FIELD SAMPLING PLAN

SUNSET ACRES CASE STUDY

Tavenier, Florida

PREPARED FOR:

MONROE COUNTY RESIDENTIAL CANAL AND INVENTORY

PREPARED BY:

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SAMPLING PLAN FOR SUNSET ACRES, TAVENIER, FLORIDA

1.0 INTRODUCTION

On July 11, 2001, Law Engineering and Environmental Services, Inc. (LAW) was authorized by Monroe County to perform a Residential Canal Inventory and Assessment. Part of the assessment includes conducting a case study of the canal contained within Sunset Acres, a subdivision in Tavenier, Florida. In 1998, modifications were made to the canal system, including the removal of a berm, thereby connecting the Sunset Acres canal to Florida Bay.

The case study, which will look at changes, if any, in water quality parameters since the connection to the bay was made, includes collection of water quality data. This sampling plan provides the protocol that will be used to collect the water quality data in the canals and adjacent waters. An overall discussion of the sampling scheme and equipment is presented below with detailed protocols provided in Appendix A.

2.0 SAMPLES AND SAMPLE LOCATIONS

The following parameters will be monitored for each sampling station: Temperature, Salinity, Turbidity, and Dissolved Oxygen (DO). Samples will be collected at six (6) locations as depicted on Figure 1: three canal endpoints (SP-1 through SP-3), perimeter canal (SP-4), mouth of canal system (bayside) (SP-5), Florida Bay (SP-6).

2.1 SAMPLING SCHEDULE

Samples will be collected approximately quarterly (four events). The sampling will include at least two episodic rain events to assess the impact of stormwater runoff in the canal system and adjacent waters. The target conditions for sampling are early morning with calm waters, preferably on falling tides. Comparable samples will be taken in the afternoon (two sampling rounds per sampling event).

2.2 METHODS

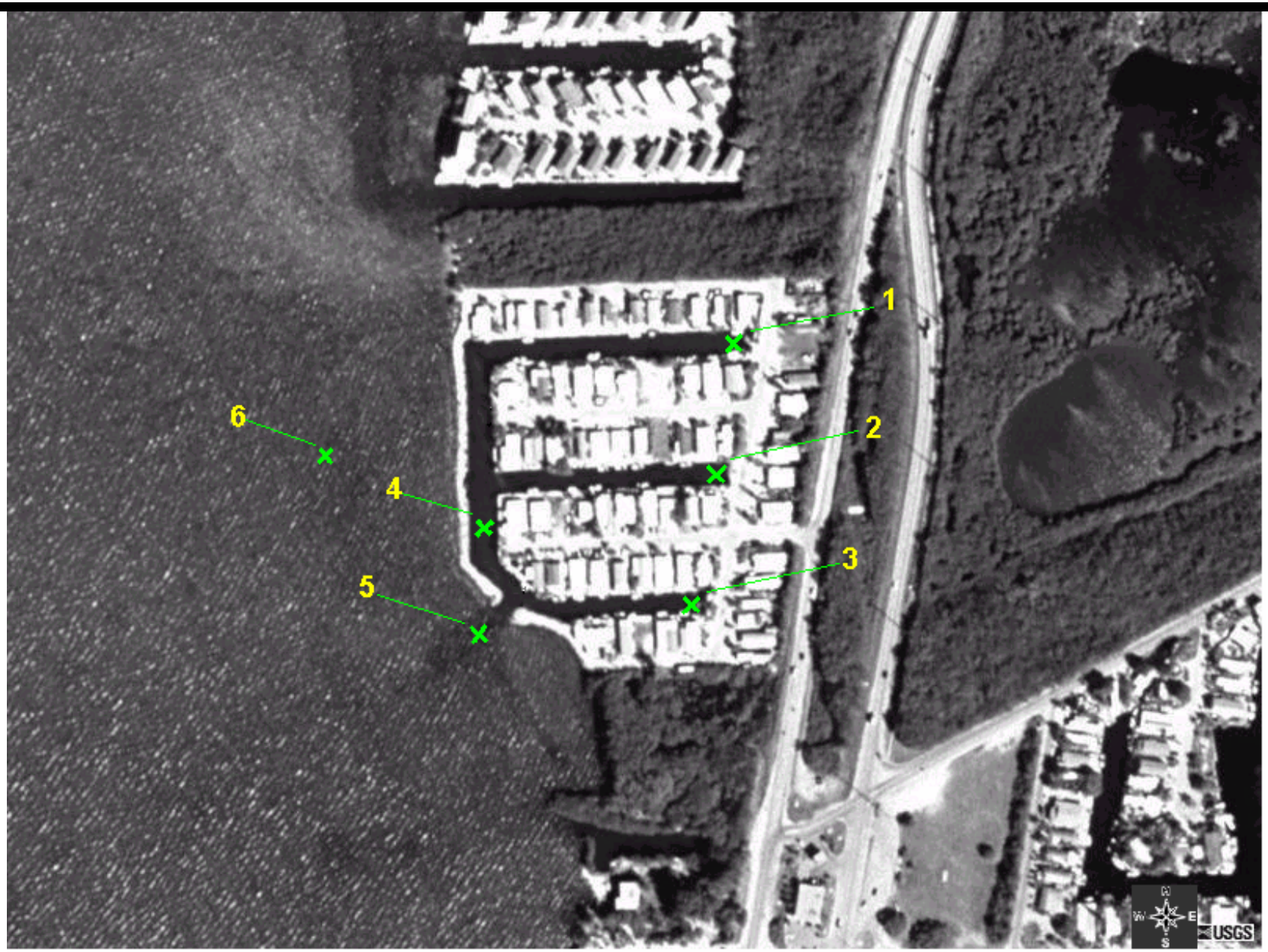
Field marking of sample locations is not required, as landmarks will serve as an appropriate guidance of geographic consistency. All canal samples will be taken at the center of channel. Samples will be collected in the same order each sampling period, starting with the innermost sample locations (at canal termini) and ending with the bay samples. At the start of the sampling day, the equipment will be calibrated and meteorological conditions will be noted and marked on the field data sheet (Procedure 1 of Appendix A). Upon arrival to an individual sample location, the sampling vessel will be anchored if necessary. GPS coordinates should be established for all points, but the bay samples should be the only locations that will require a new GPS reading for each sampling period. During sampling, FDEP's Standard Operating Procedures (DEP-QA-

001/92) and the Quality Assurance Protocols in Appendix A will be followed. The order of sampling will proceed as follows:

1. Collect sounding (depth) for sample location.
2. Collect surface water sample. See Procedure 2 of Appendix A.
3. Collect temperature, salinity and DO data first, then turbidity. See Procedure 3 of Appendix A.
4. Collect water sample(s) and measurements at depth. Collect sample from three depths: surface, mid-depth, and bottom (but no closer than 8 inches above the canal/bay bottom). Note sampling depth. See Procedure 2 of Appendix A.

The Health and Safety Plan is provided in Appendix E.

FIGURE



Monroe County Canals Pilot Study
Sunset Acres

TAVENIER, FL

LAW PROJECT NUMBER: 40700-1-2681 P1

LAWGIBB GROUP

LAW ENGINEERING & ENVIRONMENTAL SERVICES, INC.
5845 N.W. 158th STREET
MIAMI LAKES, FL 33014

FIGURE 1

SAMPLE LOCATION MAP

DRAWN BY: J.T.C.	**DATE: 11/9/01**
CHECKED BY: P.L.G.	**SCALE: NTS**

APPENDIX A

QUALITY ASSURANCE, CALIBRATION AND SAMPLE COLLECTION PROCEDURES

QUALITY ASSURANCE PROTOCOLS

The Week Before Sampling:

1. Be sure all equipment is in working order and that you have clean sample bottles and vials.
2. Check the tide tables to plan when to take samples. The website for checking the tide tables is as follows (use the data listed under Hammer Point):
   www/co-ops.nos.noaa/gov/tab2ec3d.html#94
3. Check stock and expiration date on calibration fluids and equipment such as Kim-wipes.
4. Sign out equipment van.
5. Make arrangements/reservations for boat.

The Day of and During Sampling:

1. Do not eat, drink, or smoke while sampling.
2. Do not apply perfume, insect repellant, or other sources of contaminants of water samples just before sampling.
3. Keep your samples, bucket, and instruments in the shade during sampling. If you cannot work in shade, complete the sampling steps as quickly as possible so that the temperature of the bucket sample does not change.
4. Inspect all sampling devices for cleanliness. Do not use them if they appear dirty or contaminated.
5. Look around you to see if there are any activities going on nearby that may affect your water sampling, such as pesticide or fertilizer spraying or boat cleaning. Try not to sample if these activities will affect your sample.
6. Try not to sample when it is raining. If you must, do not get any rain in the sample. Use an umbrella to shelter the bucket and bottles.
7. Rinse your bucket down-current from where you take the sample.
8. When done with sampling for the day, rinse all your equipment with fresh water and keep all your equipment clean and dry when not in use.
9. Do not use your bucket or any of your equipment for any purpose other than this study. Keep your equipment clean, dry, and in working order. If anything is damaged or is lost, call for a replacement immediately.

Equipment List:

Bucket
Umbrella
Life vests (one per person)
GPS
Phone
Sunscreen
Water
Sounder (depth gauge)
Field sampling forms
YSI model 85 – DO, salinity & temperature – calibration equipment and extra membranes
DRT-15CE – turbidimeter – and calibration fluids
Kim-wipes
Wildco sampler
DI water (in decon bottle)
Compass

PROCEDURE 1
SAMPLING SETUP, EQUIPMENT CALIBRATION AND COLLECTING METEORLOGICAL PARAMETERS

The Day before Sampling:

1. Calibrate YSI 85 meter, see procedure 3A.
2. Leave meter on.

The Day of Sampling:

1. Fill out Field Data Sheet (date, samplers, tide)
2. Record general metereological observations (cloudy, sunny, etc.)
3. Calibrate turbidity meter, see procedure 3B.
4. At end of the day, rinse all equipment with fresh water and store in a clean, dry place.

PROCEDURE 2
COLLECTING WATER SAMPLE DATA

Water sample data will be collected in the field. The parameters to be measured are (listed in order of collection):

- Temperature
- Salinity
- Dissolved Oxygen (DO)
- Turbidity

The equipment that will be used to collect temperature, salinity and DO is a YSI Model 85. Measurements can be taken directly by lowering the probe to the appropriate depth in the water column. See Procedure 3A for calibration and operating instructions for the YSI 85.

The equipment that will be used to collect turbidity is the HF Scientific DRT-15CE. Samples must be collected from the appropriate depth using a sample collection device and brought to the surface to obtain turbidity measurements. The protocol for collecting water samples from the surface and at depth are described below. See Procedure 3B for calibration and operating instructions for the DRT-15CE.

Collecting Surface Water Sample:

Surface water samples will be collected by either lowering the sampling device directly into the water or collecting a sample using a dedicated bucket or beaker as follows:

- The YSI can be lowered directly into the water to collect temperature, salinity and DO measurements. Utilizing a small weight, lower the probe for the YSI 85 to the appropriate sample depth. Holding the probe as steady as possible, record all measurement parameters as in Procedure 3A.
- The turbidity sample must be collected in a bucket/beaker for measurement. Be sure the bucket/beaker is clean. Do not ever use the bucket/beaker for any other purpose.
- Try not to sample where there is debris floating on the surface. If you must, avoid getting any debris in the sample. If debris is unavoidable, note the fact on your data sheet.
- Lower the bucket/beaker into the water and capture water near the surface. Raise the bucket/beaker and empty the water down-current for a rinse. Do this twice.
- Fill the bucket/beaker again and use this water for your samples and measurements. Pour or drain a sample portion into a turbidimeter cuvette and obtain a turbidity reading as in Procedure 3B.

Collecting Water Sample at Depth:

Water sample will be collected at depth by either lowering the sampling device directly into the water or using a Wildco sampler as follows:

- Complete all data collection for surface samples before collecting samples at depth. If a sounding has not already been taken, measure water depth now.

- Calculate depths at which samples will be collected. The depths vary depending upon the depth of water at each sample location. Samples should be collected at three intervals: surface, mid-depth and bottom. For example, for a 3.5-foot water column, measurements would be recorded for surface and at approximately 1.5 and 3 feet; for a 6-foot water column, measurements would be recorded for surface and at approximately 3 and 6 feet. However, note that the last sample should be collected **no closer than 8 inches** from the bottom.

- The YSI can be lowered directly into the water to collect temperature, salinity and DO measurements. Utilizing a small weight, lower the probe for the YSI 85 to the appropriate sample depth. Holding the probe as steady as possible, record all measurement parameters as in Procedure 3A.

- The turbidity sample must be collected using the Wildco Water Bottle. To prepare the Wildco Water Bottle for use, unwind the line to a length greater than the depth at which you will sample. **Do not detach the line from the winding board**. The messenger should already be on the line.

- Attached to each stopper is a wire with a loop. Use this wire to pull each stopper out of the end of the bottle, and then attach the loop to the metal pin in the trip mechanism nearest that stopper. The sampler is 'set' and ready when both wire loops are attached to the trip pins.

- Rinse the bottle with sea water twice before taking your sample at depth.

- Lower the bottle slowly into the water, holding the messenger securely. Count the depth marks on the line as it goes beneath the surface of the water. **Be certain the messenger remains in hand or is otherwise prevented from falling down the line before you are ready.

- When the bottle is at the desired depth, drop the messenger down the line, tapered nose first, so that it strikes the trip-release pad.

- Raise the bottle on to the boat.

- Pour or drain a sample portion into a turbidimeter cuvette and obtain a turbidity reading as in Procedure 3B.

- Repeat at for bottom sample. Note that the last sample should be collected **no closer than 8 inches** from the bottom.

Be sure to label the depth at which each sample was collected.

PROCEDURE 3
MEASURING WATER QUALITY PARAMETERS

Collect sample data in the following order:

1. Salinity,
2. Dissolved Oxygen (DO)
3. Temperature
   (See Procedure 3A for collecting these three parameters)
4. Turbidity
   (See Procedure 3B for collecting this parameter)

PROCEDURE 3A
SALINITY, DISSOLVED OXYGEN (DO) AND TEMPERATURE
THE YSI MODEL 85.

1) CALIBRATION PROCEDURE

Please see Section 5 of the Operations Manual provided in Appendix C.

One day prior to use, the YSI model 85 should be calibrated. Prior to calibration, the batteries should be replaced and a new membrane added to the measurement cell (see Section 3 of the Operations Manual). An "air" calibration for DO should be performed following Section 5.1 of the manual (use 0 altitude (sea level)). Following this, a "wet" calibration of DO should be performed utilizing a beaker of deionized (DI) water which has been bubbled with an airstone for at least 45 minutes. The probe should be inserted in the beaker with the active airstone and clamped or held in place such that it is not resting on the bottom or placed directly in the bubble stream. Repeating the steps for the "air" calibration, once altitude has been entered, the reading should be identical to the DO saturated level (temperature dependent) listed in Appendix E of the Operations Manual. If it is not, the value should be adjusted to the table value using the arrow keys. Once the reading is stable and equal to the table reading, press "enter".

The meter should also be calibrated for salinity utilizing a 50mS/cm conductivity standard and Section 5.2 of the manual. Record calibration data on the Meter Calibration Form in Appendix B.

NOTE: Do not turn the meter off after calibration. Leave the meter ON following calibration through the end of the sampling period.

2) SAMPLE COLLECTION PROCEDURE

Follow directions found in Section 7 of the Operations Manual in Appendix C.

Measurements are taken directly from the sample bucket. Remember to periodically inspect the membrane on the measurement cell for damage. While taking the reading, swirl the measurement cell around in the sample bucket. Using the "mode" button, cycle between dissolved oxygen (mg/L), conductivity, and salinity. Record salinity, conductivity, temperature and DO data on the Field Data Sheet. Rinse cell with DI water.

If a DO reading at depth drops 2 mg/L below the value of previous sample (although it may start to rise as it equilibrates), the water column is probably experiencing anoxic (<0.5 mg/L DO) or hypoxic (<3.0 mg/L DO) conditions. Anoxic conditions will often be accompanied by elevated levels of H_2S, which can bias the sample. If the Wildco sample smells of H_2S, it can be assumed that anoxic conditions exist, and "< 0.5 mg/L DO" can be recorded on the Field Data Sheet.

PROCEDURE 3B
TURBIDITY
THE DRT-15CE TURBIDIMETER

1) CALIBRATION PROCEDURE

Please see Section VII of the Operating and Maintenance Manual in Appendix D.

At the beginning of the sampling day, the DRT-15CE Turbidimeter should be calibrated. Be sure to bring the calibration standards with you in the field. In order to take and accurate reading, the sample and standard cuvettes need to be clear and unobstructed within the critical measuring area. Wipe clean any smudges or debris using a Kim-wipe (must use Kim-wipes to avoid scratching glass and damaging cuvettes). Record calibration data on Meter Calibration Form in Appendix B.

2) SAMPLE COLLECTION PROCEDURE

Follow directions found in Sections IV-VI and VIII of the Operating and Maintenance Manual in Appendix D.

Collect sample into the cuvette, which can be dipped into the sample bucket or poured from the Wildco sampler, and then wiped dry and clean. Remember to shake the sample prior to taking the reading in order to suspend and settled particles. Record Turbidity on the Field Data Sheet.

APPENDIX B

FIELD DATA SHEET
AND
CALIBRATION FORM

Field Data Sheet
Sunset Acres Case Study
Tavernier, Florida
LAW Project Number 40700-1-2681

Date: _____ / _____ / _____ Start Time: _____

Sampling Team (print name, then sign): End Time: _____

Tides for Today	
Height	Time
High	
Low	

Tide during sampling:

Beaufort Scale (circle one number):		Seastate (circle one):	
Beaufort #	Wind Description	Seastate	Wave Height (m)
0	Calm	Flat	0
1	Light air	Ripples	0.1 – 0.2
2	Light Breeze	Small wavelets	0.3 – 0.5
3	Gentle Breeze	Large wavelets	0.6 – 1.0
4	Moderate Breeze	Whitecaps	1.5
5	Fresh breeze	Moderate waves	2

Wind Direction **from** (use N, NE, NNE, etc.)

Rainfall Last 24 Hours (mm):

Bulk Water Sample:

Debris in Sample? (circle one): YES NO

Comments: _____

_____

Current Direction (use N, NE, NNE, etc.): _____

Current Strength (circle one):

SLACK (no current) MODERATE (obvious)

SLIGHT (perceptible) STRONG (you wouldn't want to swim against it)

Station	Depth (ft)	Time	Salinity (ppt)	Temperature (ºC)	DO (mg/L)	Turbidity NTU	Remarks:

Comments: _____

_____

_____

_____

LAW

LAWGIBB Group Member

METER CALIBRATION FORM

Project Name:_____ **Date:**_____

Project Number:_____ **Phase:**_____ **Task:**_____

Dissolved Oxygen (DO) Meter

Meter ID Number:_____ **Time:**_____ **AM / PM**

Time allowed for calibration solution to reach saturation:

_____Minutes (should be a minimum of 45 minutes)

Temperature of Calibration Solution and Table Value Used:

Temperature:_____°C Value_____ mg/L

Manufacturer:_____ **Lot:**_____

Calibrated By:_____ **Expiration Date:**_____

Conductivity Meter

Meter ID Number:_____ **Time:**_____ **AM / PM**

Standard Used: (Check one):

_____100 µmhos/cm _____1,000 µmhos/cm

_____10,000 µmhos/cm _____100,000 µmhos/cm

Manufacturer:_____ **Lot:**_____

Calibrated By:_____ **Expiration Date:**_____

Turbidimeter

Meter ID Number:_____ **Time:**_____ **AM / PM**

Standard	**Reading**
0.02 ntu	_____ntu
10.00 ntu	_____ntu
100 ntu	_____ntu

Manufacturer:_____

Lot:_____

Expiration Date:_____

1000 ntu _____ntu **Calibrated By:_____**

APPENDIX C

YSI MODEL 85 OPERATIONS MANUAL
DO
SALINITY
TEMPERATURE

YSI *incorporated*

YSI Model 85

Handheld Oxygen, Conductivity, Salinity, and Temperature System

Operations Manual

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SECTION 1 INTRODUCTION

The YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System is a rugged, micro-processor based, digital meter with an attached YSI combination conductivity and dissolved oxygen probe.

The YSI Model 85 is designed for use in field, lab, and process control applications as well as for environmental, aquaculture, and industrial uses. The Model 85 is available with cable lengths of either 10, 25, 50 or 100 feet. The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The probe also utilizes our easy to install cap membranes for measuring dissolved oxygen.

The YSI Model 85 probe is a non-detachable, combination sensor designed specifically for the YSI Model 85 Handheld System. The conductivity portion is a four-electrode cell with a cell constant of 5.0/cm ±4%. The dissolved oxygen portion is a polargraphic Clark type sensor.

The Model 85's microprocessor allows the system to be easily calibrated for dissolved oxygen or conductivity with the press of a few buttons. Additionally, the microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the conductivity cell constant and function of the instrument circuitry.
The system simultaneously displays temperature (in °C), along with one of the following parameters: dissolved oxygen in either mg/L (milligrams per liter) or % air saturation; conductivity; temperature compensated conductivity; (in µS/cm or mS/cm), and salinity (in parts per thousand {ppt}).

The system requires only a single calibration regardless of which dissolved oxygen display you use. The calibration of conductivity is not required but is available. A single calibration will adjust the instrument, regardless if you are reading conductivity or temperature compensated conductivity. You can switch between all of these parameters with the push of a single key.

A calibration\storage chamber is built into the instrument case. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration of the dissolved oxygen probe. This chamber also provides a convenient place to store the probe when the system is not in use, and provides protection for the electrodes within the conductivity probe. The Model 85 case is also waterproof (rated to IP65). You can operate your Model 85 in the rain without damage to the instrument.

Six AA-size alkaline batteries power the instrument. A new set of alkaline batteries will provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message.

SECTION 2 PREPARING THE METER

2.1 UNPACKING

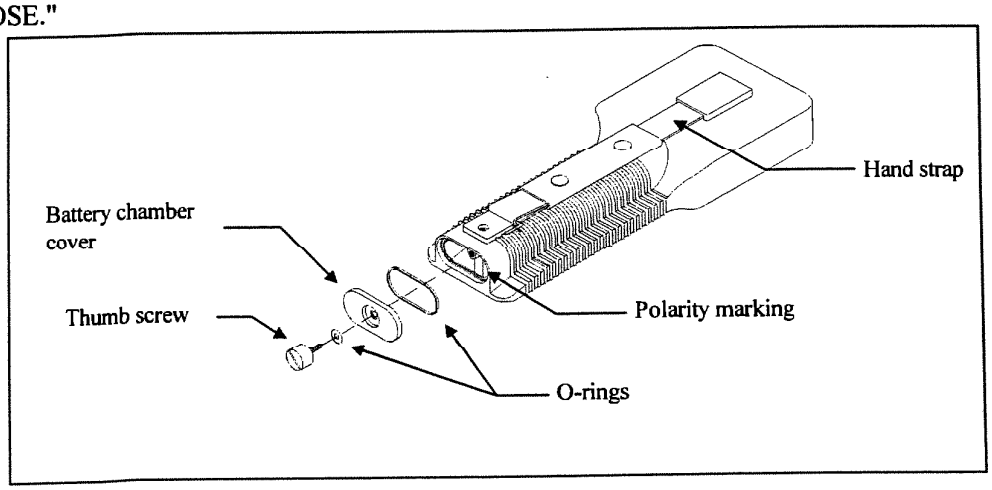
When you unpack your new YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System for the first time, check the packing list to make sure you have received everything you should have. If there is anything missing or damaged, call the dealer from whom you purchased the Model 85. If you do not know which of our authorized dealers sold the system to you, call YSI Customer Service at 800-765-4974 or 937-767-7241, and we'll be happy to help you.

2.2 WARRANTY CARD

Before you do anything else, please complete the Warranty Card and return it to YSI. This will record your purchase of this quality instrument in our computer system. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI Model 85 should ever need repair and we will be able to quickly verify the warranty period.

2.3 BATTERIES

There are a few things you must do to prepare your YSI Model 85 for use. First, locate the six AA-size alkaline batteries that were included in your purchase. Use a screwdriver or a small coin to remove the thumbscrew on the bottom of the instrument. This thumbscrew holds the battery-chamber cover in place. The battery-chamber cover is marked with the words "OPEN" and "CLOSE."



NOTE: On some models, the battery cover thumbscrew may be unscrewed by hand (a screwdriver may not be required).

There is a small label inside each of the two battery-chamber sleeves. These labels illustrate the correct way to install the batteries into each sleeve of the battery-chamber.

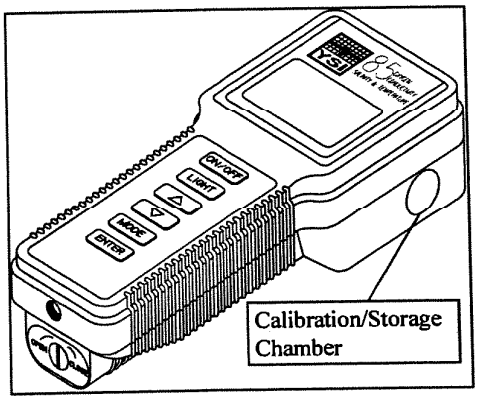
NOTE: It is very important that the batteries be installed ONLY as illustrated. The instrument will not function and may be damaged if the batteries are installed incorrectly.

Turn the instrument on by pressing and releasing the **ON/OFF** button on the front of the instrument. The liquid crystal display (LCD) should come on. Allow a few seconds for the instrument to complete its diagnostic routine. Notice that the instrument will display the specific cell constant of the conductivity probe during this diagnostic routine. If the instrument does not operate, consult the section entitled Troubleshooting.

You may also want to take the instrument into a dark room and with the instrument ON, hold down the **LIGHT** button. The instrument backlight should illuminate the LCD so that the display can be easily read.

2.4 CALIBRATION/STORAGE CHAMBER

The Model 85 has a convenient calibration storage chamber built into the instruments' side. This chamber provides an ideal storage area for the probe during transport and extended non-use. If you look into the chamber you should notice a small round sponge in the bottom of the chamber. Carefully put 3 to 6 drops of clean water into the sponge. Turn the instrument over and allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for the probe, which is ideal for dissolved oxygen calibration.



2.5 HAND STRAP

The hand strap is designed to allow comfortable operation of the Model 85 with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be easily dropped or bumped from your hand. See figure on previous page.

To adjust the hand strap on the back of the meter, unsnap the vinyl cover and pull the two Velcro strips apart. Place your hand between the meter and the strap and adjust the strap length so that your hand is snugly held in place. Press the two Velcro strips back together and snap the vinyl cover back into place.

2.6 THE METER CASE

The meter case is sealed at the factory and is not intended to be opened, except by authorized service technicians. Do not attempt to separate the two halves of the meter case as this may damage the instrument, break the waterproof seal, and will void the manufacturer's warranty.

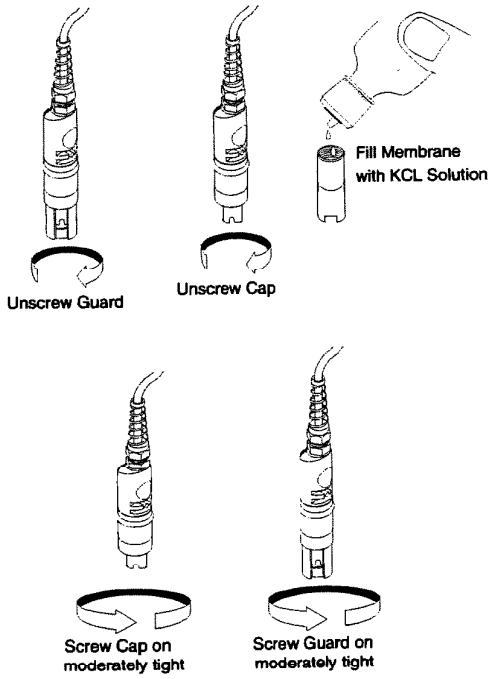
SECTION 3 PREPARING THE PROBE

The YSI Model 85 dissolved oxygen probe is shipped dry. The protective membrane cap on the probe tip must be removed and replaced with KCl solution and a new membrane cap before using the probe. Follow the instructions below to install KCl solution and the new membrane cap.

3.1 MEMBRANE CAP INSTALLATION

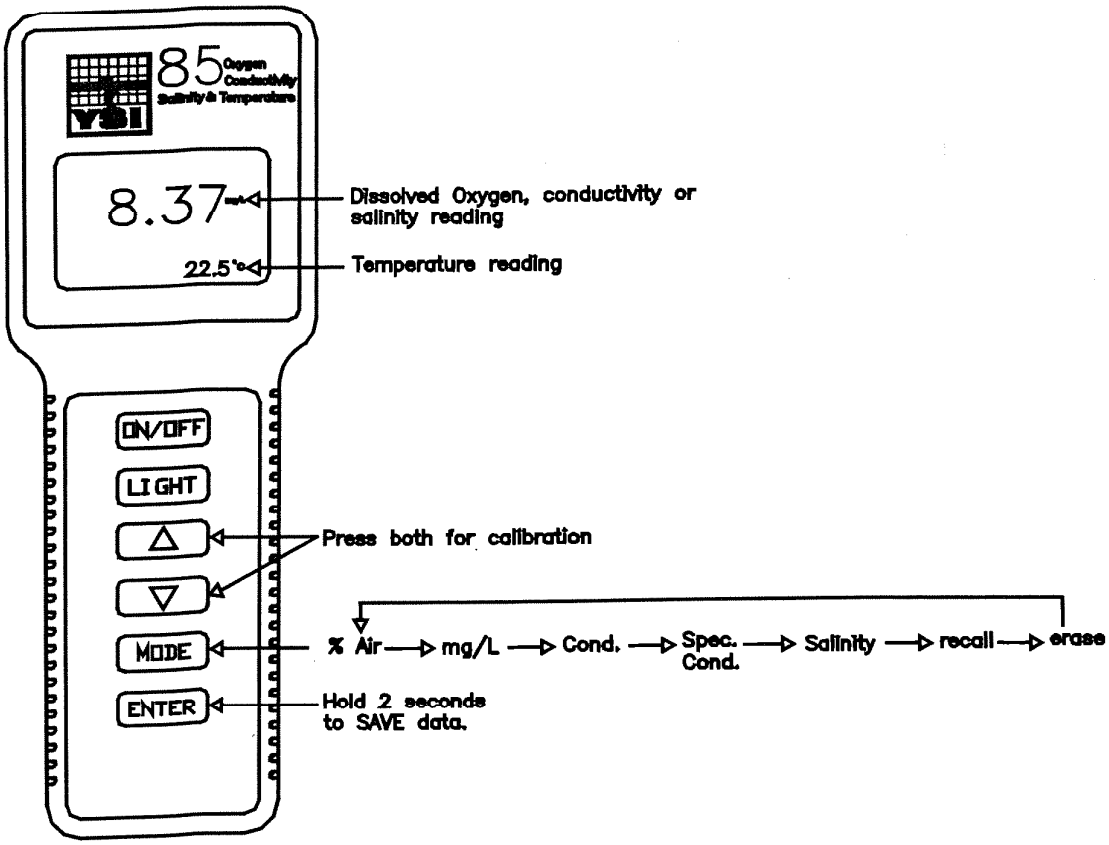
To install a new membrane on your YSI Model 85 dissolved oxygen probe:

1. Unscrew and remove the probe sensor guard.
2. Unscrew and remove the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the KCl solution bottle.
5. Hold the membrane cap and fill it at least 1/2 full with the electrolyte solution.
6. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
7. Screw the probe sensor guard on moderately tight.



SECTION 4 OVERVIEW OF OPERATION

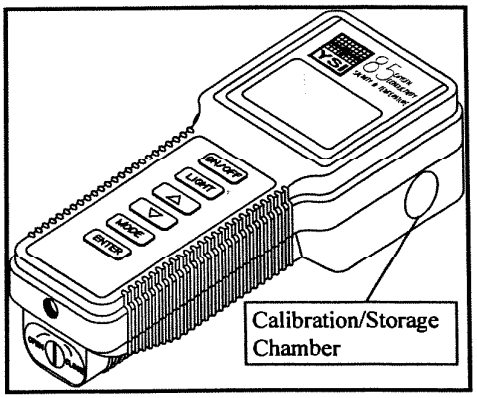
The following diagram is an overview of the operation of the Model 85. See the following sections for details of operation.



SECTION 5 CALIBRATION

5.1 CALIBRATION OF DISSOLVED OXYGEN

To accurately calibrate the YSI Model 85 you will need to know the approximate altitude of the region in which you are located.



1. Ensure that the sponge inside the instrument's calibration chamber is wet. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Press the **MODE** button until dissolved oxygen is displayed in mg/L or %. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required).

3. Use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** buttons at the same time.

4. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the **ENTER** button once.

EXAMPLE: Entering the number 12 here indicates 1200 feet.

5. The Model 85 should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current % reading (before calibration) should be on the main display. Make sure that the current % reading (large display) is stable, then press the **ENTER** button. The display should read **SAVE** then should return to the Normal Operation Mode.

Each time the Model 85 is turned off, it may be necessary to re-calibrate before taking measurements. All calibrations should be completed at a temperature which is as close as possible to the sample temperature. Dissolved oxygen readings are only as good as the calibration.

5.2 CALIBRATION OF CONDUCTIVITY

IMPORTANT: System calibration is rarely required because of the factory calibration of the YSI Model 85. However, from time to time it is wise to check the system calibration and make adjustments when necessary.

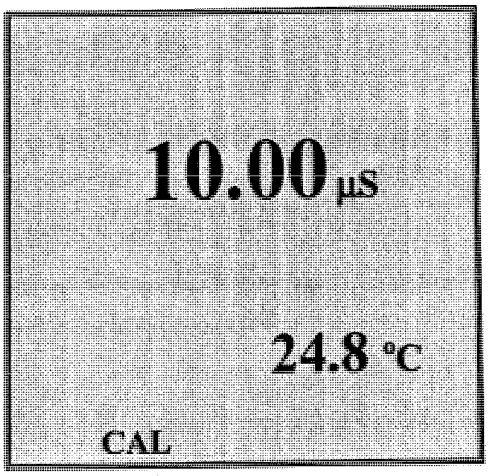
Prior to calibration of the YSI Model 85, it is important to remember the following:

1. Always use clean, properly stored, NIST traceable calibration solutions (see Accessories and Replacement Parts). When filling a calibration container prior to performing the calibration procedures, make certain that the level of calibrant buffers is high enough in the container to cover the entire probe. Gently agitate the probe to remove any bubbles in the conductivity cell.
2. Rinse the probe with distilled water (and wipe dry) between changes of calibration solutions.
3. During calibration, allow the probe time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration process. The readings after calibration are only as good as the calibration itself.
4. Perform sensor calibration at a temperature as close to 25°C as possible. This will minimize any temperature compensation error.

Follow these steps to perform an accurate calibration of the YSI Model 85:

1. Turn the instrument on and allow it to complete its self-test procedure.
2. Select a calibration solution that is most similar to the sample you will be measuring.
   - For sea water choose a 50 mS/cm conductivity standard (YSI Catalog# 3169)
   - For fresh water choose a 1 mS/cm conductivity standard (YSI Catalog# 3167)
   - For brackish water choose a 10 mS/cm conductivity standard (YSI Catalog # 3168)
3. Place at least 3 inches of solution in a clean glass beaker.
4. Use the **MODE** button to advance the instrument to display conductivity.
5. Insert the probe into the beaker deep enough so that the oval-shaped hole on the side of the probe is completely covered. Do not rest the probe on the bottom of the container -- suspend it above the bottom at least 1/4 inch.
6. Allow at least 60 seconds for the temperature reading to become stable.
7. Move the probe vigorously from side to side to dislodge any air bubbles from the electrodes.
8. Press and release the **UP ARROW** and **DOWN ARROW** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration mode.



9. Use the **UP ARROW** or **DOWN ARROW** button to adjust the reading on the display until it matches the value of the calibration solution you are using.
10. Once the display reads the exact value of the calibration solution being used (the instrument will make the appropriate compensation for temperature variation from 25°C), press the **ENTER** button once. The word "**SAVE**" will flash across the display for a second indicating that the calibration has been accepted.

The YSI Model 85 is designed to retain its last conductivity calibration permanently. Therefore, there is no need to calibrate the instrument after battery changes or power down.

SECTION 6 ADVANCED CONDUCTIVITY SETUP

The default settings of the YSI Model 85 are appropriate for the vast majority of measurement applications. However, some measurement applications require very specific measurement criteria. For that reason, we have made the YSI Model 85 flexible to accommodate these "advanced users."

If, for example, you are using the YSI Model 85 for a process control application that requires that the conductivity readings be compensated to 20 °C instead of 25 °C -- this is the section to read. Or, if your application for the YSI Model 85 involves the measurement of a very specific saline solution, the default temperature coefficient may need to be changed to get the very best measurement of that specific salt.

IMPORTANT: There is never a need to enter Advanced Setup Mode unless your special measurement application calls for a change in reference temperature and or temperature coefficient. Therefore, unless you are certain that your application requires a change to one or both of these criteria, do not modify the default reference temperature (25°C) or the default temperature coefficient (1.91%).

6.1 CHANGING THE TEMPERATURE COEFFICIENT

Follow these steps to modify the temperature coefficient of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new temperature coefficient.
5. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
6. Press the **MODE** button to return to normal operation; the CAL symbol will disappear from the display.

6.2 CHANGING THE REFERENCE TEMPERATURE

Follow these steps to modify the reference temperature of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Press and release the **MODE** button; the large portion of the display will show **25.0C** (or a value set previously using Advanced Setup).
5. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new reference temperature (any value between 15 °C and 25 °C is acceptable).
6. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
7. The instrument will automatically return to normal operation mode.

6.3 CHANGING FROM AUTORANGING TO MANUAL RANGING

If your application is easier to perform using a manual range that you select, the YSI Model 85 allows you to turn off the default autoranging feature. While you are making conductivity or temperature compensated conductivity measurements, simply press and release the **UP ARROW** button. Each additional press of the **UP ARROW** button will cycle the Model 85 to a different manual range until you return again to autoranging. Five pushes of the **UP ARROW** button will cycle the Model 85 through the four manual ranges and return the instrument to autoranging.

NOTE: You may see an error message in some manual ranges if the manual range selected is not adequate for the sample you are measuring. If this happens, simply press and release the **UP ARROW** button again until a range is selected which is suitable for your sample. If you get lost and don't know if you're in a manual range or autoranging, simply turn the instrument off and back on. Also note that the conductivity units will flash while you are in manual range. The instrument will always default to autoranging when first turned on.

The four ranges of the YSI Model 85 are:

Range 1	Range 2	Range 3	Range 4
0 to 499.9 µS/cm	0 to 4999 µS/cm	0 to 49.99 mS/cm	0 to 200.0 mS/cm

SECTION 7 MAKING MEASUREMENTS

7.1 TURNING THE INSTRUMENT ON

Once the batteries are installed correctly, press the **ON/OFF** button. The instrument will activate all segments of the display for a few seconds, which will be followed by a self-test procedure that will last for several more seconds. During this power on self-test sequence, the instrument's microprocessor is verifying that the instrument is working properly. The Model 85 will display the cell constant of the conductivity probe when the self-test is complete. If the instrument were to detect an internal problem, the display would show a **continuous** error message. See the section entitled Troubleshooting for a list of these error messages.

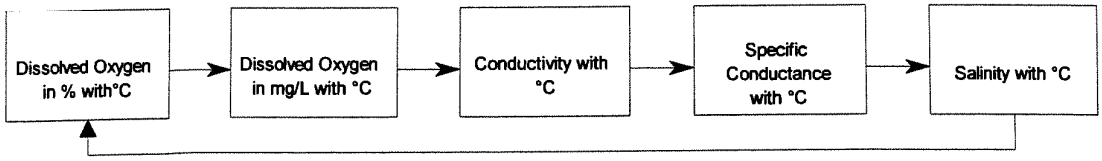
7.2 THE MEASUREMENT MODES OF THE MODEL 85

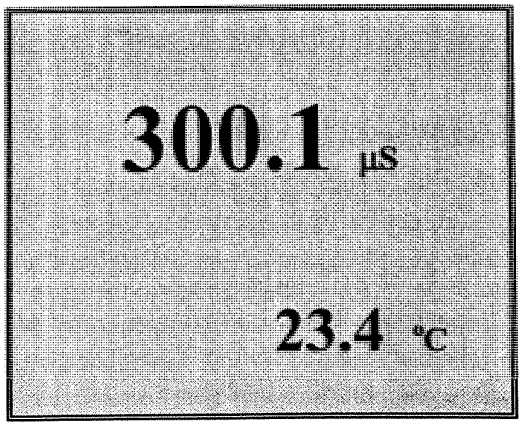
The Model 85 is designed to provide six distinct measurements:

- **Dissolved Oxygen %** -- A measurement of oxygen in percent of saturation.
- **Dissolved Oxygen mg/L** -- A measurement of oxygen in mg/L
- **Conductivity** -- A measurement of the conductive material in the liquid sample without regard to temperature
- **Specific Conductance** -- Also known as temperature compensated conductivity which automatically adjusts the reading to a calculated value which would have been read if the sample had been at 25° C (or some other reference temperature which you choose). See Advanced Setup.
- **Temperature** -- which is always displayed.
- **Salinity** -- A calculation done by the instrument electronics, based upon the conductivity and temperature readings.

NOTE: When you turn the Model 85 off, it will "remember" which mode you used last and will return to that mode the next time the instrument is turned on.

To choose one of the measurement modes above (temperature is always displayed) simply press and release the **MODE** button. Carefully observe the small legends at the far right side of the LCD.





If the instrument is reading **Specific Conductance** the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally the small portion of the display will show the **° C** flashing on and off.

If the instrument is reading **Conductivity** (not temperature compensated) the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally the small portion of the display will show the **° C** <u>**NOT**</u> flashing.

If the instrument is reading **Dissolved Oxygen** the large numbers on the display will be followed by either a mg/L or %. It is important to remember that the dissolved oxygen probe is stirring dependent. This is due to the consumption of oxygen at the sensor tip during measurement. When taking dissolved oxygen measurements the probe must be moved through the sample at a rate of 1 foot per second to provide adequate stirring.

If the instrument is reading **Salinity** the large numbers on the display will be followed by a **ppt.**

7.3 AUTORANGING & RANGE SEARCHING

The YSI Model 85 is an autoranging instrument. This means that regardless of the conductivity or salinity of the solution (within the specifications of the instrument) all you need to do to get the most accurate reading is to put the probe in the sample. This feature makes the Model 85 as simple as possible to operate.

When you first place the Model 85 probe into a sample or calibration solution, and again when you first remove the probe the instrument will go into a range search mode that may take as long as 5 seconds. During some range searches the instrument display will flash **rANG** to indicate its movement from one range to another. The length of the range search depends on the number of ranges that must be searched in order to find the correct range for the sample. During the range search, the instrument will appear to freeze on a given reading for a few seconds then, once the range is located, will pinpoint the exact reading on the display. The display may also switch to **00.0** for a second or two during a range search before it selects the proper range.

7.4 THE BACKLIGHT

At times it may be necessary to take measurements with the Model 85 in dark or poorly lit areas. To help in this situation, the Model 85 comes equipped with a backlight that will illuminate the display so that it can be easily read. To activate the backlight, press and hold the **LIGHT** button. The

display will remain lit as long as the button is depressed. When you release it, the light goes out to preserve battery life.

5. When the correct site ID# is displayed, press the **ENTER** button to display the data.

6. When you have finished recalling data, press the **MODE** button to return to normal operation.

NOTE: The Model 85 will recall data as a list. When the **UP ARROW** is depressed the Model 85 will display the Site ID# for the previously recorded date. For example: If you are reviewing Site ID# 5 and the **UP ARROW** is depressed the Model 85 will display Site ID# 4. If you are reviewing Site ID# 5 and Site ID# 5 was the last set of data stored the **DOWN ARROW** button will display Site ID# 1.

Here is an example of the Model 85 memory.
Site ID #1
Site ID #2
Site ID #3 ←—If the **UP ARROW** button was pressed the Model 85 would display Site ID #2
Site ID #4
Site ID #5

8.3 ERASING STORED DATA

1. To erase the data that is stored into the Model 85's memory, depress the **MODE** button repeatedly until the Model 85 displays **ErAS** on the screen. (see figure #2)

2. Depress and hold the **DOWN ARROW** and **ENTER** buttons simultaneously for approximately 5 seconds.

3. The Model 85 flashing DONE on the display for 1 to 2 seconds indicates successful erasure. The instrument will automatically change to normal operation after completion.

IMPORTANT: Data in all 50 site ID's will be erased completely and will be lost forever. Do not use the erase function until all recorded data has been transcribed to an archive outside the Model 85.

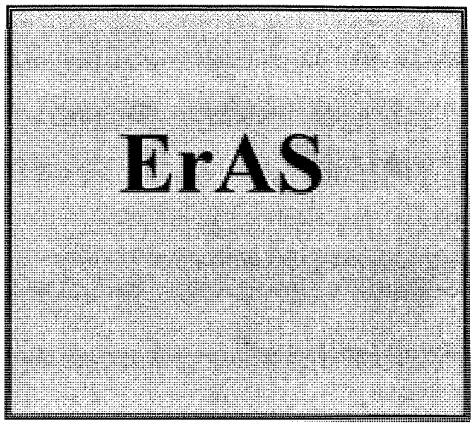


figure #2

SECTION 9 MAINTENANCE

9.1 CLEANING AND STORAGE

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it.

NOTE: ALWAYS RINSE THE CONDUCTIVITY CELL WITH CLEAN WATER AFTER EACH USE.

To clean the conductivity cell:

1. Dip the cell in cleaning solution and agitate for two to three minutes. Any one of the foaming acid tile cleaners, such as Dow Chemical Bathroom Cleaner, will clean the cell adequately. When a stronger cleaning preparation is required, use a solution of 1:1 isopropyl alcohol and 10N HCl. Remove the cell from the cleaning solution.

2. Use the nylon brush (supplied) to dislodge any contaminants from inside the electrode chamber.

3. Repeat steps one and two until the cell is completely clean. Rinse the cell thoroughly in deionized, or clean tap water.

4. Store the conductivity cell in the meter storage chamber.

NOTE: See Section 11, Dissolved Oxygen Probe Precautions for instructions on cleaning the dissolved oxygen electrodes.

SECTION 10 PRINCIPLES OF OPERATION

The dissolved oxygen sensor utilizes an oxygen permeable membrane that covers an electrolytic cell consisting of a gold cathode and a porous silver anode. This membrane acts as a diffusion barrier and an isolation barrier preventing fouling of the cathode surface by impurities in the environment. Upon entering the cell through the membrane, oxygen is reduced at an applied potential of -0.8 V referenced to the silver electrode. The reduction current at the cathode is directly proportional to the partial pressure of oxygen in liquid (expressed as %-air saturation) which is proportional to the concentration of dissolved oxygen (in mg/L) at a particular temperature. Thus the same partial pressure of oxygen (% air-saturation) in liquid gives different concentrations of dissolved oxygen (mg/L) at different temperatures because of the different solubility's of oxygen at different temperatures.

The conductivity cell utilizes four pure nickel electrodes for the measurement of solution conductance. Two of the electrodes are current driven, and two are used to measure the voltage drop. The measured voltage drop is then converted into a conductance value in milli-Siemens (millimhos). To convert this value to a conductivity (specific conductance) value in milli-Siemens per cm (mS/cm), the conductance is multiplied by the cell constant that has units of reciprocal cm (cm^{-1}). The cell constant for the Model 85 conductivity cell is 5.0/cm $\pm$ 4%. For most applications, the cell constant is automatically determined (or confirmed) with each deployment of the system when the calibration procedure is followed. Solutions with conductivity's of 1.00, 10.0, 50.0, and 100.0 mS/cm, which have been prepared in accordance with recommendation 56-1981 of the Organisation Internationale de Métrologie Légale (OIML) are available from YSI. The instrument output is in µS/cm or mS/cm for both conductivity and specific conductance. The multiplication of cell constant times conductance is carried out automatically by the software.

10.1 TEMPERATURE EFFECT ON CONDUCTIVITY

The conductivity of solutions of ionic species is highly dependent on temperature, varying as much as 3% for each change of one degree Celsius (temperature coefficient = 3%/C). In addition, the temperature coefficient itself varies with the nature of the ionic species present.

Because the exact composition of a natural media is usually not known, it is best to report a conductivity at a particular temperature, e.g. 20.2 mS/cm at 14 C. However, in many cases, it is also useful to compensate for the temperature dependence in order to determine at a glance if gross changes are occurring in the ionic content of the medium over time. For this reason, the Model 85 software also allows the user to output conductivity data in either raw or temperature compensated form. If "Conductivity" is selected, values of conductivity that are NOT compensated for temperature are output to the display. If "Specific Conductance" is selected, the Model 85 uses the temperature and raw conductivity values associated with each determination to generate a specific conductance value compensated to a user selected reference temperature (see Advanced Setup) between 15 C and 25 C. Additionally the user can select any temperature coefficient from 0% to 4%

(see Advanced Setup). Using the Model 85 default reference temperature and temperature coefficient (25 C and 1.91%), the calculation is carried out as in equation (1) below:

$$\text{Specific Conductance}(25°C) = \frac{\text{Conductivity}}{1 + TC * (T - 25)}$$

As noted above, unless the solution being measured consists of pure KCl in water, this temperature compensated value will be somewhat inaccurate, but the equation with a value of TC = 0.0191 will provide a close approximation for solutions of many common salts such as NaCl and NH_4Cl and for seawater.

Salinity is determined automatically from the Model 85 conductivity readings according to algorithms found in Standard Methods for the Examination of Water and Wastewater (ed. 1989). The use of the Practical Salinity Scale 1978 results in values which are unitless, since the measurements are carried out in reference to the conductivity of standard seawater at 15 C. However, the unitless salinity values are very close to those determined by the previously-used method where the mass of dissolved salts in a given mass of water (parts per thousand) was reported. Hence, the designation "ppt" is reported by the instrument to provide a more conventional output.
For further information on conductivity and the above standard information, refer to the ASTM document, Standard Methods of Test for Electrical Conductivity of Water and Industrial Wastewater, ASTM Designation D1125-82, and OIML Recommendation Number 56. ASTM symbols for conductivity, cell constant, and path length differ from those preferred in the general literature and also from those used in this manual.

SECTION 11 DISCUSSION OF MEASUREMENT ERRORS

11.1 DISSOLVED OXYGEN MEASUREMENT ERRORS

There are three basic types of error. Type 1 errors are related to limitations of instrument design and tolerances of instrument components. These are chiefly the meter linearity and the resistor tolerances. Type 2 errors are due to basic probe accuracy tolerances, chiefly background signal, probe linearity, and variations in membrane temperature coefficient. Type 3 errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, type 3 errors are appropriately reduced.

The sample calculations that follow are for a near extreme set of conditions.

TYPE 1 ERRORS

A. Meter linearity error: ±1% of full scale reading, or ±0.15 mg/l

B. Component and circuitry error: ±0.05 mg/l

TYPE 2 ERRORS

A. Temperature compensation for membrane temperature coefficient: ±0.03 mg/l

B. Temperature measurement errors: A maximum ±0.2°C probe error is equal to ±0.14 mg/l

TYPE 3 ERRORS

A. Altitude:

A 1000-foot change in altitude is equal to an error of approximately 3% at the 10 mg/l level.

B. Humidity:

Errors occur if calibration is performed at less than 100% humidity. The error varies with the temperature as follows:

TEMPERATURE	ERROR
0°C	0.02 mg/l
10°C	0.05 mg/l
20°C	0.12 mg/l
30°C	0.27 mg/l
40°C	0.68 mg/l

APPROXIMATING THE ERROR

It is unlikely that the actual error in any measurement will be the maximum possible error. A better error approximation is obtained using a root mean squared (r.m.s.) calculation:

$$\text{r.m.s. error} = \pm[1a^2 + 1b^2 + 2a^2 + 2b^2 + 3a^2 + 3b^2]^{1/2} \text{ mg/l}$$

11.2 CONDUCTIVITY MEASUREMENT ERRORS

System accuracy for conductivity measurements is equal to the sum of the errors contributed by the environment and the various components of the measurement setup. These include:

- Instrument accuracy
- Cell-constant error
- Solution temperature offset
- Cell contamination (including air bubbles)
- Electrical noise
- Galvanic effects

Only the first three are of major concern for typical measurements, although the user should also be careful to see that cells are clean and maintained in good condition at all times.

Instrument Accuracy = ± .5% maximum
The accuracy specified for the range being used is the worst case instrument error.

Cell-Constant Error = ± .5% maximum
Although YSI cells are warranted to be accurate to within one percent, you should still determine the exact cell constant of your particular cell. Contamination or physical damage to the cell can alter the cell constant. Performing a calibration will eliminate any error that might arise because of cell constant change.

YSI cells are calibrated to within one percent of the stated cell constant at a single point. We consider these products to be usefully linear over most instrument ranges. The cell constant can be calibrated to ±0.35% accuracy with YSI conductivity calibrator solutions.

Temperature Error = ± 1% maximum
The solution temperature error is the product of the temperature coefficient and the temperature offset from 25 C, expressed as a percentage of the reading that would have been obtained at 25 C. The error is not necessarily a linear function of temperature. The statement of error is derived from a 25 C temperature offset and a 3%/ C temperature coefficient.

Total Error
Considering only the above three factors, system accuracy under worst case conditions will be ±2%, although the actual error will be considerably less if recommended and properly calibrated cells and instrument ranges are used. Additional errors, which can essentially be eliminated with proper handling, are described below.

Cell Contamination
This error is usually due to contamination of the solution being measured, which occurs when solution is carried-over from the last solution measured. Thus, the instrument might be correctly