reading interval for the partition.

iv. Select Name, and enter site name (optional).

v. Select Create to create and initialize the partition. If you leave the Partition Menu without first selecting Create, TELEFLOW will not create the partition in the flow meter.

d. Repeat step c for each additional partition. When you have created the partition you need, select Quit from the Partition Menu. TELEFLOW will return to the Connect Menu.

Note: Configure the flow meter's memory in the following way:

PARTITION A:

Data type = Level
Mode = LEVEL
Mode Set Point = ???? (site specific)
Size (Readings) = 4032 (14 days)
Data Interval = 5 minutes
Name = ????

PARTITION B:

Data type = Rainfall
Mode = Rainfall
Mode Set Point = # inches/tirne
Size (Readings) = 6220 (21.6 days)
Data Interval = 5 minutes
Name = ????

PARTITION C:

Data type = Sampler
Mode = NA
Mode Set Point = NA
Size (Readings) = 960 (10 "full carousel" events)
Data Interval = NA
Name = ????

Once the flow meter is configured, quit out of the Partition Menu back to the Connect menu by typing Q or ESC successively until the menu is reached.

B. SAMPLER

Skip to Step 6 if you have just configured the flow meter partitions. If you are only changing the sampler controls, begin at Step 1.

1. Be sure sampler and flow meter are on.

2. Make sure that a phone line is connected to the computer's modem connection and the line is free.

3. Turn the computer on and enter the FLOWLINK program by typing FL at the DOS prompt (C:\>).

4. Enter the TELEFLOW program by selecting TELEFLOW from the main menu. Select Phonebook from the main menu. Highlight the site's phone number using the arrow key and proceed to Step 5. (If the phone number has not been created, refer to Step A-4a above).

5. Select Connect from the top menu.

6. Select Sampler from the Connect menu. TELEFLOW will retrieve the Sampler Control Definition currently stored in the flow meter and the operating status data for any connected sampler.

   TELEFLOW will also present two display boxes in the lower section of the screen. The first box reports the following information: sampler enabled or disabled, sampler latched, and pacing enabled or disabled. The second box, labeled "Sampler Control Definition," contains four items: the control condition, the latch setting ("ENABLE SAMPLER CONTINUOUSLY..."), the plotter settings, and the front panel access setting.

   a. To enable or disable sampler pacing, select Pace from the Sample Menu. TELEFLOW will present the Sampler Pace Menu. This menu contains two options: Enable and Disable. Select Disable to disable flow pacing.

   b. To create a new SCD, select SCD from the Sampler Menu.

      i. Select New from the SCD Menu. TELEFLOW will prompt you for a file name. Press Enter to accept the default or replace the default with your own file name. (TELEFLOW will not allow you to enter a file name that already exists on the current data directory.)

      ii. Select the condition from the vertical menu; then select Set/Change from the Conditions Menu to accept the selection. TELEFLOW will present the SCD Change Menu, and will update the Conditions field of the Sampler Control Definition box with your selection.

          The SCD Change Menu varies according to the selected control condition. All menus will include the Conditions, Actions, and Save options as well as one or two of the following options; Level, Flow, Rainfall, and Time. To replace the current control condition with another, select the Conditions option to access the Conditions Menu again.

      iii. To enter the Actions settings, select Actions. When you select each option of the Actions Menu (Latch, Plot, or Block), TELEFLOW will present a prompt and a Yes/No menu. When you have completed the actions settings, TELEFLOW will return to the SCD Change Menu.

      iv. Select Level to enter a level set point.

v. Select Rainfall to enter a rainfall set points: an amount of rainfall measured in a time window. TELEFLOW will present the Rainfall Set Point Menu. This menu contains two options: Amount and Time. Select Amount to enter the amount of rain for the set point. Select Time to select a time window.

vi. After entering the set points, TELEFLOW will return to the SCD Change Menu. Select Save from the menu to save the file to the current data path. TELEFLOW will prompt you again for a file name. Rename the file, if desired. Press Enter to accept the default file name.

vii. TELEFLOW will save the file, return to the SCD Menu, and update the file name at the bottom of the display. It will also revise the "NOTE:" field in the Sampler Control Defmition box to inform you that the displayed SCD is not the flow meter's current SCD.

viii. To send the SCD to the flow meter, select Transmit from the SCD Menu. TELEFLOW will send the SCD to the flow meter and change the NOTE field in the Sampler Control Definition box to inform you that the displayed SCD is now the flow meter's current SCD.

Note: Samplers should be configured with the following settings:

ACTIONS: Enable sampler continuously once the conditions are satisfied? NO

Enable flow meter's print/plotter only while SAMPLE ENABLE is active? NO

Block access to SAMPLER ENABLE from flow meter's front panel? NO

CONDITIONS: Enable sampler on Level and Rainfall

LEVEL: ???? (X axis with sampling site)

RAINFALL: 0.1 inches / 30 minutes

Once the SCD is configured and transmitted to the sampler, quit out of FLOWLINK by typing Q or ESC successively until you reach the DOS prompt (C:\>).

Procedure B-2

PROCEDURES FOR MANUAL GRAB SAMPLE COLLECTION FOR NPDES ONGOING STORM WATER PERMIT APPLICATION (FULL SUITE OF POLLUTANTS)

1. New, clean disposable gloves should be worn at all times during grab sample collection process including when cleaning/preparing sample collection equipment and when obtaining samples in field.

2. Clean sample collection container, lid, and pouring beaker (glass or stainless steel) with phosphate-free laboratory-grade detergent (Liqui-Nox™ or equivalent), hot water, and a scrub brush. Rinse equipment well with hot tap water then rinse well with deionized water. Rinse equipment twice (in a well-ventilated area) with pesticide-grade isopropanol, acetone, or hexane. Air dry sample collection equipment for 24 hours; place container, lid, and pouring beaker in plastic bag; and seal bag (without plastic tape).

3. Ensure that pH meter is calibrated to pH buffer solutions.

4. All grab samples should be obtained during the first three (3) hours of runoff from a storm event after a three (3) day dry period. Note time of sample collection for correlation with storm hyetograph and hydrograph.

5. Notify lab personnel just prior to grab sample collection.

PROCEDURES

1. Visually inspect sampler and verify that it is working properly.

2. All grab samples should be obtained during the first three (3) hours of runoff from a storm event after a three (3) day dry period. Note time of sample collection for correlation with storm hyetograph and hydrograph. Review flow meter printout.

3. Obtain pH measurement of storm water discharge using hand-held pH meter (follow manufacturer's instructions) in well-mixed center of flow. If unable to access flow with pH meter, obtain a grab sample from the well-mixed center of flow using a clean container. Measure pH of grab sample.

4. Rinse sample collection container and pouring beaker twice with source sample water. Use well-mixed center of flow; do not disturb bottom sediments.

5. Obtain sample from the well-mixed center of flow at approximately the same location (just downstream) as the sampler strainer; do not disturb bottom sediments. For manhole sites, first connect a rope to the stainless steel bucket, then lower the bucket into the manhole. Do not enter the manhole during the storm event. Approximately 5,000 mL (1.1 gal) is required (approximately 1/3 of 12.5 quart stainless steel bucket) to fill all grab sample bottles; sufficient sample for all grab samples should be taken at one time.

6. After initial grab sample collection, remaining activities should be performed under cover as much as possible. One member of the field team should take all notes, fill out labels, etc. while the other member does all of the sampling (if possible). However, two sets of hands may be required to hold sample container steady and to pour sample into container.

7. Because several of the grab sample bottles have been precharged with preservatives (NaOH, H_2SO_4, $Na_2S_2O_3$), safety goggles and new, clean disposable gloves shall be worn by personnel while filling sample bottles. All handling of opened grab sample bottles shall be conducted in an open, well-ventilated area. Material safety data sheets (MSDS) for all preservatives are given in Part D of Appendix D.

8. Swirl sample in bucket and/or pouring beaker immediately prior to filling sample bottles to ensure complete mixing.

9. Volatile Organic Analysis (VOA) Samples: VOA samples should be obtained immediately after collection of the initial storm water grab sample. The 40-mL vials should be completely filled to prevent volatilization and caution should be exercised when filling a vial to avoid any turbulence which could also cause volatilization. Fill vials by pouring sample from collection container or pouring beaker into vial. Pour the last few drops of sample into the vial so that surface tension holds the water in a "convex meniscus". Pour a few drops of sample into cap and then apply cap to ensure that no air bubbles remain in vial. After capping, turn the bottle over and tap it to check for bubbles. If any bubbles are present, remove cap, add additional sample, recap, and recheck.

10. Cyanide, Phenols, Fecal Bacteria, and Oil and Grease Samples: Sample bottles shall be opened immediately before filling to prevent loss of preservative. After swirling sample in bucket, carefully fill appropriate container near brim and cap. Fill sample bottle by pouring sample into bottle; do not immerse bottle in sample collection container. Use care not to overfill and thus lose any preservative. Removal of all air bubbles before capping is not necessary.

11. All grab sample bottles should be pre-labeled on bottle (not cap) as to parameter group for laboratory analysis. Field completion of the sample identification including sample ID (see text for format), crew ID, date, time, and location should be completed for each sample using a waterproof pen immediately upon filling sample bottle. Be sure all bottle lids are on tight and will not leak.

12. Filled grab sample bottles shall be placed immediately on ice in a small cooler. Ice should completelv surround all sample bottles.

13. The chain of custody form shall be completed for the cooler contents using a waterproof pen and placed in a waterproof plastic bag. The completed chain of custody form shall be placed inside the cooler on top of the ice; the cooler then shall be taped shut (fiber tape). The cooler should also be labeled on the outside.

14. The field log describing all sampling activities must be completed before leaving the site.

15. All equipment used to obtain grab samples should be thoroughly rinsed with tap water in the field as soon as possible after use.

16. Notify lab that you are bringing grab samples in.

17. Delivery of the cooler containing the sample bottles to the laboratory must be made as soon as possible and not longer than 6 hours after obtaining samples. The chain of custody form for the storm event grab samples shall be completed by the laboratory as part of delivery of the samples. Completed chain of custody forms should be filed in the field notebook for that monitoring station.

Procedure B-3

STANDARD OPERATING PROCEDURES FOR FIELD FLOW MEASUREMENT

Stormwater monitoring projects will require use of proper field techniques for flow measurement. Flow measurements are required to develop stage-discharge relationships for monitoring stations equipped with automatic samplers and flow meters (stage recording). The velocity-area method is the established method of making instantaneous flow measurements in stream channels and closed-conduits (pipes). This method is particularly useful where the flow is too large to permit the installation of a primary flow device. It is also useful for checking the accuracy of an installed primary flow device or other flow measurement method.

The basic principle of this method is that the flow (Q) in a channel or pipe is equal to the average velocity (V) times the cross-sectional area (A) of the channel or pipe at the point where the average velocity was measured (i.e. Q = A * V). The velocity of stormwater is determined with a Marsh-McBirney (or compatible) velocity meter; the area of the channel or pipe is calculated using an approximation technique in conjunction with a series of velocity measurements.

While the velocity-area method is an instantaneous flow measurement method, it can be used to develop a continuous flow measurement system. This is accomplished by making a number of individual measurements at different flow rates and developing a curve or curves that relate water depth, or head, to discharge (generally referred to as a rating curve). This curve can then be utilized along with a stage recorder to provide a continuous flow record.

This appendix will outline the steps necessary for accurate flow measurement in channels and pipes. It is organized in the following manner:

PART I: Open Channel Flow Measurement

PART II: Closed Conduit Flow Measurement

PART I: OPEN CHANNEL FLOW MEASUREMENT

A. Equipment List

1. Depth
    - wading rod, graduated rod, or yard stick

2. Width
    - tag line, metallic tape or 50' measuring tape
    - survey stakes

3. Velocity
    - portable flow meter
    - probe mount (approx. 3/8 inches in diameter)

4. Miscellaneous
    - field data sheets (Figure B3-1 at end of this procedure) .
    - waders or boots
    - safety line
    - life jacket
    - gloves
    - hammer or mallet

B. Initial Site Investigation (conducted during dry weather)

1. Select a cross section and mark with survey stakes.
    - straight reach, parallel streamlines
    - velocity > 0.5 fps; depth > 0.5 ft
    - uniform streambed; relatively obstruction free
    - uniform flow; free from eddies, backwater, turbulence
    - close to control section or gage station (where applicable)

2. Record the width of the cross section using the measuring tape. The number of observation verticals (points across the cross section where velocity measurements will be taken) should be chosen such that no subsection contains more than 10 percent of the total discharge. Use the following convention in determining the amount of subsections:
    - each streambank is an observation vertical
    - maintain a minimum spacing of 6 inches between verticals across the section

    Record the distances from the stream bank along the selected cross section.

3. Install staff gage.
    - Be sure the zero level is aligned with the zero level of the flow control device (where applicable).
    - Install solidly and accurately to stream bank or flow control device.

C. Flow Measurement

1. Measure depth of flow at the centerline of the channel (this determines the velocity measurement method).
    - If depth > 2.5 ft, use the *two-point method* (0.2 and 0.8 of full depth)
    - If depth < 2.5 ft or stage is rapidly changing, use the 0.6-*depth method*.

- If velocities are distoned by overhanging vegetation, rocks, piers, etc., use the *three-point method* (0.2, 0.6, and 0.8 of full depth).

2. Record the following information on the field data sheet shown on Figure B3-1 at the end of this procedure:
   - Date and location of measurements
   - Depth of flow at centerline
   - Velocity measurement method
   - Distances from streambank where velocity measurements will be taken

3. First velocity measurement at the streambank. Record the following information:
   - Time
   - Staff gage height (if applicable)
   - Depth of flow
   - Velocity reading(s)

4. Velocity measurements in the channel. Record the following information:
   - Depth of flow at corresponding vertical
   - Velocity reading(s) at corresponding vertical

5. Final velocity measurement at the opposite streambank. Record the following information:
   - Time
   - Depth of flow
   - Velocity reading(s)
   - Staff gage height (if applicable)

6. Record any observations or unusual occurrences.

D. Data Analysis

1. Enter data into the rating curve spreadsheet developed for the site.

2. Calculate flows using the mid-section method (see Figure B3-2).
   - Compute the area of the sub-section suuounding the velocity venical
   - Average the velocity readings at that vertical
   - Multiply the area times the velocity to obtain the sub-section flow
   - Repeat for each sub-section in the channel cross-section
   - Sum the flows through each sub-section to obtain the total discharge through the cross-section

3. Develop/update rating curve.

4. QAQC
    - Outliers
    - Rating shifts
    - Human error (data entry, calculations, etc.)

PART II: CLOSED CONDUIT FLOW MEASUREMENT

NOTE: For these field measurements, use the Field Data Sheet shown in Figure B3-3 at the end of this procedure.

A. Equipment List

1. Depth
    - Wading rod, graduated rod, or yard stick

2. Width
    - 50' measuring tape

3. Velocity
    - Portable flow meter
    - Probe mount (approx. 3/8 inches in diameter)

4. Miscellaneous
    - Field data sheets (Figure B3-3 at end of this procedure)
    - Waders or boots
    - Safety line
    - Life jacket
    - Gloves

B. Flow Measurement

1. Record date, time, and location of measurement.

2. Record depth of flow at the centerline.

3. Take velocity reading(s) at centerline:
    - If depth >1.0', use the 2-point measurement method (0.2- and 0.8- depth).
    - If depth <1.0', or the flow is rapidly changing, use 0.6-depth method.

4. At minimum, record velocities at the centerline and at verticals one-half the distance between the centerline and the pipe wall on either side of the centerline. Typically up to 10 observation verticals will be sufficient. Use the convention described in Step 3 to determine the number of velocity readings in the verticals.

C. Data Analysis

1. Enter data into the rating curve spreadsheet developed for the site.

2. Compute the flows:
   - Calculate area using the centerline depth and the attached table.
   - Average the velocity at each vertical.
   - Multiply the area times the average velocity to obtain the flow.

3. Develop/update rating curve.

4. QAQC
   - Outliers
   - Rating shifts
   - Human error (data entry, calculations, etc.)

Figure B3-1

Meas. No. ______

Comp. by ______

Field Data Sheet for Open Channel Velocity Measurements

Date: ______

Location: ______

Flow Conditions: ______

Depth @ Centerline: ______

Gage Height (initial): ______ Gage Height (final): ______

Velocity Measurement Method: ______

(2-pt, 3-pt, 0.6*Depth)

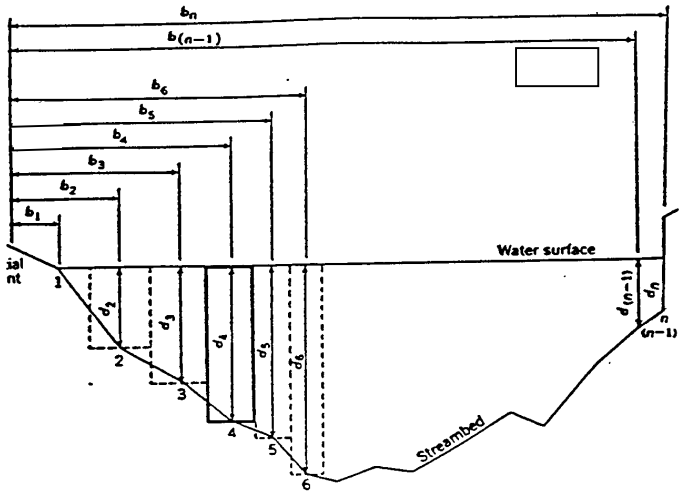
						Velocity at Observation Vertical				
	Time	Distance of Section from Bank b (ft)	Width w (ft)	Depth d (ft)	Area A (sq ft)	0.2*d v (fps)	0.8*d v (fps)	0.6*d v (fps)	Mean Velocity v (fps)	Flow Rate q (cfs)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

NOTES: ***1. Record time and gage height on initial and final readings only.***
2. Refer to figure on the back of this page for calculating flows.
3. Record any additional comments/observations on the back.
4. When using the 3-point method, average the 0.2 and 0.8 readings first, then average the 0.6 reading.

Total Flow ______

CDM

Figure B3-2



EXPLANATION

1, 2, 3 ..... n	Observation verticals
$b_1, b_2, b_3, \ldots b_n$	Distance, in feet or meters, from the initial point to the observation vertical
$d_1, d_2, d_3, \ldots d_n$	Depth of water, in feet or meters, at the observation vertical
Dashed lines	Boundaries of subsections; one heavily outlined is discussed in text

$$q_x = v_x \left[\frac{(b_x - b_{x-1})}{2} + \frac{(b_{x+1} - b_x)}{2}\right] d_x$$

$$= v_x \left[\frac{b_{x+1} - b_{x-1}}{2}\right] d_x$$

where

q_x = discharge through subsection x,
v_x = mean velocity at vertical x,
b_x = distance from initial point to vertical x,
b_{x-1} = distance from initial point to preceding vertical,
b_{x+1} = distance from initial point to next vertical, and
d_x = depth of water at vertical x.

Thus, for example, the discharge through subsection 4 (heavily outlined in fig. 41) is

$$q_4 = v_4 \left[\frac{b_5 - b_3}{2}\right] d_4.$$

The procedure is similar when x is at an end section. The "preceding vertical" at the beginning of the cross section is considered coincident with vertical 1; the "next vertical" at the end of the cross section is considered coincident with vertical n. Thus,

$$q_1 = v_1 \left[\frac{b_2 - b_1}{2}\right] d_1$$

and

$$q_n = v_n \left[\frac{b_n - b_{n-1}}{2}\right] d_n.$$

ADDITIONAL COMMENTS/OBSERVATIONS:

Figure B3-3

Meas. No. _____
Comp. by _____

Field Data Sheet for Closed Conduit Velocity Measurements

Date: _____ Time: _____
Location: _____
Flow Conditions: _____
Comments/
Observations: _____

FIELD MEASUREMENTS:

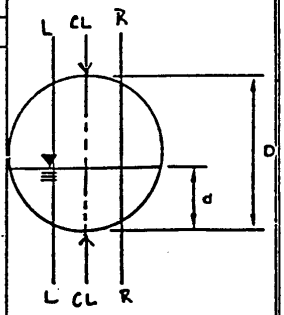
Depth at Centerline, d: _____ *ft*
Diameter of Pipe, D: _____ *ft*

	Observation Vertical (CL,L,R)	*Velocity at Observation Vertical* *0.2*d* v (fps)	*0.8*d* v (fps)	*0.6*d* v (fps)	*Mean Velocity in the Vertical* v (fps)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

FLOW CALCULATION:

d/D: _____
Area/D^2: _____
Area, A: _____ *sq ft*
Mean Velocity, V: _____ *fps*
Total Flow, Q: _____ *cfs*

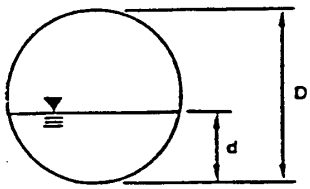
a.Calculate d/D and refer to table on back of this page to obtain Area/D^2.
b.Area, A = (D^2)(A/D^2)*
*c.Flow, Q = A*V.*



NOTES: 1. If d >= 1.0 ft, use 2-point velocity measurement method.
*If d < 1.0 ft or if flow is rapidly changing, use 0.6*d velocity measurement method.*
2. For Observation Vertical: CL = Centerline, L = Left of Centerline, R = Right of Centerline.

CDM
environmental engineers, scientists,
planners, & management consultants

Area, Wetted Perimeter and Hydraulic Radius of Partially Filled Circular Pipes



$\frac{d}{D}$	$\frac{area}{D^2}$	$\frac{wet.\ per.}{D}$	$\frac{hyd.\ rad.}{D}$	$\frac{d}{D}$	$\frac{area}{D^2}$	$\frac{wet.\ per.}{D}$	$\frac{hyd.\ rad.}{D}$
0.01	0.0013	0.2003	0.0066	0.51	0.4027	1.5908	0.2531
0.02	0.0037	0.2838	0.0132	0.52	0.4127	1.6108	0.2561
0.03	0.0069	0.3482	0.0197	0.53	0.4227	1.6308	0.2591
0.04	0.0105	0.4027	0.0262	0.54	0.4327	1.6509	0.2620
0.05	0.0147	0.4510	0.0326	0.55	0.4426	1.6710	0.2649
0.06	0.0192	0.4949	0.0389	0.56	0.4526	1.6911	0.2676
0.07	0.0242	0.5355	0.0451	0.57	0.4625	1.7113	0.2703
0.08	0.0294	0.5735	0.0513	0.58	0.4723	1.7315	0.2728
0.09	0.0350	0.6094	0.0574	0.59	0.4822	1.7518	0.2753
0.10	0.0409	0.6435	0.0635	0.60	0.4920	1.7722	0.2776
0.11	0.0470	0.6761	0.0695	0.61	0.5018	1.7926	0.2797
0.12	0.0534	0.7075	0.0754	0.62	0.5115	1.8132	0.2818
0.13	0.0600	0.7377	0.0813	0.63	0.5212	1.8338	0.2839
0.14	0.0688	0.7670	0.0871	0.64	0.5308	1.8546	0.2860
0.15	0.0739	0.7954	0.0929	0.65	0.5404	1.8755	0.2881
0.16	0.0811	0.8230	0.0986	0.66	0.5499	1.8965	0.2899
0.17	0.0885	0.8500	0.1042	0.67	0.5594	1.9177	0.2917
0.18	0.0961	0.8763	0.1097	0.68	0.5687	1.9391	0.2935
0.19	0.1039	0.9020	0.1152	0.69	0.5780	1.9606	0.2950
0.20	0.1118	0.9273	0.1206	0.70	0.5872	1.9823	0.2962
0.21	0.1199	0.9521	0.1259	0.71	0.5964	2.0042	0.2973
0.22	0.1281	0.9764	0.1312	0.72	0.6054	2.0264	0.2984
0.23	0.1365	1.0003	0.1364	0.73	0.6143	2.0488	0.2995
0.24	0.1449	1.0239	0.1416	0.74	0.6231	2.0714	0.3006
0.25	0.1535	1.0472	0.1466	0.75	0.6318	2.0944	0.3017
0.26	0.1623	1.0701	0.1516	0.76	0.6404	2.1176	0.3025
0.27	0.1711	1.0928	0.1566	0.77	0.6489	2.1412	0.3032
0.28	0.1800	1.1152	0.1614	0.78	0.6573	2.1652	0.3037
0.29	0.1890	1.1373	0.1662	0.79	0.6655	2.1895	0.3040
0.30	0.1982	1.1593	0.1709	0.80	0.6736	2.2143	0.3042
0.31	0.2074	1.1810	0.1755	0.81	0.6815	2.2395	0.3044
0.32	0.2167	1.2025	0.1801	0.82	0.6893	2.2653	0.3043
0.33	0.2260	1.2239	0.1848	0.83	0.6969	2.2916	0.3041
0.34	0.2355	1.2451	0.1891	0.84	0.7043	2.3186	0.3038
0.35	0.2450	1.2661	0.1935	0.85	0.7115	2.3462	0.3033
0.36	0.2546	1.2870	0.1978	0.86	0.7186	2.3746	0.3026
0.37	0.2642	1.3078	0.2020	0.87	0.7254	2.4038	0.3017
0.38	0.2739	1.3284	0.2061	0.88	0.7320	2.4341	0.3008
0.39	0.2836	1.3490	0.2102	0.89	0.7384	2.4655	0.2996
0.40	0.2934	1.3694	0.2142	0.90	0.7445	2.4981	0.2980
0.41	0.3032	1.3898	0.2181	0.91	0.7504	2.5322	0.2963
0.42	0.3130	1.4101	0.2220	0.92	0.7560	2.5681	0.2944
0.43	0.3229	1.4303	0.2257	0.93	0.7612	2.6061	0.2922
0.44	0.3328	1.4505	0.2294	0.94	0.7662	2.6467	0.2896
0.45	0.3428	1.4706	0.2331	0.95	0.7707	2.6906	0.2864
0.46	0.3527	1.4907	0.2366	0.96	0.7749	2.7389	0.2830
0.47	0.3627	1.5108	0.2400	0.97	0.7785	2.7934	0.2787
0.48	0.3727	1.5308	0.2434	0.98	0.7816	2.8578	0.2735
0.49	0.3827	1.5508	0.2467	0.99	0.7841	2.9412	0.2665
0.50	0.3927	1.5708	0.2500	1.00	0.7854	3.1416	0.2500

eg. $D = 4'$

$d = 1'$

$\frac{d}{D} = \frac{1}{4} = 0.25$

$D^2 = 4 \times 4$

$= 16 (S.F.)$

FROM CHART

$\frac{area}{D^2} = 0.1535$

$Area = 0.1535 \times 16$

$= 2.456 s$

$R = 0.1466 \times 4$

$= 0.5864$

Procedure B-4

DATA INTERROGATION AND ASCII FILE CREATION PROCEDURE

1. Connect the phone cord to the modem port on the computer. Make sure the phone line is free.

2. Turn the computer on.

3. From the DOS prompt (C:\>), type FL.

4. Select TELFLOW from the main menu. Choose Phonebook from the base menu and highlight the site using the arrow keys.

5. Select Connect from the top menu. The message "Dialing # ...Please stand by" will appear. When connected, the message "verifying flow/meter's status" will appear. The modem might not connect on the first attempt. After a few passes, if the modem does not connect, check for the following:

    a. Check the flow meter power: Flow meter must be ON if a connection is to be made. This step requires field inspection.

    b. Check the phone number. Is the phone number correct and does it have the necessary "code" to dial out of an office phone system (i.e. a "9" before the main number).

    c. Check the baud rate. The recommended rate is 1200. If TELEFLOW is not set for this rate, change it through the "Pgm-Config" menu.

    d. Bring a phone to the site and try to dial out from the phone jack. If you can not call from the site, the phone line is probably bad. Call the phone company for repair.

6. Select Graph from the Connect Menu. The flow meter has multiple partitions so TELEFLOW will display the Graph Menu. This menu allows you to specify the partitions you want to graph: A, B, or C. When the partition is graphed, it is automatically interrogated, and the data are downloaded to the computer.

    a. The Interrogate Menu will allow you interrogate the partitions but will not display a graph of the data. Interrogate allows you to specify which partitions you wish to interrogate: individually or singularly.

7. To retrieve data from all partitions, select ALL. If you want data from a single partition, select the appropriate letter from the menu. When TELEFLOW completes the interrogation, it will present the Restart Menu to allow you to restart the partition, if desired. This will occur only when partitions A (Flowdepth) and B (Rainfall) are interrogated.

8. To restart a partition's memory, select the corresponding letter from the Restart Menu. After TELEFLOW clears the partition, it will return to the Partition Menu.

9. Quit out of TELEFLOW and FLOWLINK. Type "Q" or ESC successively until the DOS prompt (C:\>) appears.

10. Turn computer off.

ASCII FILE CREATION PROCEDURE

These steps can be performed in the office.

1. Turn computer on and enter FLOWLINK (see Step 3 on previous page).

2. Select EXPORT from the main menu.

3. Select LEVEL from the menu.

   a. Select SOURCE.

   b. Select a data set from the vertical menu.

      - Select DESTINATION. This should be C:\FLOWLINK\FLOWDATA (or a customized site-specific directory).

   c. Select LEVEL. To export a segment of the file, select the FIRST and LAST options to change the first and last reading times.

      - Select a 24 Hour period to ensure 24 hour storm coverage.

        NOTE: Precipitation First and Last options must equal Levels.

   d. Select START to initiate translation from FLOWLINK to ASCII.
      EXPORT will prompt for an output filename for the translated file.
      Enter the filename DEPTH.CSV.
      (Only the last part of the filename will change.)

4. Press the ESC key twice, and select SAMPLER.

   a. Select SOURCE.

   b. Select a dataset from the vertical menu.

      - Make sure DESTINATION is correct.

   c. Select EXPORT. Enter the filename SAMPLE.CSV.

5. Hit the ESC key twice, and select RAINFALL.

   a. Select SOURCE.

   b. Select a dataset from the vertical menu.

      - Make sure DESTINATION is correct.

   c. Select EXPORT. This will present the Change Range menu. Use the First and Last options to change the first and last reading times. You must use the same interval used for DEPTH.CSV.

   d. Select START. Enter the filename PRECIP.CSV. .

6. Quit out of EXPORT and FLOWLINK. Type "Q" or ESC successively until the DOS prompt (C:\>) appears.

ASCII files have now been created with the file names: DEPTH.CSV, PRECIP.CSV, SAMPLE.CSV.

NOTE: For more detailed explanations of the interrogation and export steps, please refer to the FLOWLINK Instruction Manual, Chapters 7 and 9.

Be sure that the filenames shown in Steps 3d, 4c, and 5d are used. If these filenames are not used, the spreadsheet will not work properly.

Procedure B-5

SAMPLE COMPOSITING SCHEME FROM FLOWLINK ASCII FILE

The procedures below describe the steps necessary to convert storm data exported from FLOWLINK into a flow compositing spreadsheet. This spreadsheet, STORM, automatically imports the data and performs the compositing calculations. Summary tables, a storm hyetograph, a storm hydrograph, and a chain-of-custody form are automatically created by the program. The spreadsheet is self-automated and requires very little user input. The user needs only rudimentary experience with spreadsheets in order to follow these procedures. At any point during the execution of the compositing program, Ctrl-Break can be used to interrupt the calculations.

1. To load LOTUS 123 Version 2.3, type '123' from any hard drive directory prompt (i.e. C:\>).

2. Change the default spreadsheet directory to the correct sampling site directory (i.e. for the Acker Place Site the command could be '/FD C:\ACKER\'). Subdirectories must be created before this procedure, and downloaded site-specific sampler data (i.e. DEPTH.CSV, PRECIP .CSV , SAMPLE.CSV) must be stored in that site-specific subdirectory.

3. Load the spreadsheet file XFER.WKl from the selected sampling site directory. This spreadsheet will convert the ASCII file created by FLOWLINK into a LOTUS 123 spreadsheet file named TEMP.WK1. (/FR XFER.WK1)

4. The spreadsheet will automatically run the macro routine which converts the data. Look for command prompts which will appear at the top of the screen.

5. "lMPORT PRECIPITATION DATA? (1=YES / 0=NO):"
   Select "1" if rainfall data is available for this site.

6. "lMPORT SAMPLE DATA? (1=YES / 0=NO):"
   Select "1" if samples were taken during this time period. For compositing samples, this should always be "1".

7. After the macro has completed, the STORM.WKl spreadsheet will be loaded automatically. The spreadsheet file TEMP.WKl will contain all the converted ASCII data.

8. The macro routine to begin the sample compositing scheme in the STORM.WKl spreadsheet loads automatically. Look for command prompts which will appear at the top of the screen.

9. "lMPORT PRECIPITATION DATA? (1=YES / 0=NO):" (see Step 5)

10. "lMPORT SAMPLE DATA? (1=YES / 0=NO):" (see Step 6)

11. You must now write on paper the date, time, bottle number and sample number as shown on the computer screen starting at the cell location AG51.

12. Move the cell pointer to column "N". These columns show the date and time which define the X-axis of the storm hydrograph. Find the row in these columns which contains the date and time nearest to the time when the first sample was collected. (from Step 11)

13. Put an "*" in column "R" at the row which contains the time at which the first sample was collected.

14. Type ALT-D (hold the " Alt key and the "d" key at the same time) to continue with the sample compositing program.

15. Three different print ranges have been created, PRINTl, PRINT2, and PRINT3, which define a compositing summary table, a storm event summary table (with hyetograph and hydrograph) and a chain-of-custody form, respectively. These three pages can be printed separately by invoking the WYSYWYG Print command "Print". Choose Range,Set, and then choose a print range (PRINTl, PRINT2, or PRINT3). Select go. This will print the range selected.

16. Save file in the appropriate site directory using the file naming convention (date and site ID). For example, FEB11931.wkl represents a storm event on February 24, 199 at site 1 (Acker Place). It is very important to save the file under a new unique name. This will ensure that the template program and the individual storm data are preserved.

Procedure B-6

PROCEDURES FOR COMPOSITE SAMPLE COLLECTION FOR NPDES ONGOING MONITORING PROGRAM

1. New, clean disposable gloves should be worn at all times during handling of sample collection bottles in sampler carousel.

Prior to Storm Event

2. Perform routine maintenance of station immediately prior to storm event (if possible). Maintenance should include ensuring that the sampler strainer, the flow meter probe, and the rain gage cylinder are clean and free of debris.

3. Obtain sampler carousel containing clean, prepared, and capped bottles from laboratory and install in sampler. Remove lids from clean bottles before closing sampler. Ice down bottles in sampler carousel immediately prior to storm event (if possible).

4. Ensure that fully charged battery (if not connected to direct AC) is installed in sampler.

5. Check that sampler and flow meter are properly programmed and that program is running.

After Storm Event

6. After storm event is over and/or sample program is complete, download data from sampler, flow meter, and rain gage by modem (see Procedure B-5 for Data Interrogation and ASCII File Creation).

7. Go to site. Reset program; note equipment reset in equipment maintenance log located inside equipment housing.

8. Remove bottle carousel from sampler. Immediately cap all bottles. Label each bottle in carousel by filling in date, time, crew, location, etc. on pre-printed forms. Be sure to label bottles and not lids. Exposure of filled sample bottles to light should be minimized.

9. Immediately ice down filled bottles in sampler carousel. Ice should completely surround each bottle. Label outside of carousel as to contents including station location, storm event date and time, and crew ID.

10. The chain of custody form for composite samples shall be completed for the carousel contents using a waterproof pen and placed in a waterproof plastic bag. The completed chain of custody form shall be placed inside the carousel on top of the ice; the top of the carousel then should be sealed with a plastic bag (fiber tape). The carousel should also be labeled on the outside.

11. Install sampler carousel with empty cleaned bottles in sampler.

12. The field log describing all sampling activities must be completed using a waterproof pen before leaving the site.

13. At the office, transfer ASCII data into the LOTUS 1-2-3™ spreadsheet files created for that monitoring site to produce a compositing scheme for the storm event (see Procedure B-6 "Sample Compositing Scheme from FLOWLINK ASCII File".) Ensure that the filled bottles in the carousel remain iced down and covered from light during entire compositing scheme preparation time.

14. Deliver filled bottles in sampler carousel and compositing scheme for storm event to laboratory as soon as possible during working hours. The chain of custody form shall be completed by the laboratory as part of delivery of samples. Completed chain of custody forms should be filed in the field notebook for that monitoring station. Obtain another sampler carousel containing empty, capped, and prepared sample bottles from laboratory.

Procedure B-7

MAINTENANCE PROCEDURE FOR THE NPDES ONGOING MONITORING STATION RAIN GAGE

INTRODUCTION

The following "in-field" procedure corrects and calibrates an inoperable rain gage.

1. Remove the funnel from the rain gage.

2. Print a report to list the amount of rain recorded by the flow meter.

3. Flip the buckets back and forth a few times and count each time the magnet passes over the sensor.

4. Print another report to verify the correct amount of rainfall was detected.

5. If not correct, then gently bend the L-shaped bracket down towards the switch sensor (a small black box mounted on a green circuit board) as you move the magnet over the sensor. Again print a report. If the magnet had been jarred too far away from the sensor 0.01" of rain should be reported. If no rain was detected then the magnet was already too close to the sensor so go to step 7.

6. Repeat steps 3, 4 and 5 until you have successfully adjusted the magnet alignment.

7. Gently bend the bracket away from the sensor as you pass the magnet over the switch sensor. Again print a report. If the magnet had been jarred too close to the sensor 0.01" of rain should be reported.

8. Repeat steps 3, 4, and 7 until you have successfully adjusted the magnet alignment.

   Note: If the flow meter reports only half the amount, then only one side is out of alignment.

9. If you are not able to get the rain gage to record any rainfall after a few iterations of the above procedures you may want to bring the rain gage to the office or bring the ohmmeter to the site (see OHMMETER PROCEDURE).

PROCEDURE FOR SERVICING THE RAIN GAGE USING AN OHMMETER

1. Turn off power to the rain gage.

2. Set the ohmmeter to "resistance measurement" and connect a probe to each of the power terminals.

3. When the buckets are in the fully tilted position the circuit is open and the resistance should be very high. When the buckets are balanced the circuit is closed and the resistance should be very low. If both of these conditions are not satisfied, the rain gage will not record rainfall.

4. Adjust the bracket accordingly.

PROCEDURE FOR CALIBRATING THE RAIN GAGE

1. Connect the rain gage, with funnel, to a flow meter and power source. Make sure the rain gage is level.

2. Print a report to determine your starting rainfall amount. This value will be subtracted from the calibration value to determine the calibrated rainfall level. .

3. Carefully measure with a graduated cylinder 824 mL of water. Pour the water into the rain gage funnel.

4. It will take approximately three minutes for the water to drain out of the rain gage. Print a report to determine the new net amount of rainfall. Subtract the rainfall value determined in step 2 from this value to determine the calibrated rainfall level. The calibrated rainfall level should be one inch.

5. If the rain gage is not calibrated to one inch, adjust the tilt angle of the buckets by adjusting the screws beneath the buckets. For example, if more than one inch is reported, then you need to lower each side. Rotate each screw clockwise the same number of rotations. If less than an inch of rain is reported, then you must turn each screw counter-clockwise the same number of rotations.

6. Repeat steps 3, 4, and 5 until the rain gage reports one inch of rain for 824 mL of water.