Standard Operating Procedure for:
Modified Fluorometric Determination of Chlorophyll *a* (Free of Phaeophytin) Using Narrow Bandpass Filters

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TABLE OF CONTENTS

1. SCOPE AND APPLICATION
2. SUMMARY OF METHOD
    2.2. Interferences
    2.3.Definitions
3. EQUIPMENT AND SUPPLIES
4. REAGENTS AND STANDARDS
5. SAMPLE COLLECTION, PRESERVATION, AND HANDLING
6. SAMPLE PREPARATION
    6.2.Chlorophyll Filtration
    6.3.Chlorophyll Batch Preparation
7. SAMPLE ANALYSIS
    7.1.Extraction
    7.2.Instrument Setup
    7.3.Instrument Calibration
    7.4.Fluorometric Analysis
8. DATA ARCHIVAL
9. QUALITY CONTROL
10. SAFETY/HAZARDOUS WASTE MANAGEMENT
11. REFERENCES
12. TABLES, DIAGRAMS
    Figure 12.1 Vacuum Filtration System
    Figure 12.2 Filter trimming for extraction

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1. SCOPE AND APPLICATION

1.1. This method is based on EPA Method 445.0. This method is used to determine the amount of chlorophyll *a* in marine and freshwater algae. Chlorophyll *a* is calculated as "free of phaeophytin" by using a special narrow bandpass filter in this modified fluorometric method.

1.2. This procedure is used for samples with LIMS Test ID CHL-MDFL-W.

1.3. Method Detection Limits (MDL)

1.3.1. The chlorophyll *a* MDL is 0.060 µg/L for a filtered sample volume of 1000 mL with an extract volume of 14 mL. The practical quantitation limit (PQL) is calculated at 3 times the MDL.

2. SUMMARY OF METHOD

2.1. A sample is vacuum filtered onto a glass fiber filter. The filter is then macerated with a tissue grinder and steeped in 90% acetone to extract chlorophyll from the algal cells. The sample is clarified through centrifugation. The fluorescence of the clarified extract is then measured using a fluorometer with special narrow bandpass filters at an excitation wavelength of 436 nm and an emission wavelength of 680 nm.

2.2. Interferences

2.2.1. Chlorophyll pigment is sensitive to heat and light. To avoid degradation, extraction and fluorometer readings are performed in a dark room using subdued lighting only. The grinding tube is kept on ice between samples to minimize heat from friction during extraction. Also, chlorophyll sample filters are stored at -20º C.

2.2.2. Fluorescence is temperature sensitive. Fluorescence decreases as the sample temperature increases. Blanks, standards, and all samples are analyzed at ambient temperature. Using the instrument's Discrete Sample Averaging feature ensures that samples remain inside the unit for the same period of time and are therefore approximately the same temperature when measured. Recalibrate the fluorometer if the ambient temperature fluctuates ±3 ºC between calibrations.

2.2.3. Any compound that absorbs light between 630 and 665 nm may interfere with chlorophyll measurement. The spectral overlap of chlorophyll *a*, *b*, *c* and phaeophytin can cause over or underestimation of chlorophyll. The amount of chlorophyll *b* and *c* in a sample is dependent on the taxonomic composition of the phytoplankton it contains. Special narrow bandpass filters are used to nearly eliminate the interferences of chlorophyll *b* and phaeophytin *a*. This modified fluorometric method does not provide an estimate of phaeophytin *a*.

2.3. Definitions

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2.3.1. Subdued Lighting – Only red bulbs are used in subdued lighting. All other lights are turned off. This helps minimize chlorophyll degradation caused by exposure to light.

2.3.2. Fluorescence – A fluorescent molecule has the ability to absorb light at one wavelength and almost instantly emit light at a new and longer wavelength. Any fluorescent molecule, including chlorophyll *a*, has a unique "fluorescent signature."

2.3.3. Narrow Bandpass Filter – This device passes wavelengths within a certain range and screens out wavelengths outside of that range. The excitation filter specific to chlorophyll *a* allows a small band of light energy, from 431nm to 441nm, to pass through the sample extract. The emission filter for detecting chlorophyll *a* screens out stray light and background material fluorescence allowing only wavelengths from 675nm to 685nm to pass through to the detector.

2.3.4. Modified Fluorometry – By using narrow bandpass filters, this fluorometric method does not include the acidification process. The "Uncorrected" chlorophyll *a* calculations from EPA Method 445 Section 12.1 are used. Since the interference of phaeophytin *a* is selected against by filters, acidification is not needed and the chlorophyll *a* result is considered free of phaeophytin. Therefore, no correction for phaeophytin is necessary.

3. EQUIPMENT AND SUPPLIES

3.1. Filtration

3.1.1. Vacuum filtration system (See Figure 12.1)

3.1.2. Whatman GF/C 47mm Glass Fiber Filters

3.1.3. Small roll of aluminum foil, cut in 3 inch squares

3.1.4. Class A TD (to deliver) 500 mL Graduated Cylinder

3.1.5. Extra Fine tip black marker

3.1.6. 2 Rinse bottles (1 small, 1 large)

3.1.7. Rubber bands

3.1.8. Plastic zip-top bag

3.1.9. Aluminum foil, cut into approximately 4 × 6 inch pieces

3.2. Extraction

3.2.1. BD Falcon 15 mL Centrifuge tubes

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3.2.2. Test tube rack

3.2.3. Scissors

3.2.4. Eberbach Tissue Grinder motor

3.2.5. Wheaton Tissue Grinder with 30 mL tube

3.2.6. Small container with ice

3.2.7. Rinse bottle

3.2.8. Fume hood in dark room

3.3. Fluorometric Analysis

3.3.1. Sorvall HT-6 Centrifuge (S/N 40926174)

3.3.2. Turner Designs TD-700 Laboratory Fluorometer (S/N 7-1192-CE)

3.3.3. PC with Turner Designs software

3.3.4. Excitation filter (436FS10)

3.3.5. Emission filter (680FS10)

3.3.6. 13mm X 100 mm glass cuvettes

3.3.7. Glass serological disposable pipettes, sterile and individually wrapped, with pipette pump, 10 mL (volume of each new lot is checked per SOP MB-03.3)

3.3.8. Kimwipes

4. REAGENTS AND STANDARDS

4.1. Deionized Water

4.2. Acetone, HPLC grade

4.3. Aqueous Acetone Solution (90% acetone)

4.3.1. Add 900 mL of Acetone (HPLC grade) to 100 mL of deionized water.

4.3.2. To record preparation, go to **LIMS Laboratory\Technical\Standard Preparation Tracker**. Choose “BIO-MICRO” **Group**. Enter it as a **Prepared** “New Reagent” or “Duplicate Reagent”. (Duplicate Reagent can be used to copy an old record. New Reagent will have all of the fields blank.) Print a label and attach to the container.

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4.4. Turner Solid Secondary Standard

4.5. Sigma C5753 Chlorophyll *a* from spinach, 5 mg

4.6. Chlorophyll *a* Stock Standard

4.6.1. Prepare under subdued lighting. Tap the ampoule of chlorophyll *a* spinach until all the powder is settled to the bottom. Break open the tip and empty contents into a Class A 25 mL volumetric flask containing about 10 mL of 90% acetone. If necessary, rinse ampoule thoroughly with 90% acetone into the volumetric flask. Dilute to volume with 90% acetone. Add a small stir bar and mix thoroughly. Transfer standard to a dark glass bottle, label as "Chlorophyll *a* Stock" with the preparers initials, date prepared and expiration date and store in biology lab freezer.

Note: Be careful when preparing stock solution. The entire contents of the spinach ampoule must be emptied into the flask. Any spill can alter the concentration of the stock solution. Do not touch the top of the broken ampule. The edges can be very sharp.

4.6.2. To record preparation, go to **LIMS Laboratory\Technical\Standard Preparation Tracker**. Choose BIO-MICRO" **Group**. Enter it as a **Prepared** "New Standard" or "Duplicate Standard". (Duplicate Standard can be used to copy an old record. New Standard will have all of the fields blank.) Print a label and attach to the bottle.

4.6.3. Concentration of stock standard is 200 mg/L. The expiration date is 9 months from the date of preparation.

4.7. Chlorophyll *a* Working Calibration Standards

4.7.1. 200 µg/L standard (Hi Std): Pipette 0.20 mL of chlorophyll stock standard to a 200 mL Class A graduated cylinder. Bring up to volume with 90% acetone and mix thoroughly. Transfer to a dark glass bottle, label as "Chlorophyll *a* Working Hi Std" with the concentration, preparers initials, date prepared, and expiration date. Store in biology lab freezer. The expiration date is 3 months from the date of preparation.

4.7.2. 20 µg/L standard: Pipette 2 mL of the 200 µg/L standard into a Class A graduated cylinder and bring up to a volume of 20 mL with 90% aqueous acetone solution. Transfer to a dark glass bottle and label with concentration, preparers initials, date prepared, and expiration date.

4.7.3. 5 µg/L standard: Pipette 5 mL of the 20 µg/L standard into a Class A graduated cylinder and bring up to a volume of 20 mL with 90% aqueous acetone solution. Transfer to a dark glass bottle and label with concentration, preparers initials, date prepared, and expiration date.

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4.7.4. 2 µg/L standard: Pipette 8 mL of the 5 µg/L standard into a Class A graduated cylinder and bring up to a volume of 20 mL with 90% aqueous acetone solution. Transfer to a dark glass bottle and label with concentration, preparers initials, date prepared, and expiration date.

4.7.5. 0.2 µg/L standard: Pipette 2 mL of the 2 µg/L standard into a Class A graduated cylinder and bring up to a volume of 20 mL with 90% aqueous acetone solution. Transfer to a dark glass bottle and label with concentration, preparers initials, date prepared, and expiration date.

4.7.6. All standards should be recorded in **Standard Preparation Tracker**.

Note: Be as precise as possible when measuring. Use a new pipette tip for each standard concentration. The fluorometer is only as accurate as the standards used to calibrate it.

5. SAMPLE COLLECTION, PRESERVATION, AND HANDLING

5.1. See FDEP Field SOP FS 1000 for sample collection and preservation.

6. SAMPLE PREPARATION

6.1. Refer to SOP BB-30 for sample custody, labels and worksheet instructions.

6.2. Chlorophyll Filtration

6.2.1. Shake sample bottle to ensure sample is thoroughly mixed. Use a clean, well rinsed, Class A graduated cylinder to measure 1000 mL of sample. Filter through a GF/C glass fiber filter. If sample is highly turbid and difficult to filter, do not filter the entire 1000 mL volume. A smaller volume may be used as long as the filter is sufficiently loaded with algae (ex. filter is visibly green or water flow has slowed or stopped). Do not allow the vacuum to suck the filter dry. Slowly turn off the vacuum as the sample water approaches the filter and turn it off completely when the filter is nearly dry.

6.2.2. Rinse the funnel with deionized water (about 10-20 mL). Turn the vacuum back on, and when the rinse water approaches the filter, slowly turn off the vacuum until the filter is nearly dry. Rinse the funnel and graduated cylinder 3 times. Remove and fold the filter in half with the algae facing in, using the filtrate edge as a guide (not the filter edge). Blot gently with a Kimwipe to remove excess liquid, if necessary. Then, fold the filter in half again while lining up the filtrate edge. Wrap the folded filter completely in aluminum foil. Place the “A” prep label on the foil and write the filter volume on it.

6.2.3. If there is a “B” label for a sample, repeat steps 6.2.1 and 6.2.2 for the “B” label. Use equal volumes for “A” and “B” aliquots of replicate samples.

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6.2.4. Repeat steps 6.2.1.-6.2.3 for each sample. Filter a method blank sample (1000 mL) after every 20 samples. Wrap the blank filter in foil and label as "BLK" (Refer to Section 9.2.).

6.2.5. When all samples are complete, record filter volumes, filtration date/time, analyst, blanks, and dups in **LIMS Laboratory\Technical\Prep Worksheet Manager** per SOP BB-30. Blanks should be placed on the worksheet where they were actually filtered. Use a rubber band to bind the samples together, place the samples in a plastic zip-top bag, squeeze the air out of the bag and seal it. Label the plastic bag with the date and store in the biology lab freezer at -20°C. Holding time for frozen samples is 28 days from time of filtration until extraction. Record the time that samples are placed in the freezer in **Prep Worksheet Manager**.

6.2.6. Discard unused sample in the sink unless it is suspected of being hazardous waste. If suspected of being hazardous waste, notify the safety officer and supervisor for proper disposal of the sample. Place empty bottles in a garbage bag with the filter date visible on the exterior for discard purposes.

6.3. Chlorophyll Batch Preparation

6.3.1. Using the Prep Worksheet as a guide, create batches of 20 samples each in the *Chlorophyll Run Log* for analysis. Combine worksheets from different days as necessary. Batches of 20 should be labeled sequentially with a number 1-10. In the **Sample Comments** column in **Prep Worksheet Manager**, fill in the batch number for each sample.

6.3.1.1. If there are priority 1 samples, place them in the first available batch. Otherwise, create batches in the order they appear in prep worksheets.

6.3.2. Copy the prep worksheet batches into the *Chlorophyll Run Log*.

6.3.2.1. Write the batch number at the top of the Run Log page.

6.3.2.2. Print sample labels and add stickers to the Sample # column for Tube #1-21.

6.3.2.3. Tube #22 is labeled "dup." Complete this row after extracting a "B" sample.

6.3.2.4. The blank is added to the Run Log page in the order it appears on the corresponding Prep Worksheet Manager worksheet.

6.3.2.5. Enter filter volumes in the "Filter vol (mL)" column. Fill in the column for Job IDs.

6.3.2.6. Write "B" volumes under Comments in the corresponding row (i.e. B=500).

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6.3.3. Using the *Chlorophyll Run Log*, retrieve corresponding samples from the freezer to create packets for extraction.

6.3.3.1. For each batch, place all samples in the order they appear on the corresponding Prep Worksheet Manager worksheet. Wrap in foil and label the packet with batch number. Place the packets in the same container as the unbatched foiled samples and return to the freezer until extraction.

7. SAMPLE ANALYSIS

7.1. Extraction

7.1.1. Retrieve the chlorophyll packet associated with the first available batch in the *Chlorophyll Run Log* from the biology lab freezer. Record extract date/time/analyst and reagent serial numbers in the *Chlorophyll Run Log*. Fill in the Run ID. The format is YYYY-MM-DD-A. The last character is an A for the first batch of the day, B for the next batch and so forth.

7.1.2. In subdued lighting, unwrap sample filter from foil and make sure sample label information matches the *Chlorophyll Run Log*. If needed, trim the filter above the filtrate line to remove excess filter (See Figure 12.2). To avoid losing sample, do not cut too close to the filtrate line. Roll up filter and place in the grinding tube. Add 2-3 mL of 90% aqueous acetone solution.

7.1.3. Grind the filter into a slurry solution without allowing the sample to overheat. This may take up to 1 minute. Grooves may be cut into the bottom of the pestle to facilitate grinding. During extraction keep the grinding tube in ice water when not in use to minimize overheating from friction. Rinse the pestle and the walls of the tube with 1-2 mL of 90% aqueous acetone solution collecting the rinse in the tube.

7.1.4. Transfer mixture to the corresponding numbered centrifuge tube. Centrifuge tube numbers can be found in the *Chlorophyll Run Log*. Use aqueous 90% acetone solution to rinse any remaining sample in the grinding tube and on the grinding pestle into the centrifuge tube. Rinse the grinder and tube at least three times. Rinse the centrifuge tube wall, bring the final volume up to 14 mL, and cap the tube. Record extract volume in the *Chlorophyll Run Log*.

7.1.5. Repeat steps 7.1.2-7.1.4 for each sample.

7.1.6. Shake each tube vigorously, and then cover centrifuge tube rack to avoid light exposure. Allow samples to steep at 4 °C for a minimum of 2 hours. Do not exceed 24 hours. Shake tubes vigorously 1-3 times during the steeping period. Record the start and end steep time/date in the *Chlorophyll Run Log*.

7.2. Instrument Setup

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7.2.1. Turn on the fluorometer and let it warm up for at least 30 minutes. *Note:* This is longer than the instrument's initial 600 second countdown.

7.2.2. Turn on computer and open **LIMS**. Go to **Laboratory → Biology→ Chlorophyll Manager**.

7.2.3. Under **Setup Communications** select "COM 4" as the port.

7.2.4. Enter the analyst, date and time of extraction in the provided boxes. Fill in "Sample," "Volume Filtered," and "Volume Extracted" in the worksheet. Include "cstdhi_1" for the high standard and "cstdlo_1" for the low standard. "Cycle #," "Concentration," and "Raw Fluorescence" will automatically populate as the samples are run.

7.3. Instrument Calibration

7.3.1. Perform an instrument calibration when there are any instrument changes or maintenance, or if the room temperature fluctuates by more than 3 degrees Celsius from the temperature of the previous calibration. (Refer to the temperature entered in LIMS Laboratory Logbook. Also, record current temperature in LIMS Laboratory Logbook.) Use the primary working standards made in step 4.7. to calibrate the fluorometer. If an instrument calibration is not needed, skip to step 7.4.2.

7.3.2. Turn on the computer and open **HYPERTRM.EXE** program.

7.3.3. Select **Transfer/Capture Text**…

7.3.4. Under **File:**, replace "MMDDYY" in file name with current date. Be sure link is \\fldep1\DEAR\Labs\Lab5\Biology\Bench Common\Fluorometer\Calibration\calMMDDYY.txt to save calibration data.

7.3.5. Click the **Start** button.

7.3.6. Calibration settings: These settings are saved between calibrations and should only be changed as needed.

7.3.6.1. On the instrument, press [ENT] from the HOME (default) screen to enter the Setup/Calibration screen.

7.3.6.2. To return to HOME screen from any other screen, press [H].

7.3.6.3. Press [1] to choose the setup screen, then [1] again for Mode.

7.3.6.4. Use the [↔] toggle key to choose the "Multi-Optional Mode".

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7.3.6.5. Press [ESC] to return to previous screen, and then press [2] to choose the calibration procedure. Press [↔] to select "Direct Conc."

7.3.6.6. Press [ESC] to return to previous screen, and then press [3] to choose the units of measure. Press [↔] to select "µg/L". Press [ESC] twice to return to Setup/Cal screen.

7.3.7. Press [2] to begin calibration.

7.3.8. Press [1] to accept the maximum range.

7.3.8.1. The maximum range should be 250 µg/L. To change the maximum range press [9] and enter a new value. The range is 1-1000.

7.3.9. Press [5] for the number of concentrations to be used.

7.3.10. When screen reads "Hi Std Conc" press [1] to accept the current concentration of the high standard.

7.3.10.1. To change the concentration of the Hi Std, press [9] and enter a new value. The Hi Std should be around 80% of the maximum range, or 200 µg/L.

7.3.11. Add 8 mL of the Hi Std to the cuvette. Use a Kimwipe to dry and clean the sides of the cuvette. **The cuvette should be at least 75% full for an accurate reading.**

7.3.12. Insert the cuvette into the sample adaptor in the sample chamber.

7.3.13. Close the lid and press [*].

7.3.14. The screen will prompt you for the next standard. Repeat steps 7.3.10-7.3.13 for each of the remaining standards (20, 5, 2, and 0.2 µg/L), positioning the cuvette in the chamber the same way each time to avoid measurement error from variations in the glass. Triple-rinse the cuvette with 90% acetone solution to minimize reading errors from sample carryover.

7.3.15. When all standards have been run, the screen will prompt you to insert a blank. Fill the cuvette with 90% aqueous acetone and wipe the outside dry. Insert the cuvette into the sample adaptor, close lid, and press [ENT]. When the blank reading stabilizes, press [0].

7.3.15.1. After reading the blank, the calibration data set will be automatically sent to the terminal. To view the calibration at any time, press [ENT] from the HOME screen, and then press [D] to send the calibration data to the terminal. The "Slope %RSD" must be ≤ 25%, but < 5% is preferred. If greater than 25%, calibration must be repeated.

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7.3.16. Remove the cuvette and the sample adaptor from the instrument. Insert the Turner solid secondary standard into the chamber with the "H" on the left side and press [*]. After the data prints to the screen, flip the standard so the "L" is on the left side and press [*].

7.3.16.1. The standard has a high (H) and low (L) reading. Both the H and the L readings should be within 15% of the true values written on the bottom of the standard.

7.3.17. Return sample adaptor to the instrument, taking care to return it to the same position from which it was removed.

7.3.18. On the computer, select **File/Save**. Close the window.

7.3.19. Open the newly-saved file in notepad. Type the date/time and analyst's initials and **Save**.

7.3.20. If there are samples ready to be analyzed, proceed to step 7.4.2.

7.4. Fluorometric Analysis

7.4.1. Check the temperature of the room to determine if an instrument calibration should be performed. (Refer to 7.3.1.) If an instrument calibration is not needed, continue to step 7.4.2. If an instrument calibration is needed, follow the steps in section 7.3.

7.4.2. Shake sample tubes vigorously and centrifuge samples for 20 minutes at 2500 rpm. Decant supernatant from each sample into a clean centrifuge tube with matching tube number.

7.4.3. Be sure that LIMS **Chlorophyll Manager** is open on the computer and set up according to section 7.2. Record the run date/time/analyst in the *Chlorophyll Run Log*.

7.4.4. Zero the fluorometer.

7.4.4.1. Add 8 mL of 90% aqueous acetone solution to the cuvette. Wipe the outside of the cuvette with a Kimwipe. Insert the cuvette into the sample adaptor in the sample chamber and close the lid. Press [0] from the HOME (default) screen. Then press [1] to zero the fluorometer. Rinse and empty the cuvette into a designated acetone waste container.

7.4.4.1.1. To return to HOME screen from any other screen, press [H].

7.4.4.1.2. Click the **Start Data Collection** icon in LIMS **Chlorophyll Manager**,

7.4.5. Run the Turner solid secondary standard.

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7.4.5.1. Remove the cuvette and the sample adaptor from the instrument. Insert the Turner solid secondary standard into the chamber with the "H" on the left side and press [*]. After the data prints to the screen, flip the standard so the "L" is on the left side and press [*].

7.4.5.2. The standard has a high (H) and low (L) reading. Both the H and the L readings should be within 15% of the true values written on the bottom of the standard. Record the standard serial number at the top of the *Chlorophyll Run Log.* Record the percent recovery of the standard compared to the true values at the bottom of the *Chlorophyll Run Log.*

7.4.5.3. Replace the sample adaptor after the Turner solid standard has been run, taking care to return it to the same position from which it was removed.

7.4.6. Use a pipette to add 8 mL of the first sample into the cuvette.

7.4.7. Press [*] from the HOME screen to read the sample.

7.4.7.1. This initiates a sequence of a 7-second delay for signal stabilization, a 12-second averaging period, and a 5-second readout display. "DLY", "AVG" and "END" appear on the LCD display and alert the user to the instrument's current status.

7.4.8. Data is automatically sent to the computer and will populate LIMS **Chlorophyll Manager**.

7.4.9. Return the sample from the cuvette into its designated centrifuge tube. Triple-rinse the cuvette with 90% aqueous acetone solution and empty into the acetone waste container.

7.4.10. Repeat Steps 7.4.6–7.4.9 for each sample to be read, including the blank.

Note: Do not leave highly concentrated samples in the instrument for an extended period of time. Unstable readings may result.

7.4.11. If all of the quality controls (QC) meet the requirements in section 9, empty the centrifuge tubes into the acetone waste container. Do not discard any samples until all of the QC has been checked and the samples do not need to be re-read due to QC failure.

8. DATA ARCHIVAL

8.1. On the day of fluorometer use, record the temperature of room B205 in the LIMS **Laboratory Logbook** *Temperature Log*. Check this value against the temperature of the last fluorometer calibration to determine if the instrument needs to be calibrated.

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8.2. Save the LIMS **Chlorophyll Manager** file as the Run ID.

8.3. Upload data using LIMS **QC Manager**. See SOP BB-031 for verification and upload instructions.

8.4. After verification and upload, refer to SOP BB-032 for data authorization.

8.5. Calculations for Phytoplankton samples:

$$\text{Chlorophyll } a \text{ free of phaeophytin (µg/L)} = \frac{[(C_e) \times V_1 \times DF]}{V_2}$$

where: C_e = chlorophyll concentration of extract solution
V_1 = volume of extractant (L)
DF = dilution factor
V_2 = volume of sample filtered (L)

9. QUALITY CONTROL

9.1. Continuing Calibration Verification and positive control (CCV)

9.1.1. Analyze the solid secondary standard batch at the beginning of every batch to verify calibration. Measure readings for both the "H" and "L" side of the standard. Record the standard number in the appropriate box at the top of the *Chlorophyll Run Log* page.

9.1.2. If either of the readings differ by more than 15% from the original readings after the previous calibration (found on the bottom of the standard), re-calibrate the fluorometer before analyzing the batch.

9.1.3. If solid standard is not available, analyze the 200 ug/L calibration standard along with the positive control as described in Section 9.3.

9.2. Negative Control

9.2.1. Filter 1000 mL of deionized water for a laboratory blank after every 20 samples filtered.

9.2.2. Analyze the laboratory blank in the order it appears in the CHL Run Log.

9.2.3. The acceptance limit is ≤ 0.060 µg/L (method detection limit).

9.2.4. Corrective Action: If a blank failure occurs, return the blank sample to the centrifuge tube, rinse the cuvette thoroughly with 90% aqueous acetone, and then re-read the blank. If this does not correct the problem, run a 90% acetone sample to help determine whether the problem is caused by instrument malfunction or

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blank contamination. If there was an instrument malfunction, correct the problem and then re-read the samples.

9.3. Positive Control

9.3.1. If secondary solid standard is not available, as a laboratory control sample (LCS), analyze the 2.0 ug/L chlorophyll *a* working standard at the beginning of every batch during fluorometric analysis.

9.3.2. Record the working standard serial number in the Standard S# box on the *Chlorophyll Run Log* page.

9.3.3. Calculate percent recovery of LCS as follows:

$$\%\,\mathrm{Rec} = \frac{(C_e)}{TV} \times 100\%$$

where: C_e = chlorophyll concentration of extract solution
TV = True value of the chlorophyll standard

9.3.4. The acceptance limit for recovery is 85-115%.

9.3.5. If the recovery exceeds the limits, re-zero the fluorometer with 90% acetone solution and re-run the standard.

9.3.6. Corrective Action: If standard has repeated low failures, it is possible that the standard was exposed to heat or light over time and has degraded. Make a new batch of working standard. If standard continues to fail, the instrument may need to be re-calibrated.

9.4. Sample Duplicates

9.4.1. Analyze a laboratory replicate for 5% of samples. The acceptance limit is ≤25% RPD.

9.4.2. Corrective Action: Calculate the RPD for the duplicates. If they are not within the acceptance limit, re-run both duplicates at the end of the batch. Record the RPD at the bottom of the *Chlorophyll Run Log.*

10. SAFETY/HAZARDOUS WASTE MANAGEMENT

10.1. Do not pour acetone or any reagent/standard containing acetone down the sink. Pour any waste acetone in the waste flask located in the chlorophyll room sink. When this is full, cap it and label it with “Acetone Waste, Hazardous Waste,” amount, date generated, and initials. Follow the Health and Safety plan for proper disposal of full waste acetone bottles.

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10.2. The extraction process which involves filter grinding should take place under a fume hood since the tissue grinder causes volatilization of acetone.

10.3. The tissue grinder fits tightly inside the grinder tube and can become stuck if not altered before use. This can cause the grinder and tube to heat up and increase the risk of glass breakage. Be sure to reduce the size of new tissue grinders using sandpaper before using for the first time.

10.4. Refer to the Health and Safety Plan.

10.5. Read MSDS information for reagent handling and disposal.

11. REFERENCES

11.1. Standard Methods Online Edition SM10200H(2001)

11.2. EPA Method 445.0 Revision 1.2

11.3. NELAC Quality Systems Manual

11.4. TD-700 Laboratory Fluorometer Operating Manual

11.5 FDEP Laboratory Quality Manual https://floridadep.gov/dear/florida-dep-laboratory/content/dep-laboratory-quality-assurance-manual-and-sops

11.6. FDEP Laboratory Health and Safety Plan http://publicfiles.dep.state.fl.us/DEAR/DEAR%20Safety/FDEP%20Health%20%20Safety%20Plan%20B%20-%20June%202016.pdf

11.7. DEP SOP BB-030: *Sample Custody, Preparation Labels and Worksheet Instructions for Bench Biology Samples*

11.8. DEP SOP BB-031: *LIMS QC Manager Data Uploading Instructions for Bench Biology and Microbiology Samples*

11.9. DEP SOP BB-032: *Test Level Authorization of Uploaded Results for Bench Biology Samples*

11.10. DEP SOP FS1000: *General Sampling Procedures*

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12. TABLES, DIAGRAMS

Figure 12.1. Vacuum Filtration System

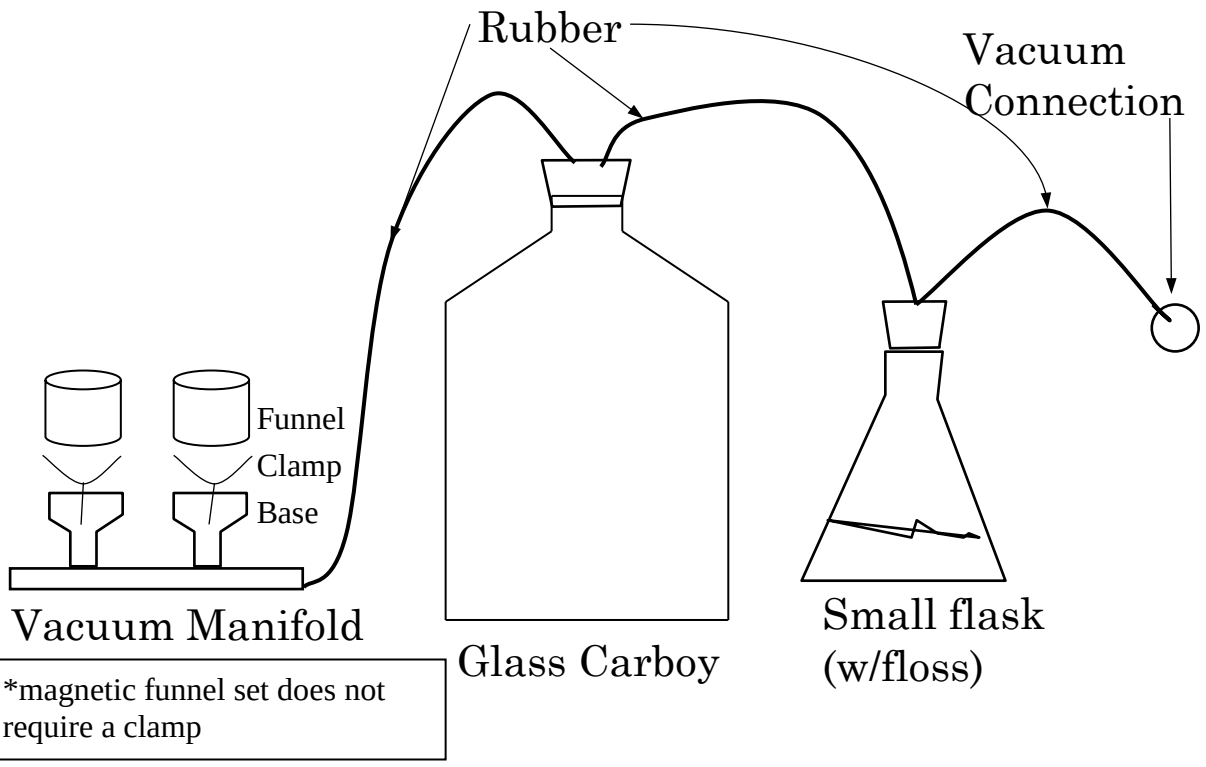
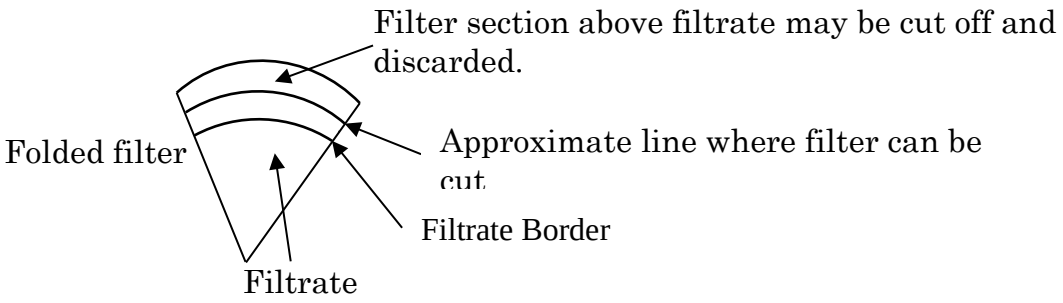


Figure 12.2 Filter trimming for extraction



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Appendix of Changes

01/13/2010	This is a new SOP for fluorometric determination of chlorophyll. There is currently no active SOP for this procedure. I incorporated the three remaining SOPs relating to fluorometry into this document; BB28.2, BB28.3, BB28.4. CF
12/09/2010	Added section for CCV, updated reference to Health and Safety Plan, removed reference to $MgCO_3$ suspension which is not part of EPA Method 445.
12/06/2011	Updated information in Fig 12.1 to reflect new equipment. Updated reference to quality control manual.
12/18/2012	Updated chlorophyll calculation to use correct term for component.
12/12/2013	Updated filtration and extraction volumes. Updated MDL and PQL values.
08/06/2014	Added new LIMS chlorophyll manager data collection instructions.
08/19/2015	Added centrifuge to the equipment list; added LIMS Logbook for recording temperatures and Standard Prep Tracker for recording reagents; updated instructions for filling in the Chlorophyll Run Log; re-worded the Extraction section to more closely match the process in SOP BB-29; reformatted Section 7.3. Instrument Calibration; updated the file link in Sec 7.3.1.3; removed "approximately" from 7.3.3. and replaced with a defined limit; updated the network link in Section 7.3.; corrected the time and speed required for centrifuging the samples.
12/30/2016	Added instructions to include new information to be recorded on updated run log.
12/14/2017	Revised information in sections 6.3, 7.2, 7.3, 8.1, 9.2, and 9.3. Updated links to FDEP Laboratory Quality Manual and FDEP Laboratory Health and Safety Plan in References section.
01/03/2019	Updated new MDL. Revised sections including chlorophyll filtration; chlorophyll batch preparation; and fluorometric analysis. Updated link for FDEP Laboratory Quality Manual.

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