WQ-NO3 with WQSensors Software

Smart Sensors
Powerful Software

12.59 ppm

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What is a WQSensor?

WQSensors offer the latest in smart sensor technology with direct computer interface. An integral USB connector offers a simple, hassle-free connection without meters, batteries, or power supplies - displaying the data in real-time directly onto the PC. Common water quality parameters include: temperature, dissolved oxygen, pH, ORP, NO_3, NH_4, and Cl.

Every sensor ships with WQSensor Software, which offers a simple graphical interface to the smart sensors. The software includes the popular NexSens SCIENCE LIBRARY with an interactive periodic table, unit converter, and other useful science utilities. Download a FREE copy today!

Software Installation

WQSensor Software is distributed on CD-ROM. The setup program starts automatically when the CD is inserted. If the program does not load automatically, you can manually start the setup process by running Setup.exe from the CD ROM drive. We suggest that you accept the default options presented by the WQSensor Software setup program.

Uninstalling WQSensors Software

If you need to uninstall WQSensor Software, click **Settings** in the **Start Menu**. Select **Control Panel**, followed by **Add / Remove Programs**. Follow the step-by-step instructions to remove WQSensor Software and all associated files.

1 Sensor Operation

1.1 Ion Selective Electrode Sensors

1.1.1 WQ-NO3 – Nitrate ISE Sensor

WQSensor probes come ready to go and with most of the accessories you will need. Additionally, you will need calibration buffers and calibration beakers or containers. These items should be located in any lab where WQSensors will be used, or they can be purchased from a local chemical supplier. These supplies may also be purchased from a NexSens Technology dealer:

http://www.nexsens.com/company/where_to_buy.htm

WQ-NO3 Sensor

These replaceable tip sensors offer ion specific measurements. An internally stored unique ID and GLP file ensures quality data, and tracks calibration and sensor status.

Nitrate Package Includes:

- WQ-NO3: ISE sensor with 6 feet of cable and integral USB connector and NO3 module.
- NO_3 Standard: 1000 ppm NO_3^- as $N-NO_3^-$
- NO_3 Fill Solution: $0.04(NH_4)SO_4$
- NO_3 ISA 2M $(NH_4)SO_4$
- ISE storage bottle
- WQSensor Software & Knowledge Library CD
- WQSensor Quick Start Guide

WQ-NO3 Sensor Specifications

|		
Concentration Range	0.1 ppm to 14,000ppm (7 x10^{-6}M to 1 M)	
Temperature Range	0 to 50°C	
pH range	2.5 to 11 pH	
Reproducibility	±4%	
Known Interferences	ClO_4^-, I^-, ClO_3^-, F^-	
Minimum Sample Size	3 mL in a 50 mL beaker	
Size:	Electrode length	155 mm
	Body Diameter	12 mm
	Cap Diameter	16 mm
	Cable Length	6 ft.

1.1.2 Making ISE Sensor Measurements

Preparing ISE Sensors for Measurements

1. Remove the protective cap covering the sensor tip.

   Caution: Do not touch the sensing element with your fingers.

2. The Reference Fill Solution in the reference chamber should be above the reference fill line in the electrode. If the reference fill solution is below this line, add Reference Fill Solution from the bottle provided. To fill, slide the sleeve of the electrode Fastfill cap down to uncover the fill holes.

3. Shake the electrode downwards like a thermometer to remove any air bubbles trapped inside. Make sure to slide the Fastfill sleeve to the closed position.

4. Rinse the electrode with distilled or de-ionized water, blot dry. Do not rub dry.

5. Immerse the tip of the electrode in distilled or de-ionized water and stir the water for 5 minutes. This will properly clean the electrode.
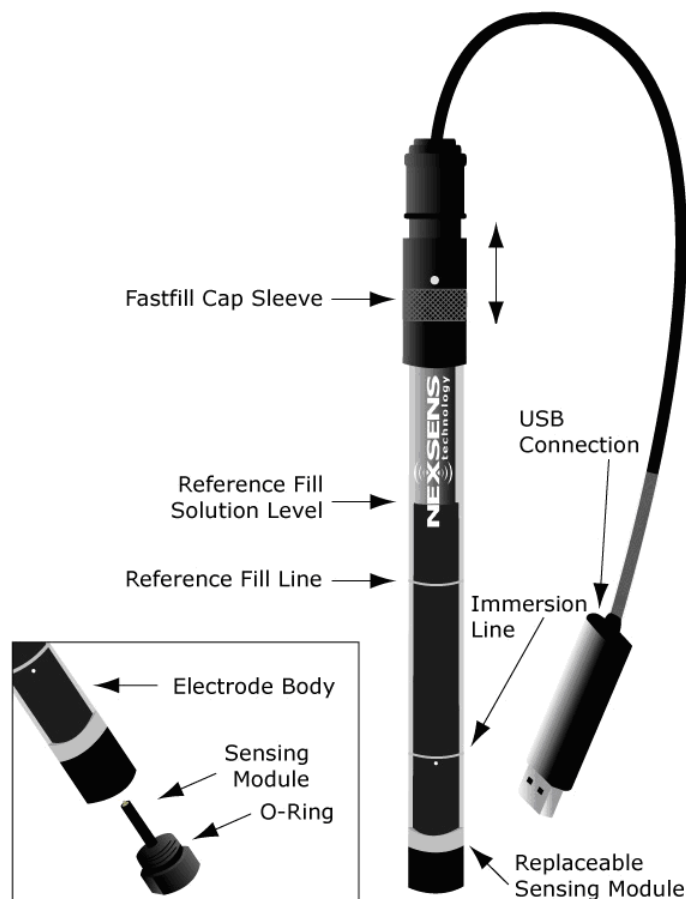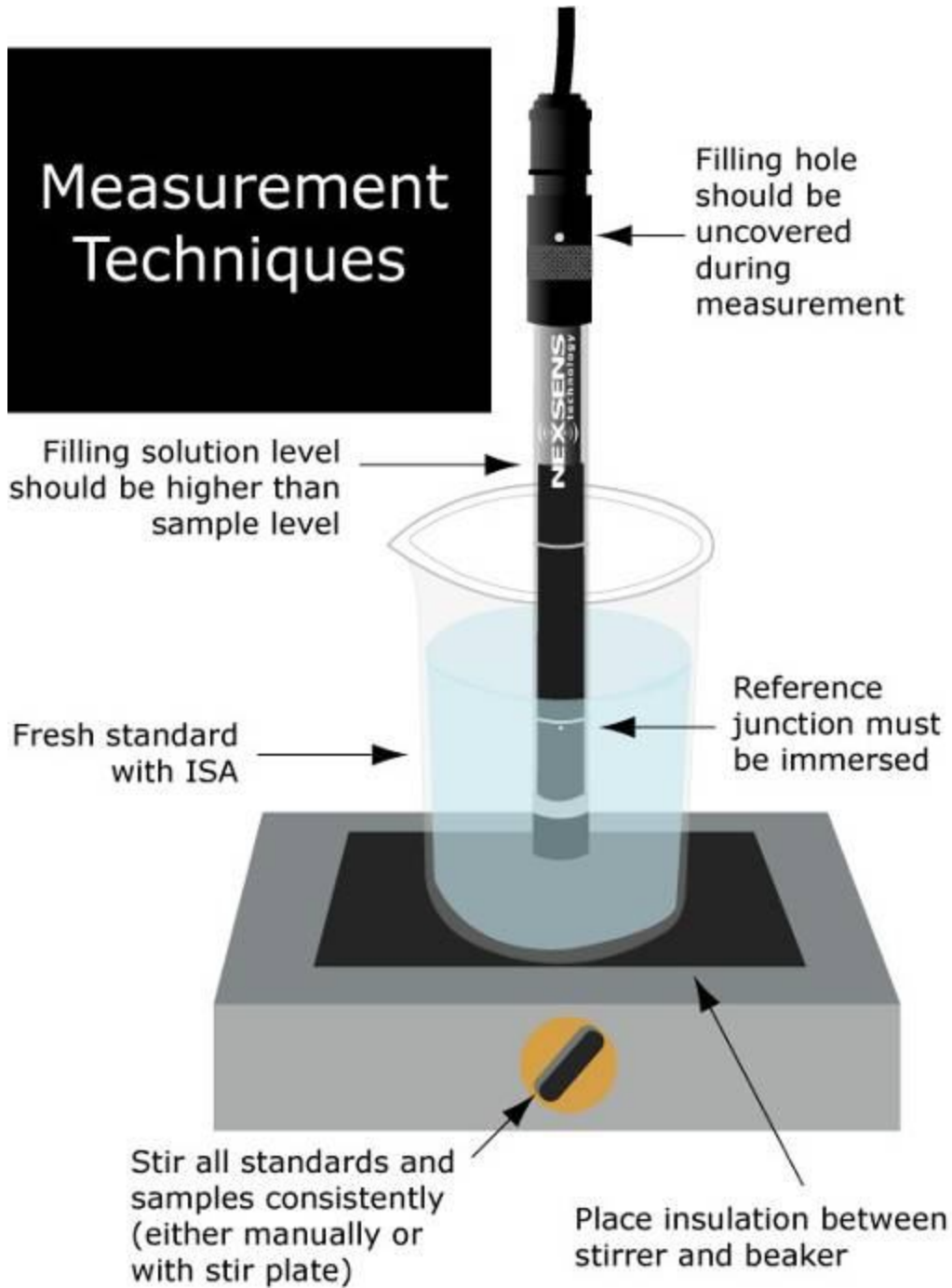
Making ISE Sensor Measurements

The quality of results depends on the quality and accuracy of the measurement technique and standards used. The following guidelines are recommended.

1. Prepare fresh standards for calibration daily. Prepare at least two standard solutions that differ in concentration by a factor of 10 and bracket the expected sample values. The standards are typically prepared by diluting a 1000 ppm stock solution of the ion to be measured. Use high quality distilled or deionized water for dilution.

2. Always add ISA to ensure that all samples and standards have a similar ionic strength. Use ISA in a 50:1 sample to ISA ratio for the WQ-NO$_3$ probe.*

3. Calibrate and measure all samples and standards at the same temperature (within 1°C). If temperature changes occur, the sensor should be recalibrated.

4. Always have the FastFill sleeve open during measurements. This puts atmospheric pressure on the reference fluid giving a more reproducible flow out of the junction.

5. After immersion in solution, check the electrode for any air bubbles on the sensing element. Remove any air bubbles by gently tapping on the electrode.

6. Make sure that the Reference Filling Solution level is higher than the sample level.

7. Make sure that the sample level covers the immersion line on probe.

8. Stirring is recommended as it decreases the amount of time needed to reach equilibrium. Stir thoroughly at a slow to moderate speed, using either a magnetic stirrer or the probe as a stirring rod. Stirring rate should be consistent among all standards and samples.

   Note: Magnetic stirrers may generate enough heat to change solution temperature. A piece of insulating material such as cork, cardboard, or styrofoam between the stir plate and beaker will help prevent heat transfer.

9. Always rinse electrodes with distilled or deionized water between measurements. Blot dry. Never rub dry.

10. Concentrated samples (over 0.1 M) should be diluted before measurement.

*Note: The WQ-NO$_3$ sensor functions in a pH range of 2.5-11. The addition of a buffer to the ISA will adjust standards and samples to the desired pH value. More complex ISA formulations can include additives that complex possible interferences. Interfering ions for the WQ-NO$_3$ include: ClO_4^-, I^-, ClO_3^- and F^-.

Measurement Techniques

Filling hole should be uncovered during measurement

Filling solution level should be higher than sample level

Reference junction must be immersed

Fresh standard with ISA

Stir all standards and samples consistently (either manually or with stir plate)

Place insulation between stirrer and beaker

Calibrating ISE Sensors

Prepare two standard solutions that differ in concentration by a factor of ten and bracket the expected sample concentration range (i.e 10 ppm & 100 ppm standard if measuring samples between 20 and 50 ppm). Standards should be made fresh daily. The standards should be at the same temperature as the sample.

During or after calibration, observe the mV reading slope. Slope is defined as the change in millivolts observed with every ten-fold change in concentration.

- A WQ-NO_3 sensor slope should typically be between 57.1 mV +/- 5mV at 25 °C per decade of concentration. Every 1/2 a degree in temperature generally moves this value up or down 0.1 mV.

Observing the slope value provides the best means for checking electrode performance. This can be done by checking the GLP file or by turning on mV in the **Settings** menu during calibration.

1. Connect the ISE sensor to the PC via the USB connector.

2. Slide the sleeve of the electrode FastFil cap down to uncover the fill holes.

3. Place 100 mL of the lower concentration standard into a 150 mL beaker. Add 2 mL of ISA.* Stir thoroughly.

4. Rinse electrode with distilled or de-ionized water, blot dry, and then place in the beaker. Current readings in concentration and mV will appear on the screen. Wait for the mV readings to stabilize, this could take 1-2 minutes.

5. Press the Calibrate button and click on the ISE ppm reading. Enter the concentration value of the first standard and press the **Calibrate** button.

6. Place 100 mL of the higher concentration standard into a second 150 mL beaker. Add 2 mL of ISA. * Stir thoroughly.

7. Rinse electrode with distilled or de-ionized water, blot dry and place in the second beaker. Current readings in concentration and mV will appear on the screen. Wait for the readings to stabilize, this could take 1-2 minutes.

8. Press the **Calibrate** button and click on the ISE ppm reading. Enter the concentration value of the second standard and press the **Calibrate** button.

ISE sensors should be calibrated as often as possible, such as each day before use. For maximum accuracy, calibrate every one to two hours. Calibration drift can be checked by immersing the probe in standard. If the value has changed significantly since calibration, recalibrate.

***Note**: A smaller volume of standard and ISA may be used, but ensure the standard covers the immersion line indicated on the probe, and that ISA is added in a 50: 1 standard to ISA ratio.

1.1.3 Maintenance and Care

Sensing Module Assembly
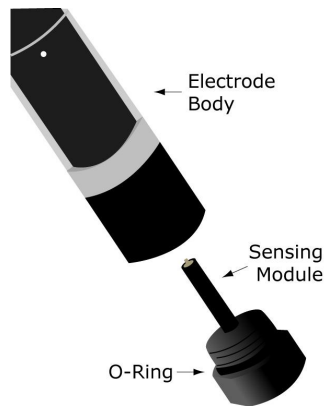
Install the replacement sensing module into the electrode body by screwing the sensing module until it is hand tight.

Caution: Do not touch the sensing element with your fingers or over tighten the sensing module.

ISE Sensor Storage

Short Term Storage (1-3 days)

Rinse the electrode thoroughly with distilled or de-ionized water. Place the tip in a solution of 2 mL of ISA in 100 mL of distilled or de-ionized water. Slide the FastFil sleeve up to close the refill holes.

Long Term Storage

Sensor tip: The electrode sensor tip should be stored dry. Rinse the electrode thoroughly with distilled or de-ionized water and blot dry. When completely dry, place in protective boot in which it was shipped.

Reference chamber: The reference junction should be wet at all times. Fill the reference chamber with Reference Filling Solution so that the surface of the solution is above the Reference Fill line. Slide sleeve up to close refill holes.

Salt deposits may form on the reference chamber. Wipe away any salt deposits with distilled or de-ionized water. Warm water will remove salt deposits more quickly, and is recommended if there is an abundance of salt deposits.

When ready to use the probe again, follow the instructions in the "Preparing ISE Sensors for Measurements" section of the manual.

Cleaning and Reconditioning

PVC ISE:

A good working ISE response stabilizes within one or two minutes. However the ISE can become sluggish if the membrane becomes dirty from grease or particles in the sample.

A PVC ISE, such as the WQ-NO$_3$ sensors, should just be rinsed with water. After thoroughly rinsing with de-ionized water, the electrodes should be reconditioned by soaking for 2-4 hours in the lowest standard used for calibration.

Caution: Do not touch the sensing element with your fingers or rub the sensing element. It can be dabbed with a damp cloth to clean off salt deposits, but it is best to soak the element.

1.1.4 ISE Sensor Troubleshooting Guide

Problems may arise due to errors with:

- Electrode function
- Standards
- Samples
- Technique

Follow the steps below to isolate the source of the problem.

Electrode Function

The following steps should be performed to test electrode slope. Slope is defined as the change in millivolts observed with every ten-fold change in concentration.

- A WQ-NO$_3$ sensor slope should typically be between 57.1 mV +/- 5mV at 25 °C per decade of concentration. Every 1/2 a degree in temperature generally moves this value up or down 0.1 mV.

Observing the slope value provides the best means for checking electrode performance. This can be done by checking the GLP file or by turning on mV in the **Settings** menu during calibration.

The difference between the mV values of first and the second standards is identified as the electrode slope. If the electrode slope is not within the normal range, the following procedure may restore the electrode. Before beginning, check that the Reference Fill Solution level in the reference chamber is higher than the reference fill line.

1. Soak the electrode in a 10 ppm standard solution for 2 hours before use.

2. Recheck the mV slope.

   Note: All standard solutions should be prepared fresh. You must use ISA. All standards must be at the same temperature as the calibration reagent.

If the electrode slope is still outside the normal range after this procedure, please contact the NexSens technical service department.

Standards:

The quality of results depends greatly upon the quality of the standards. Always prepare fresh standards when problems arise; it could save hours of troubleshooting. Error may result from contamination of prepared standards, accuracy of dilution, quality of distilled water, or a mathematical error in calculating the concentrations.

Keep all solutions tightly covered when not in use.

Samples:

If the electrodes work properly in standards, but not in samples, there may be interfering ions, complexing agents, or substances which could affect responses. If possible, determine the composition of the samples and use the appropriate complexing agents for interfering ions.

Check that the pH of the solution is within the operating range of the probe.

Be sure that the expected concentration of the sample is within the measurement range of the probe.

Technique

Closely follow the methods described in the "Making ISE Sensor Measurements" section of the manual.

2 Software Operation

2.1 Working with Data

After running WQSensors software and connecting a WQSensor, real time data can be viewed in the **Sensors** menu. When a single sensor is connected it will be displayed as shown. The serial number of the sensor, as well as the time of last obtained reading, is displayed on the bottom of the screen.

If multiple sensors are connected, they will be displayed in a tabular format as shown. Numerical buttons on the bottom of the screen allow scrolling through each panel of four sensors.
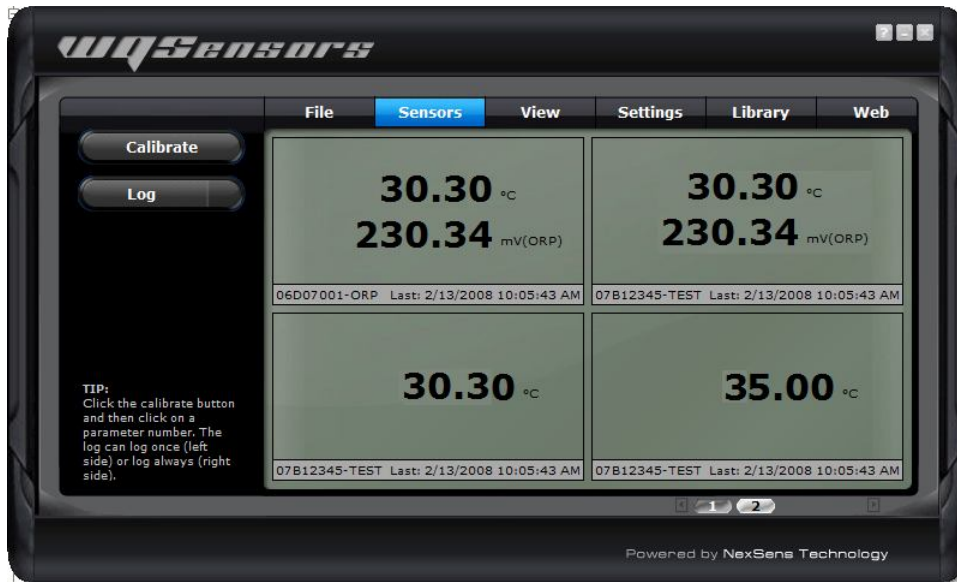
Logging Data

Data can be logged either as single measurements or as a stream of measurements over user-specified time intervals. This interval can be specified by clicking the **Interval** button in the **Settings** menu. Logged data can be viewed by clicking the **Report** button in the **View** menu.

To log a single data point, click on the left hand side of the **Log** button. The left side of the button will turn blue and a short animation with the letter **L** will display on the bottom left hand corner of the screen.
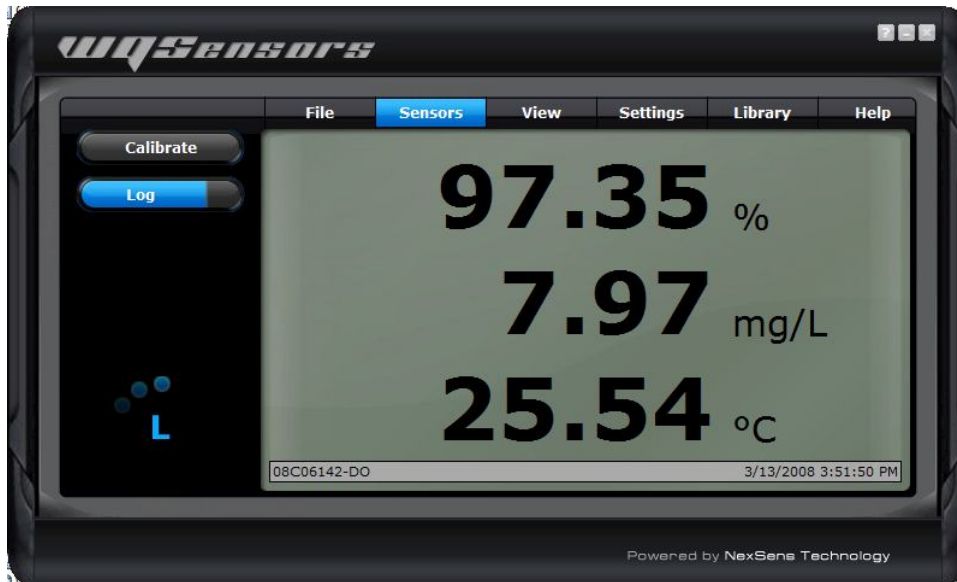
To start logging continuous measurements at the user defined interval, click on the right hand side of the **Log** button. The entire button will turn blue and at the log interval, a short animation with the letter **L** will display on the bottom left hand corner of the screen.

Calibrating Sensor Readings

To calibrate Sensor Readings:

1. Click on the **Calibrate** button

2. Select the parameter reading to calibrate as shown below

3. Enter the calibrated value

4. Click the **Calibrate** button again to complete the change

A short animation with the letter **C** will display on the bottom left hand corner of the screen. Temperature and mV values cannot be calibrated (except for calibration of ORP). This calibration is stored on the sensor, which means that the sensor can be calibrated on one computer and still returned calibrated results no matter which other computers it is used on.

Refer to the calibration guidelines in the sensor sections earlier in this manual for information on when and what values to calibrate with.

2.2 Data Validation and Review

Good Laboratory Practice Files

WQSensors software automatically records every calibration to a Good Laboratory Practice (GLP) file. The GLP file will include the time, data, sample readings, and diagnostic data for each calibration. This file is stored on the sensor and will carry over from PC to PC.
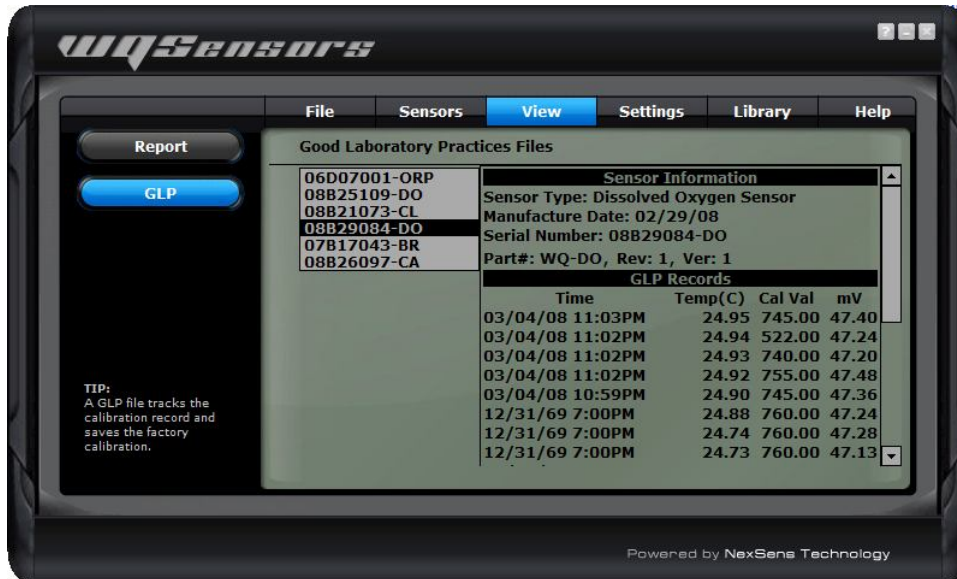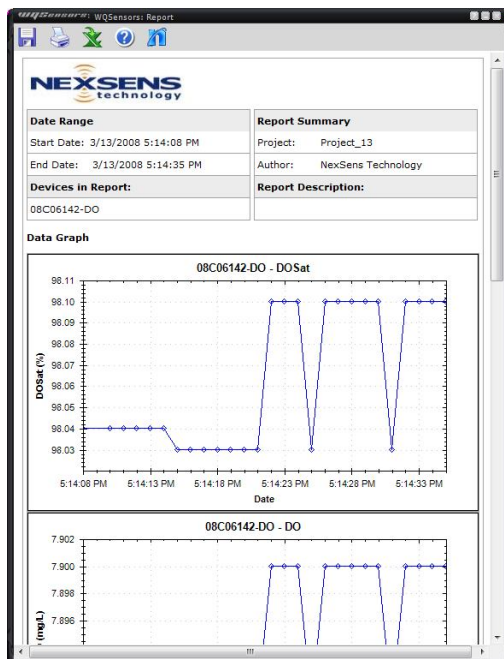
Data Reports

Data is stored inside WQSensors software project files and can be viewed in graphical, statistical, and tabular formats. To view this data click the **View** button, then click the **Report** button. Select the desired report options and then click **Generate**.

From the report tool bar data can be saved, printed, or exported to Microsoft Excel ©.

2.3 Changing Software Settings

Customizable options are available in WQSensors software in the Application Settings menu.

Show introduction animation?

This option specifies whether to display the opening animation that plays each time WQSensors software is started. Un-checking this box will disable the software from playing the animation each time.

Remember last menu location?

This option specifies whether the WQSensors software should reload the last menu opened each time the WQSensors software starts. Un-checking this box will make the **Sensors** menu the default page when starting WQSensors software. This feature is useful if a specific **Library** menu table or formula is used often.

Convert Celsius to Fahrenheit?

This option specifies whether to display temperature values in Celsius or Fahrenheit. Un-checking this box will display all temperature readings in degrees Fahrenheit.

Show mV values?

This option specifies whether the **Sensors** menu should display the mV readings from the sensors. Un-checking this box will disable the display of mV values. mV readings are diagnostic information and are not required to take measurements. They are useful, however, in determining sensor performance and calibration.
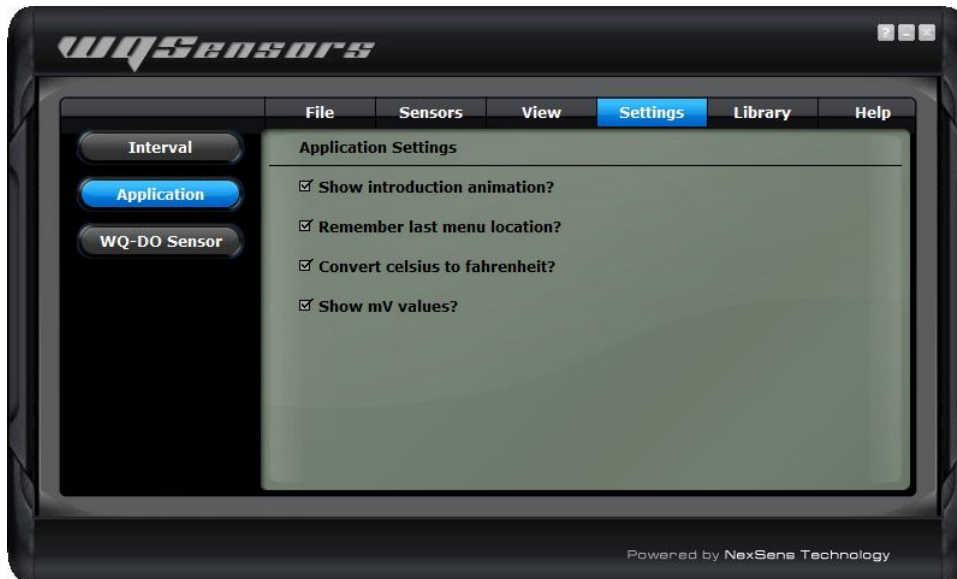
Changing Log Interval

The intervals at which the sensor logs data can be changed in the Software Logging Interval menu. Clicking the **Interval** button on the **Settings** menu displays the current log interval in seconds. To change the interval, enter a new value and click **Apply**.
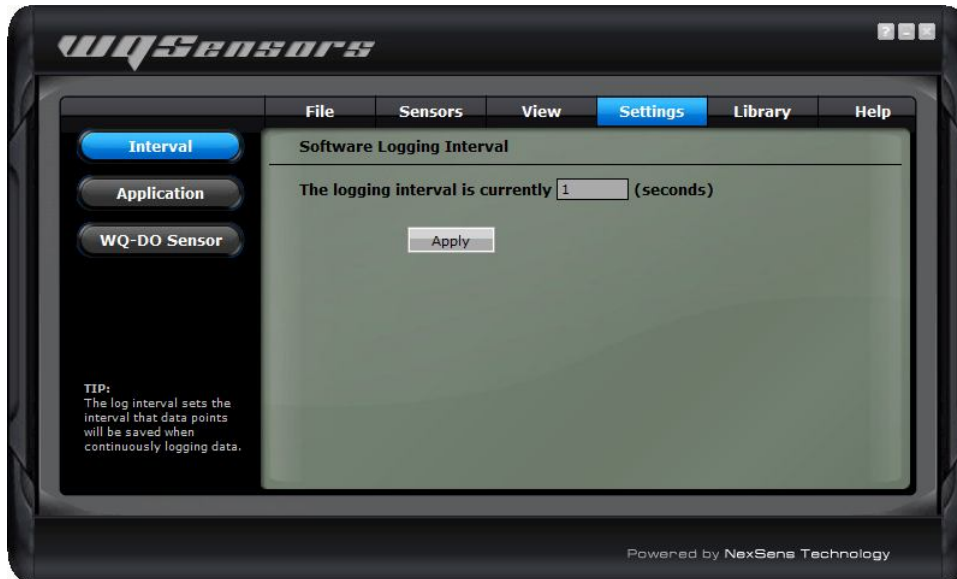
Please see the Logging Data section for starting and stopping this feature.

2.4 Science Library

The WQSensor software **Library** menu is a desktop reference for water, wastewater, and environmental professionals. It's packed with tables, calculations, and many conversions.

Features include:
- Converting units of measure
- Calculating flow over a weir
- Determining the inside diameter of PVC pipe
- Finding the ammonia tolerance level for rainbow trout
- Determining the atomic weight of bromine
- Finding the concentrations of elements in sea water
- And much more…
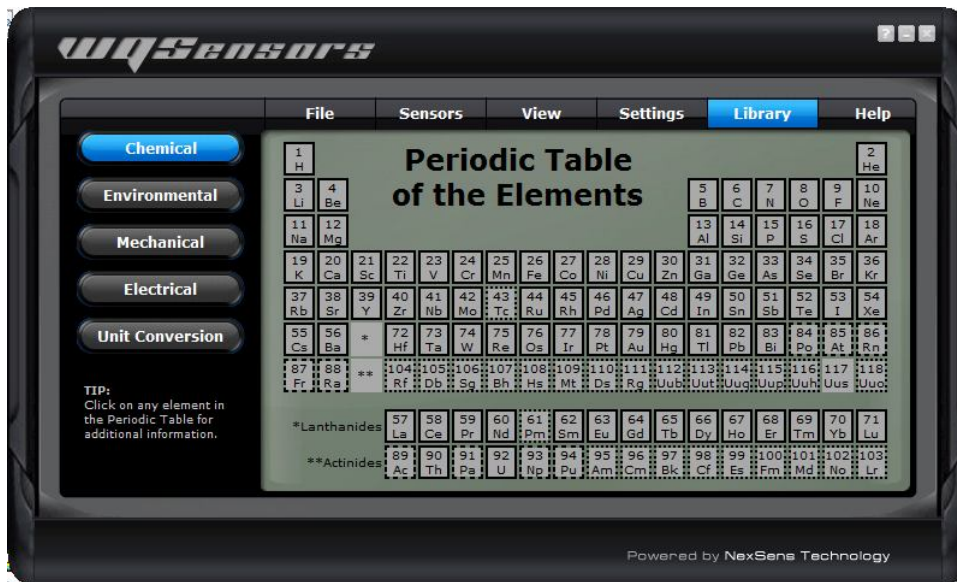
2.5 Help and Support

WQSensors software integrates the internet into part of its functionality. Software updates, technical support, and other information can be obtained in the **Help** menu.

Technical questions or comments

NexSens technical staff can be reached right inside of the program. Click on the **Help** button in the **Help** menu to send an email directly to NexSens technical support. Be sure to include a name and email address that they can contact you with. If you would prefer to be contacted by phone, include that in the message along with your phone number.

Note: An internet connection is not required to run WQSensors software.

2.6 Working with Project Files

When WQSensors software first runs, it defaults to **Project_1**. This is simply a default name for the default project file. Each project file contains information about every sensor that was connected to the computer while that file was open, as well as any data that was collected during that time as well.

Creating new project files

To create a new project, for a specific experiment or study, click the **New** button in the **File** menu and enter a project name. Click **OK** when finished.

Open an existing project

To open a previously created project, select **Open** from the **File** menu. Select the project to open and click **OK**. WQSensors software will begin using that project file as the current project.

Renaming project files

To rename the current project, select **Rename** from the **File** menu. Enter a new name and click **OK**.

To rename projects, other than the current one, simply select **Open** and select the project to be renamed from the list of existing projects. This project can then be renamed on this tab.

Appendix

Appendix A: Material Safety Data Sheets

Material Safety Data Sheets can be found at: http://www.nexsens.com/support/msds.htm

Appendix B: Warranty and Service

NexSens Technology, Inc. warrants WQSensors against defects in materials or workmanship for a period of 6 months from the date of delivery to the original customer. This warranty is limited to the replacement or repair of such defects, without charge, when the instrument is returned to NexSens Technology, Inc. Damage due to accidents, misuse, tampering, lack of reasonable care, loss of parts, failure to perform prescribed maintenance, or accidents of nature are not covered. This warranty excludes all other warranties, express or implied, and is limited to a value not exceeding the purchase price of the instrument.

Limitation of Warranty

This warranty is not applicable to any NexSens Technology, Inc. product damage or failure caused by (i) failure to install, operate or use the product in accordance with NexSens Technology, Inc. written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with NexSens Technology, Inc. written instructions, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by NexSens Technology, Inc.

Warning: NexSens Technology, Inc. products are not authorized for use as critical components in any life support system where failure of the product is likely to affect its safety or effectiveness.

Authorized U.S. Service Centers

– Corporate Headquarters –
NexSens Technology, Inc.
1328 Parkway Court
Dayton, Ohio 45432

– Phone: (937) 426-2703
– Fax: (937) 426-1125
– E-Mail: support@nexsens.com

Appendix C: Computer Requirements

WQSensor Software requires the following minimum system configuration:

- Pentium class PC
- 64 MB RAM
- 100 MB hard drive
- 2MB video card
- CD-ROM drive for Software installation
- Adobe Flash
- Windows 2000 (SP1 or higher) or Windows XP

Appendix D: Step-by-Step Driver Installation

After installation of the WQSensor Software, USB communicate with the sensor will be enabled. When the adapter is plugged in for the first time, Windows will automatically recognize it and start the **Found New Hardware** wizard. See the following sections for details.

Installation for Windows 2000

When the USB adapter is plugged in for the first time, Windows will detect and start the Found New Hardware Wizard:

1. Click **Next** when the Found New Hardware Wizard dialog box appears.

2. Check the "Search for suitable driver for my device" option. Click **Next** to continue.

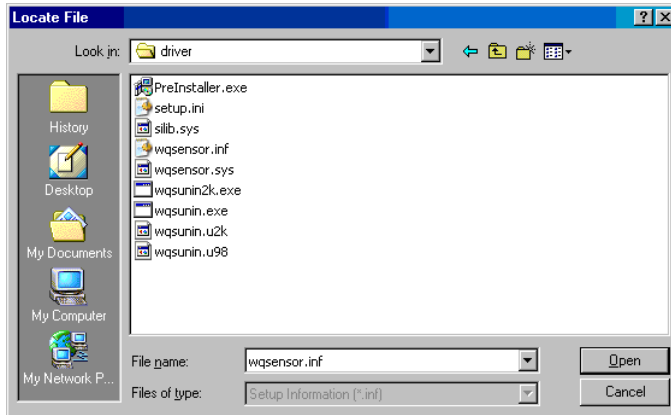**3a.** If the **WQSensor installation CD** is in the CD-ROM drive, place a check mark in the "CD-Rom drives" option and click **Next**. This is the recommended method, if the WQSensor CD is available. Windows will scan the CD and automatically install the driver.

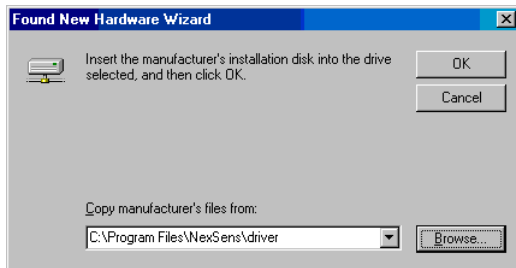**3b.** If the WQSensor software is unavailable or the software has been downloaded from the internet. Check "Specify a location" and click **Next**.
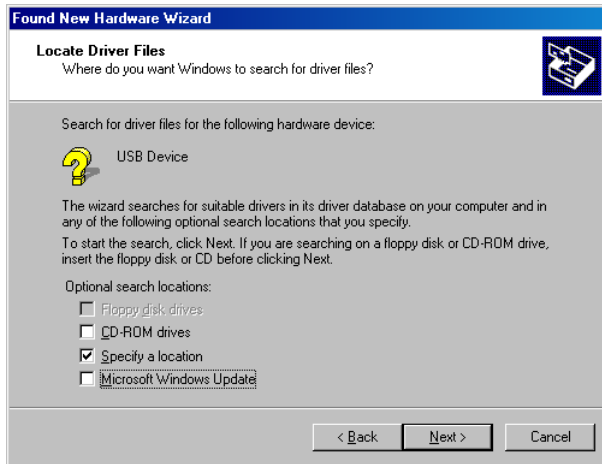
Click **Browse** and go to the location of the driver. By default the driver is located in "C:\Program Files\NexSens\WQSensor\Driver\wqsensor.inf". Click **Open.**

Click **OK** to continue.

4. Once Windows has successfully found the driver, click **Next**.
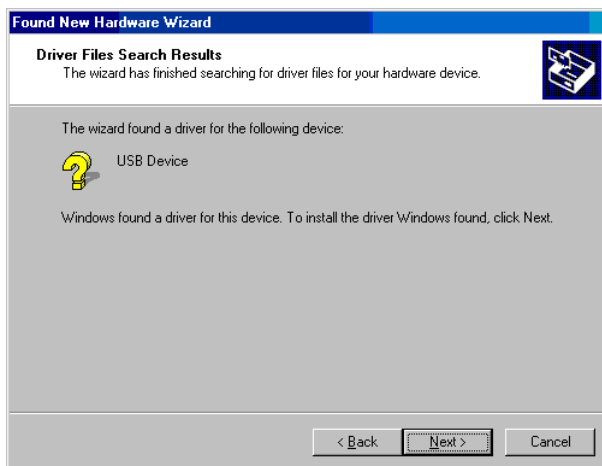
5. Click **Finish** in the following window. Make sure that the driver has been successfully installed.
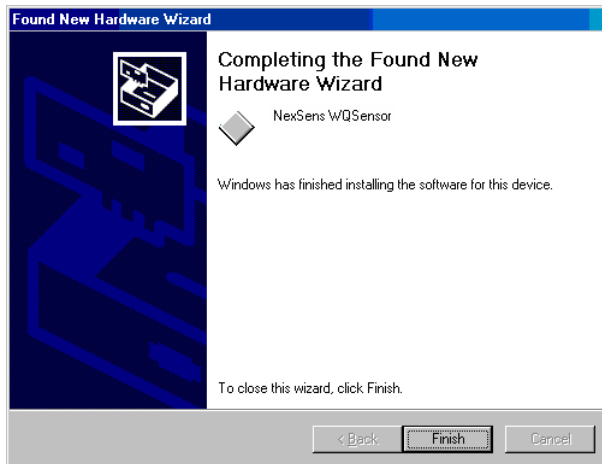
Note: The above steps only need to be completed successfully once.

Installation for Windows XP

When the USB adapter is plugged in for the first time, Windows will detect and start the Found New Hardware Wizard:

ⓘ Found New Hardware ☒
NexSens:WQSensor:WQ-TEMP

1. Select **No, not this time** and click **Next**, when the Found New Hardware Wizard appears.

2a. If the **WQSensor installation CD** is in the CD-ROM drive then click the **Install the Software automatically** option and click **Next**. This is the recommended method, if the WQSensor CD is available. Windows will scan the CD and automatically install the driver.
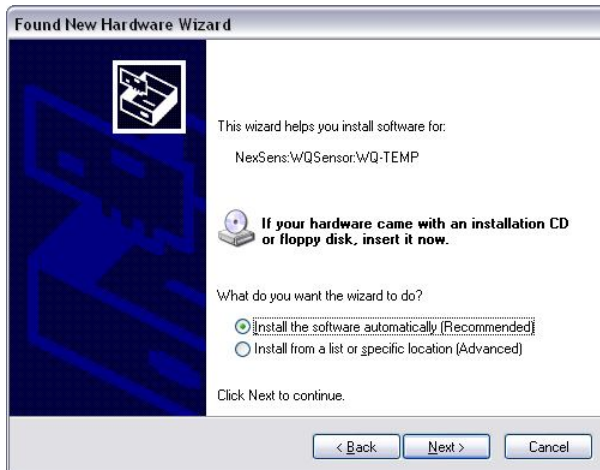
2b. If the WQSensor software is unavailable or the software has been downloaded from the internet. Check "Specify a location" and click **Next**.


Click **Browse** and go to the location of the driver. By default the driver is located in "C:\Program Files\NexSens\WQSensor\Driver\wqsensor.inf".
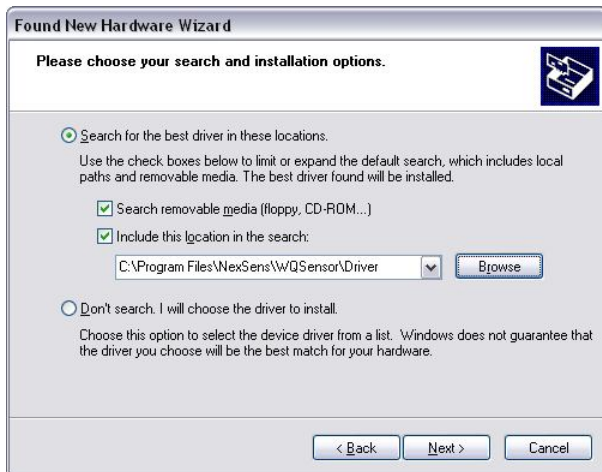

Click **Ok**

3. If the following dialog box appears, click **Continue Anyway**.

4. Windows will search for the driver.

Make sure that the driver has been successfully installed. If it has been, click **Finish**.

Note: The above steps only need to be completed successfully once.

If for any reason the following window appears:

The driver will need to be reinstalled. Typically Windows will not redisplay the Found New Hardware wizard automatically again. Therefore Windows Device Manager will have to be used.

The Device Manager can be accessed by going to the **Start** menu and clicking on **Control Panel**. Click on the file labeled **System**.
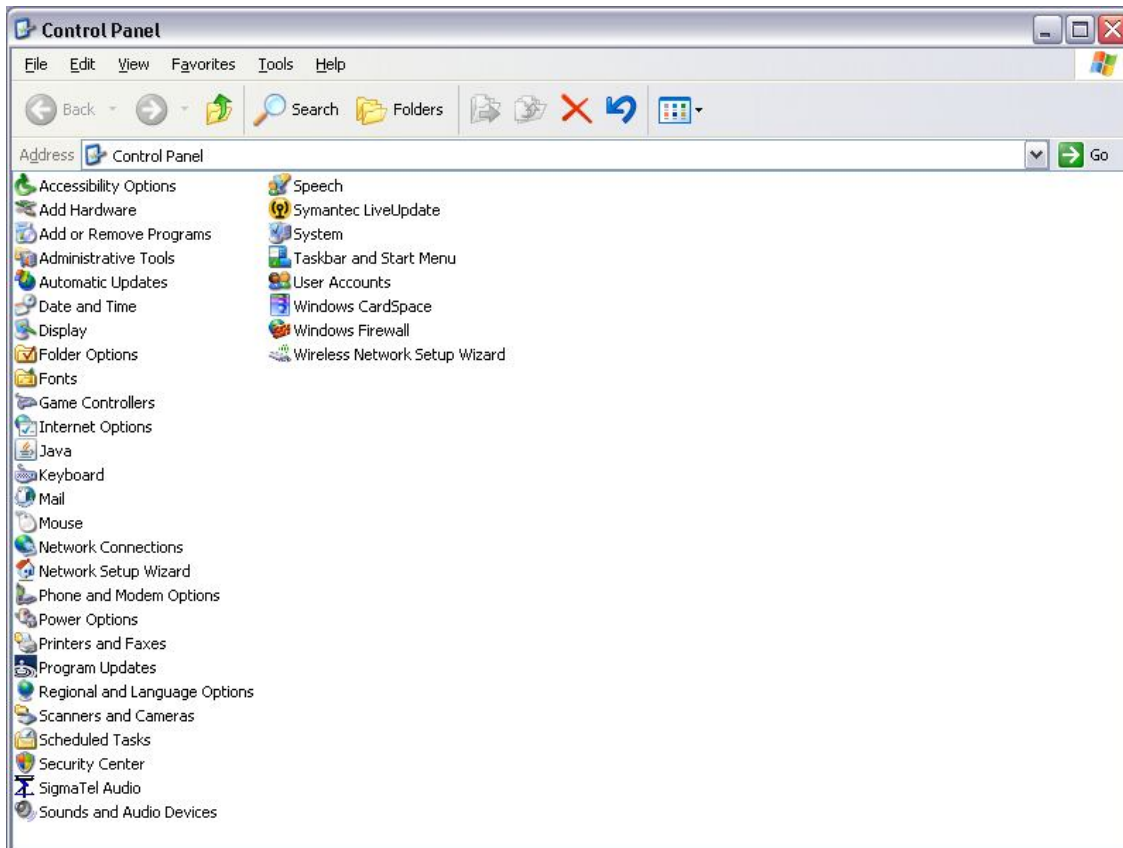
The **System Properties** dialog box will appear. Go to the **Hardware** tab and click **Device Manager**.

You should see a device labeled **USB Device** that has a yellow icon by its name.
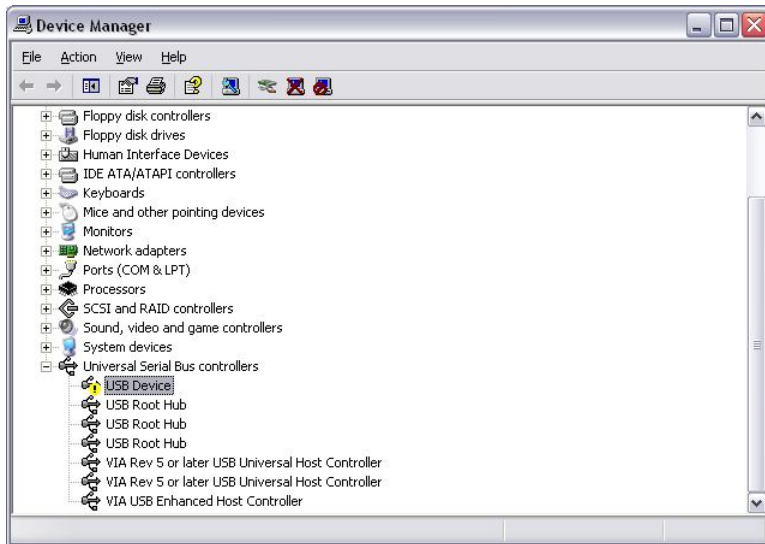
Right click on the device and select **Update Driver**. This will restart the Found New Hardware Wizard. Go back to step one and follow to install the driver.
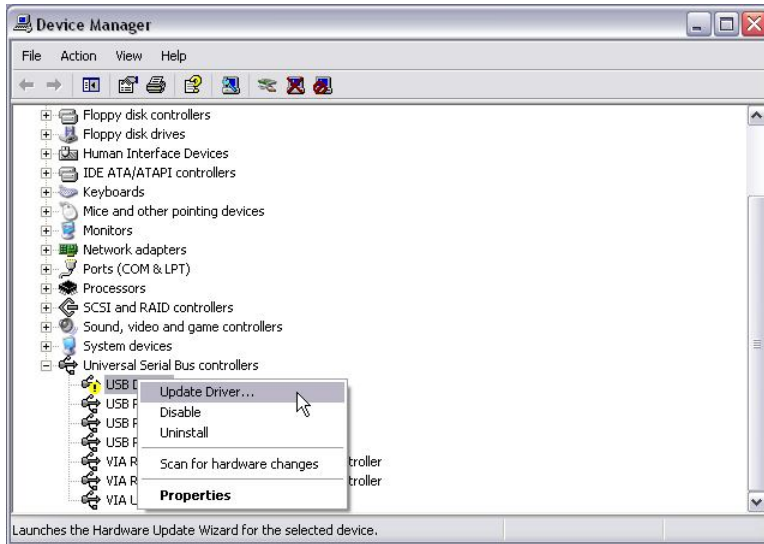
If you need further assistance call a NexSens Support Representative at (937)-426-2151 or email us at info@NexSens.com.

Installation for Windows Vista

In Windows Vista, driver installation is automatic. You may see a small screen pop up on the bottom right hand corner of the screen for the first few seconds the device is plugged in, after which it will appear in the software.

Appendix E: ISE Frequently Asked Questions

1. **What is an ISE probe?**
2. **What is ISA, and why is it added when using many of the ISE probes?**
3. **What is the relationship between ionic activity and concentration?**
4. **What is the difference between Nitrogen-Nitrate and Nitrate? Or Nitrogen-Ammonium and Ammonium?**
5. **How do you convert from Molarity (M) to parts per million (ppm) and mg/L?**
6. **How do I dilute the stock standard to make lower concentrations of standards for calibration?**
7. **What is the real world range of ISE probes?**

1. **What is an ISE probe?**

   ISE stands for Ion Selective Electrode. Ion Selective Electrodes are membrane-based electrochemical sensors. The membrane on the electrode is the component that makes the electrode selective for a particular ion.

   Four different types of ISEs can be described based on the material of the membrane:
   - Glass membrane (pH)
   - Solid State membrane (Chloride, Bromide, Fluoride)
   - Polymeric membrane (Ammonium, Calcium, Nitrate)
   - Gas Permeable membrane (Dissolved Oxygen)

   When an ISE probe is placed in solution, the ion of interest (i.e. chloride, calcium, etc.) will interact with the ISE membrane in a selective way. An electrical potential will develop across the membrane. This electrical potential is proportional to the free ionic activity of the solution. When the activity increases (more free ions in solution) the electrode potential becomes more positive when the electrode is sensing a cation and more negative when the electrode is sensing an anion.

   This electrical potential is then measured against a stable electrical potential in a reference electrode. WQSensors use combined reference electrodes, meaning that the reference electrode is contained within the same probe body as the electrochemical sensing electrode.

   For a tenfold change in ionic activity (i.e. 10ppm to 100ppm), the electrode potential at 25°C changes by 59.2 ± 5 mV when the ion being measured is monovalent (Br^-, Cl^-, F^-, NO_3^-, NH_4^+), and 29.6 ± 5 mV when the ion being measured is divalent (Ca^{+2}).

2. **What is ISA, and why is it added when using many of the ISE probes?**

   ISA stands for ionic strength adjuster. It is important to add ISA to all standards and samples when using most ISE electrodes (with the exception of a few, such as pH and dissolved oxygen). The addition of ISA ensures that all samples and standards will have a similar ionic strength. This is important because the ionic strength of a solution affects the relationship between activity and concentration. By bringing the ionic strength of all samples and standards to a similar level, the effect of variable ionic strengths on the activity is overcome thus reducing the margin of error.

3. What is the relationship between ionic activity and concentration?

Ion selective electrodes respond to ionic activity in a solution. However, most researchers are really interested in the total concentration of a species in solution. Although ionic activity is related to concentration, they are not necessarily the same.

Two factors affect the relationship between activity and concentration: the presence of complexing species; and the total ionic strength of a solution.

First, activity refers only to free, unbound ions. A portion of the total concentration may be bound or complexed by other ions in the solution and therefore does not exist in the free ionized state. An ISE probe only senses the activity of the free unbound ions.

Second, ionic activity depends on the total ionic strength of the solution, which is a measure of its overall ionic composition. In general, as ionic strength increases, the ratio of ionic activity to the ionic concentration (that portion of the total concentration which is uncomplexed) for a given species changes. This ratio is called the activity coefficient.

For solutions which contain only uncomplexed ions, the total concentration is simply the ionic activity divided by the activity coefficient. Adding ISA (ionic strength adjuster) to all standards and solutions helps to remove any differences among solution caused by variations in ionic strength.

4. What is the difference between Nitrogen-Nitrate and Nitrate? Or Nitrogen-Ammonium and Ammonium?

Nitrogen exists in various forms, including nitrate (NO_3^-), ammonium (NH_4^+), and ammonia (NH_3). In order to differentiate among the various forms of nitrogen in a sample, analysis of nitrogen is often expressed in terms of the amount of nitrogen combined in its various forms, such as nitrate-nitrogen, or ammonium-nitrogen. The term nitrate-nitrogen defines all the nitrogen in the sample that exists as nitrate and the term ammonium-nitrogen defines all the nitrogen in the sample that exists as ammonium.

There is a simple mathematical relationship to convert from the expression of nitrate to nitrate-nitrogen, or ammonium to ammonium-nitrogen. This relationship is based on the chemical formula for the ion.

Every element has an atomic mass. The atomic mass for nitrogen is 14, because it has 7 electrons and 7 protons. The atomic mass for oxygen is 16, because is has 8 protons and 8 electrons.

The chemical formula for nitrate is NO_3^-. It is a combination of 1 nitrogen atom, which has an atomic mass of 14, and 3 oxygen atoms, each of which has an atomic mass of 16. Therefore, the atomic mass for nitrate is 62 (14+ 48 = 62). If a solution had a concentration of 62 ppm nitrate, it would contain 14 ppm nitrogen and 48 ppm oxygen. This can be expressed either as 62 ppm nitrate, or 14 ppm nitrate-nitrogen.

To convert from nitrate-nitrogen (NO_3^--N) to nitrate (NO_3^-), simply multiply by 4.43:

Nitrate (NO_3^-) = Nitrate-Nitrogen (NO_3^--N) x 4.43

The conversion factor 4.43 comes from the atomic mass of nitrate divided by the atomic mass of nitrogen (62/14). For instance, if 10 and 100 ppm NO_3^--N standards were prepared for calibration, this would be equal to 44.3 and 443 ppm NO_3^- standards.

For ammonium-nitrate (NH4$^+$-N)

Similarly, the atomic mass for ammonium is 18. This is because ammonium is a combination of 1 nitrogen atom, which has an atomic mass of 14, and 4 hydrogen atoms, each of which has an atomic mass of 1.

To convert from ammonium-nitrogen (NH_4^+-N) to ammonium (NH_4^+), simply multiply by 1.286.
Ammonium (NH_4^+) = Ammonium-Nitrogen (NH_4^+-N) x 1.286

Similarly, if 10 and 100 ppm NH_4^+-N standards were prepared for calibration, this would be equal to 12.86 and 128.6 ppm NH_4^+ standards.

Note: The standards sold with the WQSensors are sold as 1000 ppm NO_3^-N and 1000 ppm NH_4^+-N.

5. How do you convert from Molarity (M) to parts per million (ppm) and mg/L?

The molarity of a solution is the number of moles of solute per liter of solution. The molar mass of any particle (atom, molecule, formula, or ion) is the sum of the average atomic masses of all atoms forming that particle. This is also known as molecular weight.

The molar mass of an atom is its average atomic mass expressed in grams. The atomic mass of all atoms can be found in the periodic table.

For dilute solutions, one part per million equals one mg/L. In most cases, the two are considered equal.

To convert from molarity to ppm, first determine the molar mass of a substance. For instance, chloride has a molar mass of 35.5 (*rounded up from 35.45*). A solution with 1 M concentration would have 35.5 g of chloride per 1 L of solution.

Chloride

Molarity moles/Liter (M)	grams/L (g/L)	Parts Per Million (ppm)	milligrams/L (mg/L)
1 M	35.5	35,500	35,500
10^{-1} M (0.1 M)	3.55	3,550	3,550
10^{-2} M (0.2 M)	0.355	355.0	355.0
10^{-3} M (0.3 M)	0.0355	35.5	35.5
10^{-4} M (0.4 M)	0.00355	3.550	3.550

6. How do I dilute the stock standard to make lower concentrations of standards for calibration?

Standards are made from the 1000 ppm or 10^{-1} M stock standard. When preparing standards, you should prepare two standards that differ by a factor of 10, and bracket the expected concentration range of your sample. For example, if you expect the chloride concentrations in your samples to be 20 to 80 ppm, you should prepare standards that are 10 and 100 ppm.

To prepare standards from your stock standard, follow the subsequent formula:

$$V_1C_1 = V_2C_2$$

Where V=Volume and C=Concentration. V_1C_1 are the volume and concentration of your stock standard, where V_2C_2 are the volume and concentration of your diluted standard. When preparing a new standard from stock standard, V_1 (volume of stock standard) is your unknown.

For example, say you want to prepare 100 mL of 10 ppm and 100 ppm chloride standard from your 1000 ppm stock standard. Then, you need to figure out what volume of your stock standard is used:

For the 10 ppm standard:

V1 = the volume of stock standard used to make your new more dilute standard. **This is your unknown.**

C1 = 1000 ppm in the stock solution
V2 = total volume made in the more dilute standard you are making = 100 mL
C2 = concentration of new more dilute standard = 10 ppm

$$V_1 = (V_2C_2)/C_1$$

V_1= (100*10)/1000 = 1 mL of 1000 ppm stock standard

Therefore, pipette 1 mL of 1000 ppm standard into a 100 mL volumetric flask, then bringing to 100 mL volume with distilled or deionized water.

Note: ISA is added to the standard after the dilution. Its volume is not considered in the dilution. This is because it will also be added to the samples. This way, both the standards and samples are equally diluted by the ISA.

For the 100 ppm standard:

V1 = the volume of stock standard to use to make your new more dilute standard. **This is your unknown.**

C1 = 1000 ppm in the stock solution
V2 = total volume made in the more dilute standard you are making = 100 mL
C2 = concentration of new more dilute standard = 100 ppm

$$V_1 = (V_2C_2)/C_1$$

V_1= (100*100)/1000 = 10 mL of 1000 ppm stock standard

Therefore pipette 10 mL of 1000 ppm standard into a 100 mL volumetric flask, then bringing to 100 mL volume with distilled or deionized water.

Note: ISA is added to the standard after the dilution. Its volume is not considered in the dilution. This is because it will also be added to the samples. This way, both the standards and samples are equally diluted by the ISA.

7. After soaking a Nitrate electrode overnight in a low standard, why does it not respond when I try to calibrate?

This is a common problem with all nitrate electrodes. Soaking overnight in a standard 'numbs' the membrane to any changes and needs to be air dried for at least 12 to 24 hours before you try to use it again. Next time you want to soak the electrode prior to use, try only soaking it for 10-20 minutes and then calibrating.

8. What is the real world range of ISE probes?

The specified range of ISE probes given in the "Specifications" section of this manual is for clean solutions without any interference ions present. For example, chloride ISE probes are given as 1.8ppm to 35,500ppm

In real world samples the range, as you measure near the limits, may be quite less depending on the identity of interference ions, temperature of samples vs. temperature of calibration standards, or fouling of the sample being measured.

To ensure measurement results match the probe range:

1.   Measure samples in clean beakers and environments where the temperature of the sample matches the temperature of the standard the probe was calibrated.

2.   Run multiple samples per measurement.

3.   Ensure long term care of the probe by using ISA buffer solution in measurement standards as well as keeping the probe filling solution clean and full inside of the probe body.

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