



VOLUNTEER HANDBOOK

2020



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WELCOME TO ARIZONA WATER WATCH



Arizona Water Watch (AZWW) is a citizen science water quality action program led by the Arizona Department of Environmental Quality (ADEQ), designed to enable local volunteers and state scientists to collaboratively work together to collect high quality data on Arizona's streams, lakes and wetlands.

The goal of AZWW is to empower those who are interested in surface water quality by providing training, equipment and guidance to volunteers. With your help, more of Arizona's unique waterways can be studied.

AZWW volunteers conduct monitoring by collecting samples and observations for water chemistry, E. coli, field parameters (DO, pH, Temperature, etc.), and habitat data. Volunteers learn and see the processes from start to finish and directly contribute to making a difference.

Since consistency is a vital piece of the scientific method, this handbook is designed to ensure that data is collected in the same manner from all volunteers and ADEQ staff.

AZWW supports you with:



Training workshops



Standardized monitoring protocols



Testing equipment



Guidance for creating a watershed-specific sample plan



Online data entry portal



Volunteer Emma collecting data on West Fork of Oak Creek.

By joining AZWW as a volunteer, you will directly contribute to identifying areas of concern and aiding in the protection of Arizona waters. Volunteers are the heart of AZWW. Thank you!

Training dates, how-to videos and forms are available at azdeq.gov/azww/volunteers.

“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.”

-Margaret Mead

PERSONAL SAFETY

Personal safety of volunteers is the most important part of any trip into the field. Volunteers should never place themselves in dangerous or risky situations. Any hazards that are known by field personnel should be communicated to other members of the field crew. Field work should be postponed if there is any indication that field activity could be dangerous (lightning, bees, ect.). All field work has some risk associated with it such as driving, hiking on uneven surfaces, wading in streams or working with chemicals while wearing appropriate personal protective gear. This is normal risk. Working during lightning storms, at night, during flash flood conditions, or during snowy weather is not considered normal risk.

Only sample at sites identified in the sample plan. Do not enter private property unless prior permission from the land owner and the AZWW coordinator have been given.

WATER QUALITY BACKGROUND



Sen Pedro River, Arizona

Water in Arizona is used for drinking, swimming, irrigating crops, fishing and supporting wildlife and aquatic life. For water quality purposes, we consider the uses of a stream or lake and apply designated uses to each waterbody in the state. Streams and lakes also have numeric values applied to the designated uses to ensure that a certain level of quality is met. Those values have been determined by years of data collection and analysis, and we call those numeric values **standards**.

Learn more at azdeq.gov/programs/wqd.

GETTING STARTED

Becoming an AZWW citizen scientist is simple:

CONTACT THE COORDINATOR

Become a citizen scientist with AZWW by visiting azdeq.gov/azww/volunteers, downloading the *Volunteer Registration/Photo Release* form in the sidebar under FORMS, and send the completed form to the AZWW coordinator. The coordinator will work with the volunteer to help design a study specific to the waterway of interest.

BUILD A PLAN

The program coordinator will work with you to create a Sample and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP), which has two main benefits. First, volunteers and scientists can work together to target specific areas in need of data. Secondly, it's a crucial step in collecting high-quality data that we are able to use. The program coordinator will provide examples and the SAP/QAPP template, or they may write the document.



Friends of Rio De Flag right before they conduct wet dry mapping on the Rio De Flag.

GETTING STARTED CONT.

GET TRAINED

An AZWW coordinator will provide an annual refresher class digitally, or an in-person training at a volunteer sampling location. The training will teach volunteers how to collect water samples, use scientific equipment properly, document current conditions of the waterbody and submit data electronically. After you're trained and have the proper equipment checked out, you're ready to do science!

Within the first few months of participation, volunteer groups will be contacted and asked to complete an in-person or virtual field audit. The audit is required per ADEQ's credible data needs, but also provides an opportunity to fine-tune and adjust sampling habits and identify site-specific issues. The audit will help the program coordinator identify potential areas of concern and understand issues volunteers are encountering. This collaborative effort will help protect our waterbodies for future generations.

To help volunteers keep sampling processes fresh in their minds, video micro-lessons are also available at azdeq.gov/azww/volunteers. Whenever a procedure in this handbook has a video micro-lesson available online, you'll see this icon next to it:



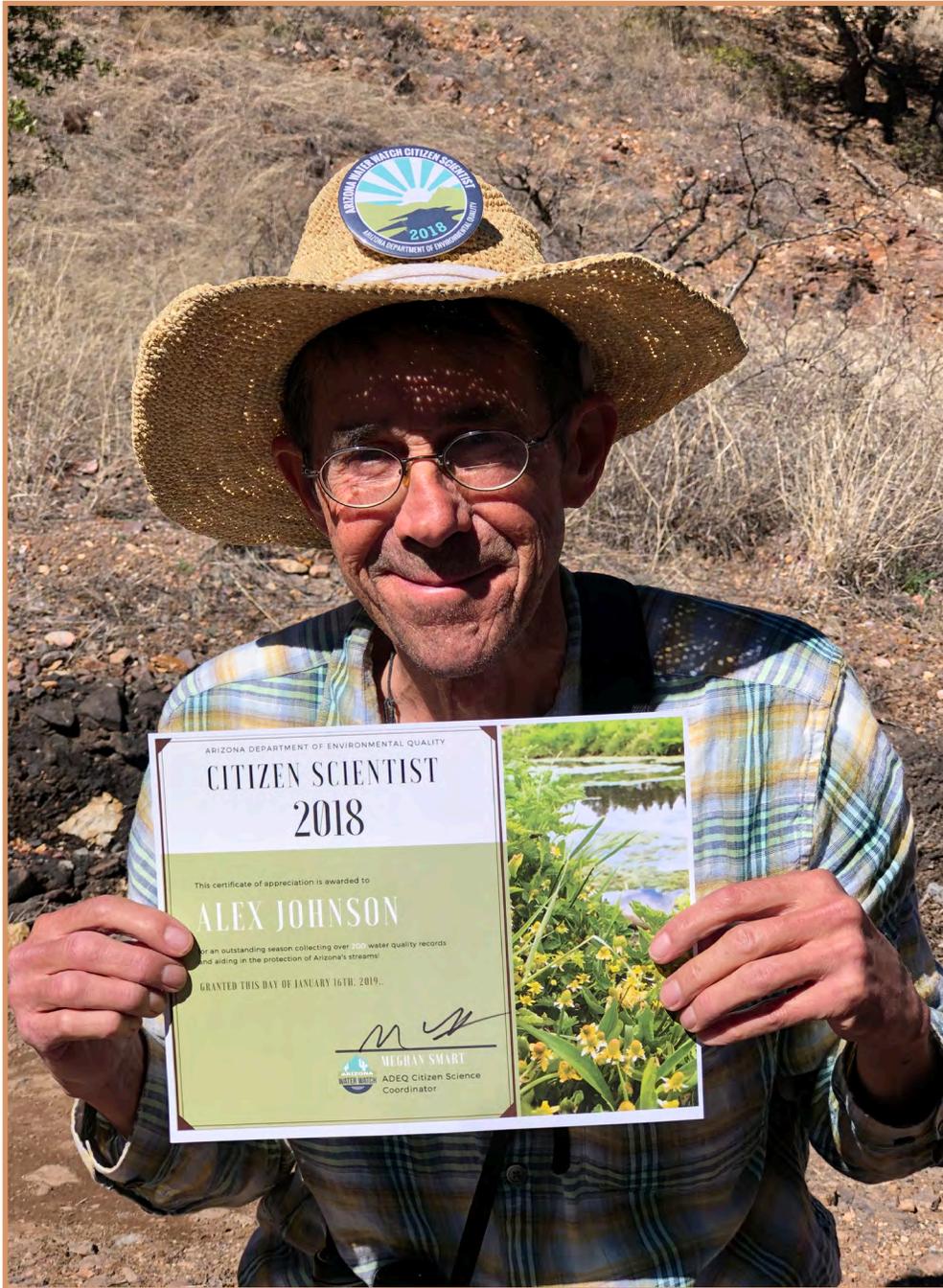
Micro-lesson topics include:

- *E. coli* sampling and processing
- Measuring flow
- Measuring turbidity
- Using a multi-parameter probe
- Wet-dry mapping
- Water quality sample collection
- Dilution for *E. coli*
- Dilution for turbidity



CELEBRATING YOUR EFFORTS

Volunteer appreciation is a main pillar of AZWW. Taking time to celebrate a job well done and the collaborative efforts of volunteers and scientist working together is important. A team that celebrates together creates a bond and works better together on projects. Recognition can come in many forms including certificates and volunteer buttons.



AZWW volunteer Alex shows off his AZWW certificate and button.

COLLECTING FIELD DATA

Field data are like vital signs for streams. It's the initial reading of what is going on in the system and can alert us to overarching problems. Field data parameters are collected using specific scientific equipment for which procedures like calibration, storage and maintenance should be closely followed.

Each volunteer group will require different equipment, check with the AZWW coordinator for information about our equipment loaner program. The equipment used should be identified in the SAP, properly calibrated, and maintained during the sampling season.

We now have an online form you can access at azdeq.gov/AZWW.

This online form allows you to electronically submit data, creating a more seamless path for your data into the database. Data can be submitted electronically. Contact the AZWW coordinator to create a group specific electronic data form, making it easier and faster to submit data. The coordinator will also provide a link to allow you to access your data at anytime.



AZWW coordinator Meghan having a laugh with Sandra while filling out a field data form.

THE FIELD DATA FORM

We recommend you record your field data on the paper form in the field and then input it into the online portal using a computer or mobile device. If you don't have access to the proper equipment, the program coordinator may provide paper forms.

DATA FORM HEADER:

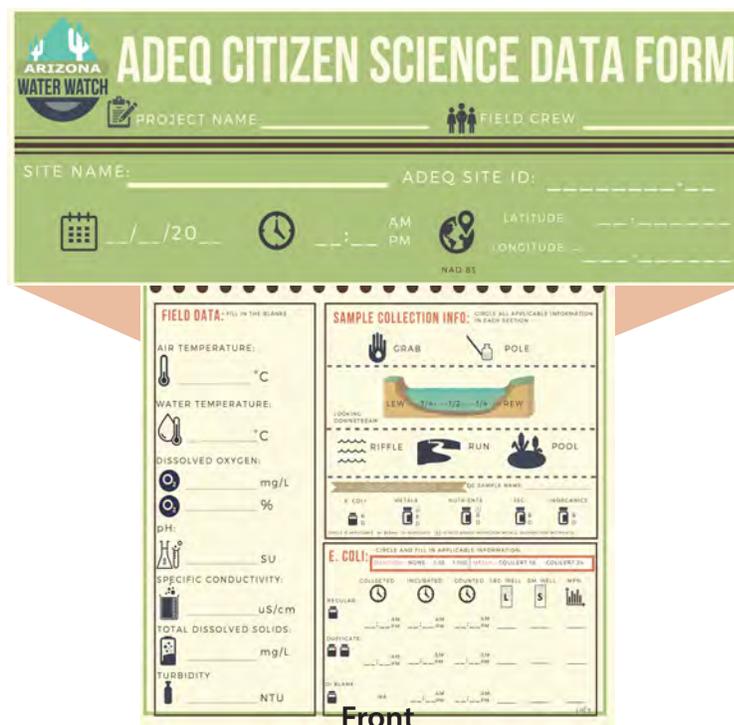
Field Crew: Add the initials of the samplers.

Site Name: Add a descriptive site name. For example, "Wet Beaver Creek near the USGS gage".

ADEQ Site ID: Provided by AZWW coordinator. Site ID includes a numeric river value along with the watershed and stream code. For example: the East Verde River at 12.21 miles upstream from the confluence of the Verde would have a Site ID of "VREVR012.21".

Date and Time: Example formats: 06/25/2021, 08:30 AM

Location: If this site has already been geo-located, it's not necessary to complete this information every sampling trip. If it hasn't been geo-located, using a GPS in the NAD 83 datum, add the latitude and longitude in decimal format.



The image shows the front of the "ADEQ Citizen Science Data Form". The header is green and features the "ARIZONA WATER WATCH" logo on the left and the title "ADEQ CITIZEN SCIENCE DATA FORM" in large white letters. Below the header, there are fields for "PROJECT NAME" and "FIELD CREW". The main body of the form is white and contains several sections: "SITE NAME:" and "ADEQ SITE ID:" with dashed lines for input; a date field with a calendar icon and a time field with a clock icon; and a location section with a globe icon, "LATITUDE", and "LONGITUDE" fields, and "NAD 83" text. Below these are two columns of data entry fields. The left column is titled "FIELD DATA: FILL IN THE BLANKS" and includes fields for AIR TEMPERATURE (°C), WATER TEMPERATURE (°C), DISSOLVED OXYGEN (mg/L and %), pH, SU, SPECIFIC CONDUCTIVITY (uS/cm), TOTAL DISSOLVED SOLIDS (mg/L), and TURBIDITY (NTU). The right column is titled "SAMPLE COLLECTION INFO: CIRCLE ALL APPLICABLE INFORMATION IN EACH SECTION" and includes a diagram of a stream with "GRAB" and "POLE" sampling methods, a diagram of a stream with "RIFFLE", "RUN", and "POOL" sampling methods, and a section for "E. COLI" with sub-sections for "REGULAR" and "ADULTS" with various icons and checkboxes.

Front

FIELD DATA



FIELD DATA:

Temperature: A multi-parameter probe¹ can be used to measure water temperature. A handheld thermometer can be used for air temperature. Record measurement in Celsius.

Dissolved Oxygen (DO)

Measure DO in the water. Your probe might measure in parts per million (ppm), which is synonymous with mg/L. Also record the percent of oxygen available in the water.

pH

This is a measure of hydrogen in water on a scale from 0 (acidic) to 14 (basic).

Specific Conductivity

This measures the concentration of dissolved solids ionized in water. Record in micro-Siemens per centimeter (us/cm).

Total Dissolved Solids (TDS)

This is the measurement of minerals, salts, or metals dissolved in water. Again, ppm is synonymous with mg/L and may appear on some meters.

Turbidity²

This is the measurement of the cloudiness of water, typically caused by sediment particles. Units used are Nephelometric Turbidity Units (NTU).

FIELD DATA: FILL IN THE BLANKS

AIR TEMPERATURE: _____ °C

WATER TEMPERATURE: _____ °C

DISSOLVED OXYGEN: _____ mg/L
_____ %

pH: _____ SU

SPECIFIC CONDUCTIVITY: _____ uS/cm

TOTAL DISSOLVED SOLIDS: _____ mg/L

TURBIDITY _____ NTU

¹ See Appendix B for multi-parameter probe instructions

² See Appendix A for turbidity instructions

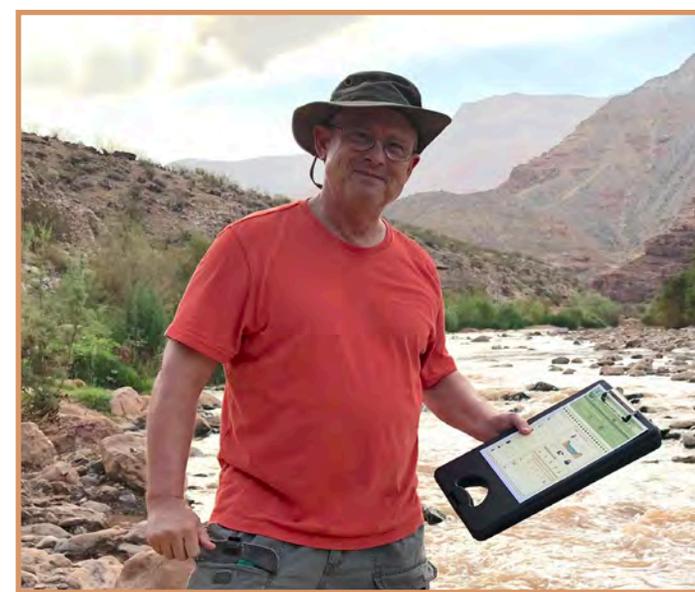
SAMPLE COLLECTION INFO

SAMPLE COLLECTION INFO:

Sampling Method: We use one of two methods to collect water quality samples: a **grab** sample is collected by dipping a bottle in the water with gloved hands. Or, a reach **pole** holds a sample bottle. The coordinator can provide the pole and instructions.

Sampling Location: Water samples are collected facing upstream so the water is flowing into the collection bottles. Samples can be collected at various stations of the stream, but most often are collected at the midpoint. If the stream is unsafe to swim, collection can occur from the **Left Edge of Water (LEW)** or the **Right Edge of Water (REW)**. The right and left directions are determined while facing downstream. Circle the area that best represents from where the sample was collected.

Sampling Location Habitat: A **riffle** is the portion of a stream with faster flow, shallow depth, and typically white-capped surface waters. A **run** is the portion of the stream that is visually moving with a smooth surface, but typically doesn't have white caps. A **pool** is an area of deposition and is deep in comparison to the riffle and runs. Riffles are the preferred location for water quality sampling, but both runs and pools can be sampled. Circle the appropriate habitat where the sampling occurred.



AZWW volunteer Richard completes a field data form.

Samples Collected: Accounting for the different samples collected during a sampling trip helps keep track of data as it comes in from different labs and people. Some sites may only require that *E. coli* be collected at a site, while a different site will have *E. coli*, nutrients, and metals collected. Circle the applicable samples collected by circling the bottle and parameter name. If a quality assurance **Duplicate (D)** or **Blank (B)** was collected, note it by circling the appropriate letter to the right of the bottle icon on the form. Collect one duplicate sample per day for *E. coli*. For chemistry, contact the AZWW coordinator to determine where and when to collect lab chemistry samples.

SAMPLE COLLECTION INFO CONT.

Collecting Water Chemistry Samples

Volunteer groups around the state can collect water quality samples according to data gap needs. Sometimes you will be collecting specifically for one or multiple data categories. A full suite of water quality data includes:

- **Suspended Sediment:** Collected in a 1 liter wide mouth bottle. Send to a lab to determine the amount of fine and course sediment. Sediment can affect the aquatic life and fish in a waterbody. No preservative added.
- **Dissolved Metals:** Collected in a 1 liter bottle and then filtered using a .45 micrometer filter into a 500 ml bottle. After the sample is filtered, add 40 drops of nitric acid are added to the sample for preservation. The sample is sent to the lab to see if things like mercury or lead are in the sample.
- **Total Metals:** Collected in a 500 ml bottle. 40 drops of nitric acid are added to the sample for preservation. The sample is sent to the lab to see if things like mercury or lead are in the unfiltered sample.
- **Nutrients:** Collected in a 1 liter bottle. 80 drops of sulfuric acid are added to the sample for preservation. Sent to the lab to analyze for things like phosphorus and nitrogen.
- **Inorganics:** Collected in 1 liter bottle. No preservations are added. The sample is sent to the lab to be analyzed for things like hardness and calcium.



A few friendly volunteers: Burt, Lorley and Cocoa.

Collecting water quality samples is a four-step process:

1. Contact the AZWW coordinator to determine data needs and secure lab funding
2. Pick up the water sampling kit from the coordinator
3. Collect the samples at the designated location, following proper protocols
4. Drop the samples off to the coordinator

SAMPLE COLLECTION INFO CONT.



Water Quality Sampling Protocol

Once you have determined what samples are needed and the coordinator has given you the water sampling kit, you are ready to collect water quality samples. Refer to the water quality sampling checklist (download at azdeq.gov/azww/volunteers):

- **Date and time on Label:** Use a sharpie to add the sample date and time on the bottle. Double check that the Site ID and stream name were added to the bottle by the volunteer coordinator. If not, add the stream name. For example: *Fossil Creek at Waterfall*.
- **Tape:** Add a piece of tape over the labeled bottle. This prevents the information from being scrubbed off in the ice chest.
- **Gloves:** Gloves must be worn at all times when sampling to prevent contamination of the samples.
- **Triple rinse bottles:** Each bottle must be triple-rinsed using stream water. While wearing gloves and facing upstream, open a bottle and let stream water fill it halfway. Replace the cap, shake the bottle and empty the water downstream to prevent contamination of the sample. Repeat three times for each bottle. The sample bottles are certified lab bottles, but may have opened slightly while in transport to the sampling location. Rinsing the bottles helps decrease contamination. *NOTE: E. coli sample bottles will never be rinsed.*
- **Water collection:** Identify moving water, like a riffle or a run. Sampling a pool is the least desirable, try to avoid this if possible. If it's safe, walk out to the middle. Wait a few moments for the sediment to settle. While wearing gloves and facing upstream, collect the water quality sample. At some streams, a reach pole is used to collect the sample.



SAMPLE COLLECTION INFO CONT.

- **Data Form:** Fill out the data sheet with all of the sampling location information. Identify details like location sampled (riffle, run, pool), if a sample was collected using pole, and what type of sample was collected (Suspended Sediment, Nutrients, etc.).
- **Preservatives:** Open the nutrient sample, add 80 drops of sulfuric acid, and replace the lid. Invert the sample to distribute the preservative. For total metals, add 40 drops of nitric acid to the sample and follow the same process. Dissolved metals will not get acid until the sample has been filtered; the AZWW coordinator may sometimes filter the sample and add the acid once the water quality samples have been submitted. Note on the bottle and on the data form that the samples have been preserved.
- **Check lids:** Check that the sample bottle lids are on securely.
- **Ice chest:** Add all of the samples to an ice chest with cubed wet ice. Keeping the samples cool maintains the integrity of the samples.
- **Contact ADEQ:** Contact the AZWW coordinator to arrange a pickup time. The coordinator will then get the samples to the lab.

Collecting Water Quality Chemistry Control Samples:

As part of ADEQ's Quality Assurance Program Plan (QAPP), water quality chemistry control samples are collected and submitted to the lab as a check on equipment and processing. You may be asked to collect a quality assurance control sample. There are two types of control samples you may be handling:

Duplicate samples: a set of similar samples collected from the same site, at about the same time, and analyzed in the same manner.

Blank samples: pre-filled bottles with de-ionized water that travel in the ice chest and are taken to the sample site while you collect your regular sample. Blank samples provide a check for cross-contamination during sample collection and shipment. The program coordinator will provide you with extra bottles and help identify where and when the quality control samples will need to be collected.



AZWW volunteer Jerry processes a water quality sample.

E. COLI SAMPLING



E. COLI:

Samples are collected wearing gloves and using a sealed, sterile 100ml bottle submerged in the stream while facing upstream. The bottle should be opened and recapped under water during sampling so that surface contaminants are not sampled. *E. coli* has a 6-hour holding time. Time starts when the sample is collected. Samples must be chilled and processed within 6 hours of sample collection.

E. COLI: CIRCLE AND FILL IN APPLICABLE INFORMATION

DILUTION: NONE 1:10 1:100 MEDIA: COLILERT 18 COLILERT 24

	COLLECTED	INCUBATED	COUNTED	LRG. WELL	SM. WELL	MPN
REGULAR:				<input type="checkbox"/>	<input type="checkbox"/>	
	AM : : PM	AM : : PM	AM : : PM			
DUPLICATE:						
	AM : : PM	AM : : PM	AM : : PM			
DI BLANK:	NA	AM : : PM	AM : : PM			

1 of 2

1. Using a sharpie, label the bottle with site ID, date, and time.
2. Put gloves on.
3. Take the plastic seal off of the 100 ml plastic bottle.
4. Wade to the middle of the river and face your body upstream. If midstream cannot be safely accessed, collect *E. coli* (and other field parameters) in another location, but note it under the sample collection portion of the field form.
5. Exercise caution not to stir up sediment and prevent any cross contamination that might occur during the sampling process. Allow sediment to resettle if stirred up prior to collecting the *E. coli* sample.
6. Place the bottle roughly 6 inches below the surface of the water (facing upstream).
7. Open and recap the *E. coli* bottle under water during sampling so that surface contaminants are not sampled.
8. Place the *E. coli* bottle on ice as soon as possible for transportation to the lab
9. Be sure to write on the field form what time the *E. coli* sample was collected. Keep in mind that the sample has a 6-hour holding time until it will need to be processed.

For tips on *E. coli* sampling, processing and much more, check out our video micro-lessons at azdeq.gov/AZWW/Volunteers

E. COLI PROCESSING



E. coli Processing Steps

As mentioned before, *E. coli* has a 6-hour holding time and the clock starts ticking once the sample is collected in the 100 ml bottle. The *E. coli* processing mat can help walk you through each step for *E. coli* processing. Lay the placemat on a table, wipe down the mat using a 70% ethonol solution, and then put all of the items on top of the icons as you process. Steps 3-7 on the placemat will need to be repeated per *E. coli* sample. The processing mat can be found on our website or you can request one from the program coordinator.

1. Turn on sealer and incubator. Keep in mind that the incubator takes about 4 hours to heat up and you may want to turn it on prior to collecting the *E. coli* samples. Verify that the incubator is operating at 35 +/- 0.5° C.
2. Put gloves on.
3. Add site information on the back of the *E. coli* sampling tray. Information to include: site ID, date, time added to the incubator, and leave a space to add the time out (i.e., when you read the *E. coli* sample the following day). Be sure to add the time put into the incubator to the field form under the "incubated" clock icon.
4. Add the 24-hour media to the sample. Before adding, check that there is 100ml of water - if needed, pour some out until the water level is accurate. When opening the reagent packets, avoid inhaling the media.
5. Invert the bottle with the combined water and media inside, rotating gently to dissolve media.
6. Confirm that the green light on the sealer is on and the machine has warmed up. Gently pull the tray's foil tab to separate the foil from the tray. Avoid touching the inside of the foil or tray. Pour the mixture directly into the tray avoiding contact with the foil tab. Tap or gently flick the small wells 2-3 times to release any air bubbles.
7. Place the filled tray onto the rubber mat, aligning the wells with the holes. Feed them together through the sealer with the wells facing down. Remove the tray from the rubber mat and place the tray in the preheated incubator with the wells facing down.

After 24 hours, remove the samples from the incubator. Turn off the incubator if sampling is complete for the week.

8. Using a UV light in a dark area, mark the fluorescing wells with a permanent marker. Wells that are yellow under plain light are positive for total coliforms. Wells that are yellow under plain light *and* fluoresce under UV light are positive for *E. coli*. Count and record the number of *E. coli*-positive wells, large or small. Once the number of large and small wells is obtained, the "most probable number" (MPN) is recorded from the MPN table (see APPENDIX C).
9. Record the time the sample was read on the data form. Add the number of large wells, the number of small wells, and the MPN to the field data sheet.
10. The used *E. coli* bottles and trays are considered biohazards and will need to be placed in a bucket with water and a 10% bleach solution for one hour for decontamination. Score the back of the tray with a knife and uncap the bottles so the bleach can get inside the tray. After all trays and bottles have been bleached for an hour, they can be placed in the trash and the solution can be tipped down a drain with running water. An AZWW coordinator can provide a red biohazard bag for you to store your used samples for disposal.

E. COLI PROCESSING CONT.



CITIZEN SCIENCE
E. coli
Processing Mat

Wipe down mat, place equipment on images below, and follow step by step instructions.









1

Turn on sealer and incubator

Incubator should be turned on 4 hours prior to sampling

Set Incubator Temp to:
35 °C
Temperature Range +/- 0.5°C

2

Put gloves on

3

Add information to E. coli sampling tray:

- Site ID
- Date
- Time added to incubator
- Time out (to be filled in after 24 hours incubation)

4

Add media to E. coli bottle

5

Invert E. coli bottle until media is completely dissolved

1 of 2

6

Confirm sealer has heated up

Green light should be lit up on sealer

Pour the E. coli sample (with dissolved media) into the tray

Gently flick/tap bubbles from the bottom of the tray



Not to scale

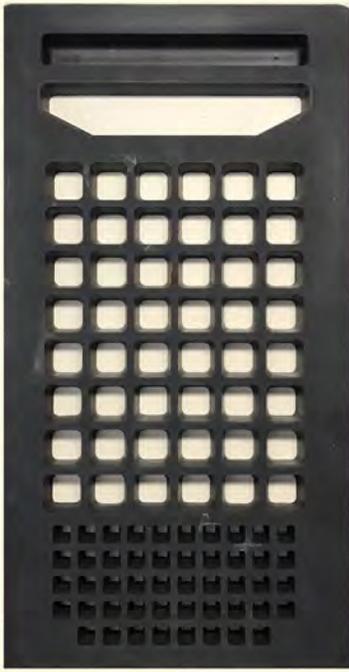
7

Align the tray with the rubber mat

Gently feed the rubber mat into the sealer (small cells first, white side up)

Remove the tray from the rubber mat and place the tray into the preheated incubator

Turn the sealer off



Not to scale

2 of 2

E. COLI PROCESSING CONT.



E. Coli Quality Control

It's recommended to take a daily quality control (QC) sample for *E. coli*. This can be done in two ways.

- **Duplicate:** Two *E. coli* samples are taken at the same location and same time, and the results should be within the 95% confidence interval of one another. An MPN generator software program can be downloaded for free from IDEXX at idexx.com/water/mpn-generator.html or you can email the coordinator to figure out what the 95% confidence interval should be.
- **Blank:** Where an *E. coli* bottle is filled with deionized water and processed. The results should all be clear and non-fluorescing, otherwise it's an indication there was contamination during processing and all samples from that day are invalid. Note accordingly on the datasheet in the *E. coli* section.

E. coli is a bacterial organism found in the guts of warm-blooded animals. Through various ways, *E. coli* can make its way into waterbodies and can potentially cause illness. *E. coli* is also an indicator species for all waterborne diseases (viral, bacterial, and parasitic). We use *E. coli* as a water quality indicator to give us insight into all waterborne diseases in a waterbody.

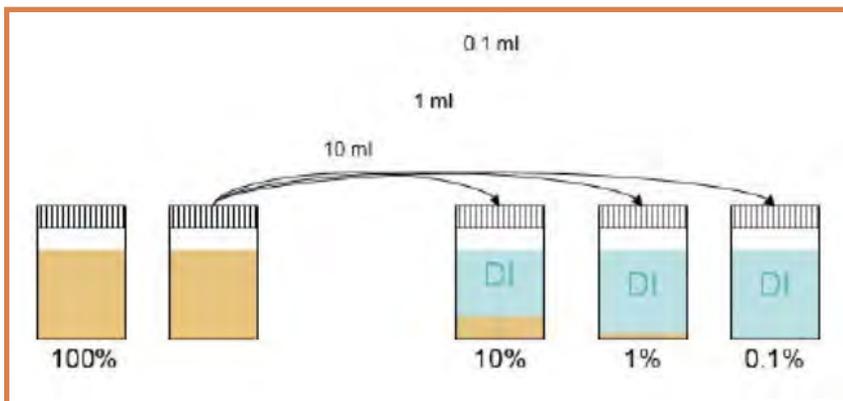
E. COLI PROCESSING CONT.

E. Coli Dilutions

If an *E. coli* sample is very turbid (looks like chocolate milk) it will most likely read above what the MPN table can calculate. The max reading is >2419.6 MPN. High MPN counts may be experienced during storm runoff events, high recreational periods, and downstream of known fecal pollution sources. To perform a dilution:

1. Collect samples in two separate bottles.
2. The first bottle is processed following the standard processing procedures outlined.
3. Using the second sample bottle, pipette 10ml of the sample into an empty *E. coli* bottle. Then repeat using a 1ml and 0.1ml pipette into separate IDEXX bottles. Add deionized water to each bottle, filling them to the 100ml line.
4. Prepare samples following the standard procedures outlined.
5. Multiply the dilution ratio by the result for each sample (see table below)
6. Enter the result from the dilution bottle with the greatest amount of sample. In the example given in Figure below, the value of 25,040 CFU/100 mL would be entered into the database.
7. Circle which dilution was done on the field form and add the calculated MPN value under the MPN calculator icon.

Dilution	MPN Value	Multiplier	Result
100%	Too numerous to count	1	Too numerous to count
10%	Too numerous to count	10	Too numerous to count
1%	250.4	100	25,040 CFU/100 mL
0.1%	47	1000	47,000 CFU/100mL



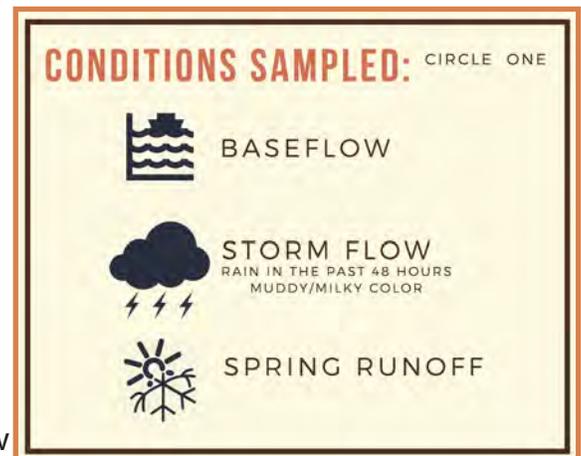
Bacteria dilutions of 100%, 10%, 1% and 0.1% for sites with bacteria that are expected to be greater than 2419.6 CFU/100 mL. The brown liquid is the sample, while the blue is deionized water.

CONDITIONS SAMPLED

CONDITIONS SAMPLED:

It's important to note what the weather conditions were within the 48 hours preceding the time of sampling. Rain can affect chemical and biological values and needs to be noted on the form. Some projects require storm flow samples, like ephemeral streams that do not flow year-round. Other projects require baseflow conditions to be sampled. Make sure to double check the projects SAP to confirm which condition is best suited for the project.

Select one of the three options: **baseflow** (the typical flow of the stream, most likely clear), **storm flow** (heavy rains within the past 48 hours and the stream is turbid and muddy looking), or **spring runoff** (increased flow due to snow melt can be clear or slightly milky).



Burt, an AZWW volunteer, and Cory, an ADEQ GIS expert, take a sampling break on the banks of Little Squaw Creek.

FIELD CALIBRATIONS

FIELD CALIBRATIONS:

Different multi-parameter probes and turbidity meters will have different protocols for calibration. Turbidity will need to be calibrated for every sampling event, while DO, pH and Specific Conductivity should be calibrated before a general sampling event. Refer to the appendices or the calibration manuals in the equipment case for details.

FIELD CALIBRATIONS: FILL IN THE BLANKS

DISSOLVED OXYGEN:
BP= _____ mmHg POST CAL= _____ %

TURBIDITY (NTU)
STANDARD= _____ STANDARD READING= _____

▲ PERCENT DIFFERENCE SHOULD BE LESS THAN 10%



Dissolved Oxygen Calibration

Calibrate for DO after using the multi-parameter probe at a site. See APPENDIX B for instructions, or watch the video micro-lesson at azdeq.gov/azww/volunteers.



Turbidity Calibration

Turbidity should be calibrated before every sample measured. Handle the glass cells with care. Smudging and scratches will affect the readings. See APPENDIX A for instructions, or watch the video micro-lesson at azdeq.gov/azww/volunteers. Also see APPENDIX A for instructions on turbidity dilutions.



Volunteers from Friends of Rio De Flag conduct wet-dry mapping.

FLOW DATA



FLOW DATA:

Measuring flow is vital to understanding how much water is at a point at a certain time. Flow can be calculated using the float method with a measuring tape, small plastic bottle, and a timer. Flow is best measured in a run, where there is water flowing smoothly.

FLOW DATA: FILL IN THE BLANKS

WIDTH (FT) x (AVG OF 3) DEPTH (FT) x (AVG OF 3) VELOCITY (FT/SEC) x 0.85 (CORRECTION FACTOR)

CIRCLE METHOD USED FOR FLOW: FLOAT METHOD: USGS GAGE:

Float Method Procedure

1. Determine the float reach (distance) by measuring and marking two points along the length of the channel. Try and get a length of at least 10 feet. Record this value on the field form under distance.
2. Measure three depths across at the channel cross-section. Average the 3 depths and record the value on the field form under depth.
3. Measure a representative width of the stream and record that value on the field form under width.
4. Partially fill the float bottle with water.
5. Two observers are best when calculating the velocity of the stream. One observer stands at the top of the reach and the second observer stands at the bottom of the reach with the times. The observer at the top of the reach gently tosses the float bottle into the channel above the marker and calls out "start" when it crosses the upstream point. The other observer stands at the bottom of the reach and presses start on the timer when observer one calls out "start" and waits for the float bottle to cross the second point. Make note of the time (in seconds) that it took to travel the reach.
6. Repeat the toss three times and average the three times together. Place this value on the field form under time.
7. Determine the flow, in cubic feet per second, by multiplying the width (ft) x average depth (ft) x ((distance (ft)/average time (seconds)) x 0.85. A coefficient of 0.85 is commonly used to convert the velocity of a surface float to mean velocity in the vertical (USGS Field Manual, 2004).
8. Record the CFS on the field data sheet.

PICTURES

PICTURES:

1. Stand in the middle of the stream, facing upstream, and take a landscape picture with your device.
2. Take four photos: upstream, downstream, right bank and left bank.
3. Walk the area and take pictures of anything of importance that might change or alter the quality of the stream. Things like bank sluffing, large trash items, wildlife, channel substrate, algae, etc.
4. Check the boxes on the field form after pictures have been collected.

PICTURES: TAKE THE FOLLOWING PHOTOGRAPHS AND ANYTHING OF INTEREST

UPSTREAM

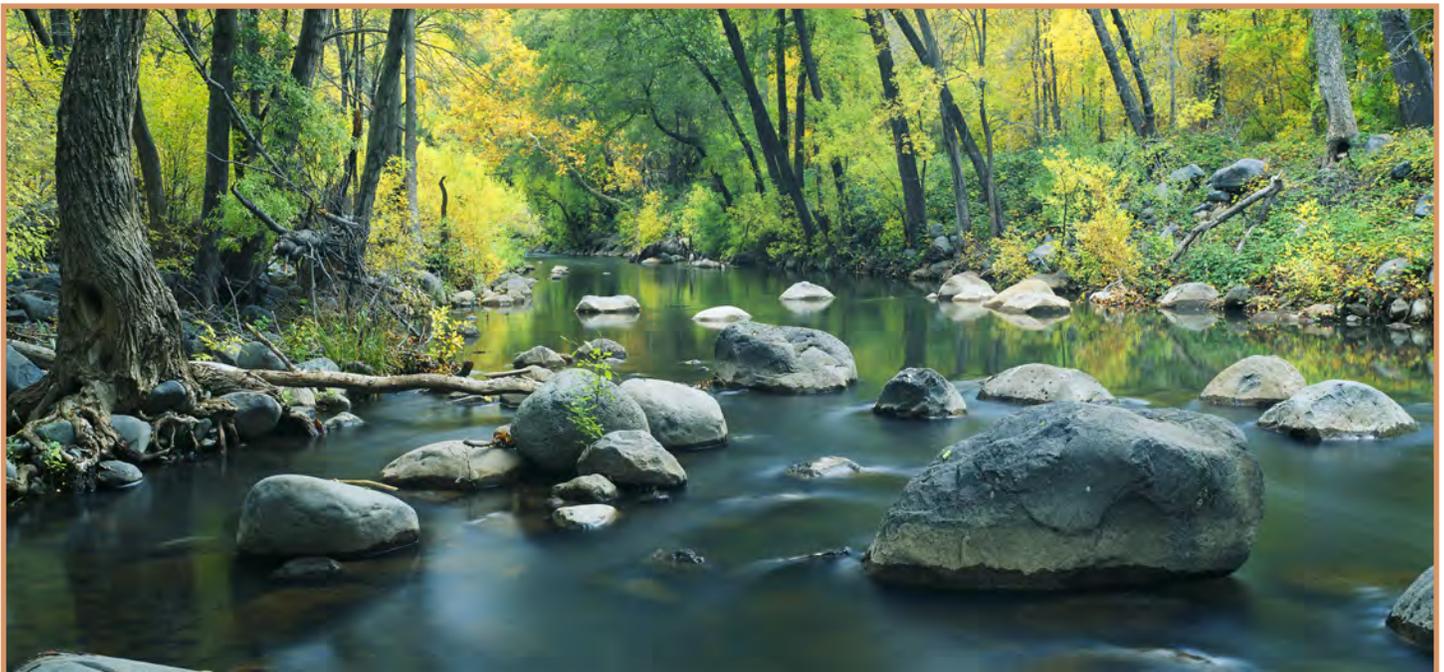
DOWNSTREAM

LEFT BANK RIGHT BANK

⚠ BANK DIRECTION DETERMINED BY LOOKING DOWNSTREAM

OTHER:

"Photography is a way of feeling, of touching, of loving.
What you have caught on film is captured forever...
it remembers little things long after you have
forgotten everything"
-Aaron Siskind



A stream near Sedona, Arizona.

FIELD NOTES

FIELD NOTES:

This is the perfect place to identify all things observed that are of importance to the waterbody. The note section is a great way to share what you saw, with others who were not there. Handwrite your notes and/or circle the icons to identify observations at the site.

FIELD NOTES:
TAKE DETAILED NOTES ABOUT THE STREAM AND THE WATERSHED.

FORM CHECKED BY: [Redacted]

SUGGESTED OBSERVATIONS FOR NOTES:

TRASH • WATER COLOR • ODOR • FISH • CRAYFISH
FROGS • LEAVES IN CHANNEL • ALGAE • MACROPHYTES
RIPARIAN • WILDLIFE • CATTLE • FIRE • BUGS

2 of 2

Potential Observations

Trash: Describe the quantity and type of trash in the stream and on the banks.

Water Color: Clear, Milky, light brown, dark brown, oily sheen?

Odor: Sewage, chlorine, fishy, rotten eggs?

Fish: Present? How many? Are they abundant?

Crayfish: Present? How many? Are they abundant?

Frogs: Present? How many? Are they abundant?

Leaves in channel: Absent? Rare? Common?

Algae: Estimate the percentage covering the stream bed 10 meters above water sampling site.

FIELD NOTES CONT.

Macrophytes: Estimate the percentage covering the stream bed 10 meters above water sampling site.

Riparian: Describe types and health of riparian vegetation.

Wildlife: Describe observations: feces, tracks, grazed vegetation, etc.

Cattle: Describe observations: feces, tracks, grazed vegetation, etc.

Fire: Describe observations: exposed soil, burnt vegetation, etc.

Bugs: Describe observations: aquatic bugs (flip over rocks), terrestrial bugs, etc.

Other (any details that would help gain a better understanding of the sampling site and details of the day):

- Equipment Issues
- Low Flow Conditions
- Dry Stream
- Fish Kill
- Flooding or signs of flooding (debris)
- Any changes in protocol/techniques



Sierra Club volunteers gather field conditions at Verde River.

FIELD FORM SIGNOFF

Have a colleague read over the field form to ensure that all necessary items were collected. Look to make sure that all blank lines and check boxes have been filled in and marked. Ensure that photos were collected. Ask questions to the note taker if something wasn't clear in the notes. Once the team agrees that everything is complete, sign your initials in the form checked by box under the field note section. This is common practice with field forms and it's proven to be a useful tool!



Patagonia Area Watershed Study (PAWS) completes AZWW training.



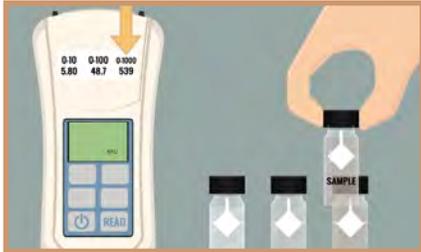
Meghan, Kitch, Tricia and Jessica done sampling for the day.

APPENDIX A: USING A TURBIDITY METER



Calibration

At your site, collect your water sample by rinsing the vial three times and then filling it with the stream water, then tighten the cap. Take your sample back to a flat, dry surface to use your turbidity meter.



Before measuring any sample, you'll need to calibrate the meter each time.

Locate the three gel standard vials that are included with your meter. Choose the standard which most closely matches your sample in turbidity, or cloudiness. Record the sample value from the bottle in your field data form in "Field Calibrations," under "Turbidity - Standard."

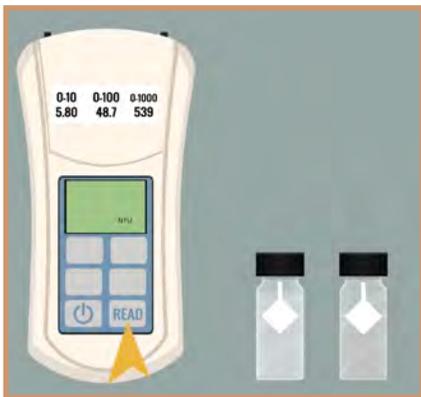


Clean the outer surface with the velvet cloth included with the meter. Press POWER to turn it on. Insert the vial into the meter so that the tip of the white diamond on the vial aligns with the indicator near the hole. Close the lid and press "READ" – the display value should be within a 10% difference of the standard vial label. If not, you may try to re-clean and re-oil the vial to take another measurement. Record the value on your data form under "Field Calibrations" and "Turbidity – Standard Reading."

Remove the calibration vial from the meter.

Measurement

With your meter still powered on, and the outside of the vial dried and clean, place your sample vial in the meter so that the tip of the white diamond aligns with the indicator near the hole. Close the lid and press "READ".



Write the value from the screen on your data form under "Field Data – Turbidity."

Now remove the sample, and be sure to calibrate again with any samples you are measuring at any other site.

APPENDIX B: USING A MULTI-PARAMETER PROBE



Before You Go: pH Calibration

Remove the probe from the case and empty the storage solution. Turn on the iPod, open iSitu and press the FLASK icon. pH is a two-point calibration, which means you will have two buffer solutions – one labelled pH 7 and one labelled pH 10.



First, fill the calibration cup with pH 7 solution to the line and submerge the probes. In your iSitu app, tap the FLASK icon, then “pH Sensor: 2-point Calibration”.

Place the probe into the calibration cup and press START. When the calibration is stable, tap ACCEPT. Write down the pH 7 level on your Pre-Calibration form. Remove the probe from calibration cup and rinse the cup and sensors with DI water.



Now, fill the calibration cup with pH 10 solution to the line, and submerge the probes. Repeat the process and write down your pH 10 level on your pre-calibration form. Remove the probe from calibration cup and rinse the cup and sensors with DI water. After calibration, place a wet sponge in the calibration cup while storing the probe to keep the sensors moist while traveling.

After You Finish: Multi-Parameter Calibration

After you return from sampling, remove the probe from the case and remove the sponge. Rinse the probe, re-dampen the sponge and place it in the vented calibration cup. Turn on the iPod, open iSitu and press the FLASK icon.



Calibrating Dissolved Oxygen:

From your FLASK icon, tap “RDO Sensor”, then “100% Saturation”. Now place the probe into the calibration cup and tap START. When the calibration is stable, tap ACCEPT. Write down the Saturation Percentage and the Barometric Pressure in your Pre-Calibration form.

APPENDIX B: USING A MULTI-PARAMETER PROBE CONT.

When finished, remove probe and sponge from the calibration cup and rinse the cup and sensors with DI water.

Post-Sampling pH Calibration:

Fill the calibration cup with pH 7 solution and insert the probe. Read the pH value from the home screen and record it on your form. Remove the probe and rinse the cup and sensors with DI water.



Next, fill the calibration cup with pH 10 solution and insert the probe. Read the pH value from the home screen and record it on your form. Remove the probe and rinse the cup and sensors with DI water.

Post-Sampling Specific Conductivity Calibration:

Fill the calibration cup with conductivity solution and insert the probe. Read the Specific Conductivity value from the home screen and record it on your form. Remove the probe and rinse the cup and sensors with DI water. The result should be within 10% of the original pH calibration.



Place the plastic sleeve back on the probe and add the storage solution to the line. Be sure to store the probe upright so that the storage solution does not leak out.

APPENDIX C: MOST PROBABLE NUMBER (MPN) TABLE

INDEXX Quanti-Tray® /2000 MPN Table (per 100ml) # Small Wells Positive

# Large Wells Positive	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	<1	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.1	15.1	16.1	17.1	18.1	19.1	20.2	21.2	22.2	23.3	24.3
1	2.0	3.0	4.0	5.0	6.0	7.1	8.1	9.1	10.1	11.1	12.1	13.2	14.2	15.2	16.2	17.3	18.3	19.3	20.4	21.4	22.4	23.5	24.5	25.6	26.6
2	2.0	3.0	4.1	5.1	6.1	7.1	8.1	9.2	10.2	11.2	12.2	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.6	21.6	22.7	23.7	24.8	25.8	26.9
3	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.3	11.3	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.7	20.8	21.8	22.9	23.9	25.0	26.1	27.1	28.2
4	4.1	5.2	6.2	7.2	8.3	9.3	10.4	11.4	12.5	13.5	14.6	15.6	16.7	17.8	18.8	19.9	21.0	22.0	23.1	24.2	25.3	26.3	27.4	28.5	29.6
5	5.2	6.3	7.3	8.4	9.4	10.5	11.5	12.6	13.7	14.7	15.8	16.9	17.9	19.0	20.1	21.2	22.2	23.3	24.4	25.5	26.6	27.7	28.8	29.9	31.0
6	6.3	7.4	8.4	9.5	10.6	11.6	12.7	13.8	14.9	16.0	17.0	18.1	19.2	20.3	21.4	22.5	23.6	24.7	25.8	26.9	28.0	29.1	30.2	31.3	32.4
7	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	26.0	27.1	28.3	29.4	30.5	31.6	32.8	33.9
8	8.6	9.7	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.8	22.9	24.1	25.2	26.3	27.4	28.6	29.7	30.8	32.0	33.1	34.3	35.4
9	9.8	10.9	12.0	13.1	14.2	15.3	16.4	17.6	18.7	19.8	20.9	22.0	23.2	24.3	25.4	26.6	27.7	28.9	30.0	31.2	32.3	33.5	34.6	35.8	37.0
10	11.0	12.1	13.2	14.4	15.5	16.6	17.7	18.9	20.0	21.1	22.3	23.4	24.6	25.7	26.9	28.0	29.2	30.3	31.5	32.7	33.8	35.0	36.2	37.4	38.6
11	12.2	13.4	14.5	15.6	16.8	17.9	19.1	20.2	21.4	22.5	23.7	24.8	26.0	27.2	28.3	29.5	30.7	31.9	33.0	34.2	35.4	36.6	37.8	39.0	40.2
12	13.5	14.6	15.8	16.9	18.1	19.3	20.4	21.6	22.8	23.9	25.1	26.3	27.5	28.6	29.8	31.0	32.2	33.4	34.6	35.8	37.0	38.2	39.5	40.7	41.9
13	14.8	16.0	17.1	18.3	19.5	20.6	21.8	23.0	24.2	25.4	26.6	27.8	29.0	30.2	31.4	32.6	33.8	35.0	36.2	37.5	38.7	39.9	41.2	42.4	43.6
14	16.1	17.3	18.5	19.7	20.9	22.1	23.3	24.5	25.7	26.9	28.1	29.3	30.5	31.7	33.0	34.2	35.4	36.7	37.9	39.1	40.4	41.6	42.9	44.2	45.4
15	17.5	18.7	19.9	21.1	22.3	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33.3	34.6	35.8	37.1	38.4	39.6	40.9	42.2	43.4	44.7	46.0	47.3
16	18.9	20.1	21.3	22.6	23.8	25.0	26.2	27.5	28.7	30.0	31.2	32.5	33.7	35.0	36.3	37.5	38.8	40.1	41.4	42.7	44.0	45.3	46.6	47.9	49.2
17	20.3	21.6	22.8	24.1	25.3	26.6	27.8	29.1	30.3	31.6	32.9	34.1	35.4	36.7	38.0	39.3	40.6	41.9	43.2	44.5	45.9	47.2	48.5	49.8	51.2
18	21.8	23.1	24.3	25.6	26.9	28.1	29.4	30.7	32.0	33.3	34.6	35.9	37.2	38.5	39.8	41.1	42.4	43.8	45.1	46.5	47.8	49.2	50.5	51.9	53.2
19	23.3	24.6	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.3	37.6	39.0	40.3	41.6	43.0	44.3	45.7	47.1	48.4	49.8	51.2	52.6	54.0	55.4
20	24.9	26.2	27.5	28.8	30.1	31.5	32.8	34.1	35.4	36.8	38.1	39.5	40.8	42.2	43.6	44.9	46.3	47.7	49.1	50.5	51.9	53.3	54.7	56.1	57.6
21	26.5	27.9	29.2	30.5	31.8	33.2	34.5	35.9	37.3	38.6	40.0	41.4	42.8	44.1	45.5	46.9	48.4	49.8	51.2	52.6	54.1	55.5	56.9	58.4	59.9
22	28.2	29.5	30.9	32.3	33.6	35.0	36.4	37.7	39.1	40.5	41.9	43.3	44.6	46.0	47.4	48.8	50.2	51.6	53.0	54.4	55.8	57.2	58.6	60.0	61.4
23	29.9	31.3	32.7	34.1	35.5	36.8	38.3	39.7	41.1	42.5	43.9	45.4	46.8	48.3	49.7	51.2	52.7	54.2	55.6	57.1	58.6	60.1	61.6	63.1	64.6
24	31.7	33.1	34.5	35.9	37.3	38.8	40.2	41.7	43.1	44.6	46.0	47.5	49.0	50.5	52.0	53.5	55.0	56.5	58.0	59.5	61.1	62.6	64.2	65.8	67.3
25	33.6	35.0	36.4	37.9	39.3	40.8	42.2	43.7	45.2	46.7	48.2	49.7	51.2	52.7	54.3	55.8	57.3	58.9	60.5	62.0	63.6	65.2	66.8	68.4	70.0
26	35.5	36.9	38.4	39.9	41.4	42.8	44.3	45.9	47.4	48.9	50.4	52.0	53.5	55.1	56.7	58.2	59.8	61.4	63.0	64.7	66.3	67.9	69.6	71.2	72.9
27	37.4	38.9	40.4	42.0	43.5	45.0	46.5	48.1	49.6	51.2	52.8	54.4	56.0	57.6	59.2	60.8	62.4	64.1	65.7	67.4	69.1	70.8	72.5	74.2	75.9
28	39.5	41.0	42.6	44.1	45.7	47.3	48.8	50.4	52.0	53.6	55.2	56.9	58.5	60.2	61.8	63.5	65.2	66.9	68.6	70.3	72.0	73.7	75.5	77.3	79.0
29	41.7	43.2	44.8	46.4	48.0	49.6	51.2	52.8	54.5	56.1	57.8	59.5	61.2	62.9	64.6	66.3	68.0	69.8	71.5	73.3	75.1	76.9	78.7	80.5	82.4
30	43.9	45.5	47.1	48.7	50.4	52.0	53.7	55.4	57.1	58.8	60.5	62.2	64.0	65.7	67.5	69.3	71.0	72.9	74.7	76.5	78.3	80.2	82.1	84.0	85.9
31	46.2	47.9	49.5	51.2	52.9	54.6	56.3	58.1	59.8	61.6	63.3	65.1	66.9	68.7	70.5	72.4	74.2	76.1	78.0	79.9	81.8	83.7	85.7	87.6	89.6
32	48.7	50.4	52.1	53.8	55.6	57.3	59.1	60.9	62.7	64.5	66.3	68.2	70.0	71.9	73.8	75.7	77.6	79.5	81.5	83.5	85.4	87.5	89.5	91.5	93.6
33	51.2	53.0	54.8	56.5	58.3	60.2	62.0	63.8	65.7	67.6	69.5	71.4	73.3	75.2	77.2	79.2	81.2	83.2	85.2	87.3	89.3	91.4	93.6	95.7	97.8
34	53.9	55.7	57.6	59.4	61.3	63.1	65.0	67.0	68.9	70.8	72.8	74.8	76.8	78.8	80.8	82.9	85.0	87.1	89.2	91.4	93.5	95.7	97.9	100.2	102.4
35	56.8	58.6	60.5	62.4	64.4	66.3	68.3	70.3	72.3	74.3	76.3	78.4	80.5	82.6	84.7	86.9	89.1	91.3	93.5	95.7	98.0	100.3	102.6	105.0	107.3
36	59.8	61.7	63.7	65.7	67.7	69.7	71.7	73.8	75.9	78.0	80.1	82.3	84.5	86.7	88.9	91.2	93.5	95.8	98.1	100.5	102.9	105.3	107.7	110.2	112.7
37	62.9	65.0	67.0	69.1	71.2	73.3	75.4	77.6	79.8	82.0	84.2	86.5	88.8	91.1	93.4	95.8	98.2	100.6	103.1	105.6	108.1	110.7	113.3	115.9	118.6
38	66.3	68.4	70.6	72.7	74.9	77.1	79.4	81.6	83.9	86.2	88.6	91.0	93.4	95.8	98.3	100.8	103.4	106.0	108.6	111.2	113.9	116.6	119.4	122.2	125.0
39	70.0	72.2	74.4	76.7	78.9	81.3	83.6	86.0	88.4	90.9	93.4	95.9	98.4	101.0	103.6	106.3	109.0	111.8	114.6	117.4	120.3	123.2	126.1	129.2	132.2
40	73.8	76.2	78.5	80.9	83.3	85.7	88.2	90.8	93.3	95.9	98.4	101.1	103.9	106.7	109.5	112.4	115.3	118.2	121.2	124.3	127.4	130.5	133.7	137.0	140.3
41	78.0	80.5	83.0	85.5	88.0	90.6	93.3	95.9	98.7	101.4	104.3	107.1	110.0	113.0	116.0	119.1	122.2	125.4	128.7	132.0	135.4	138.8	142.3	145.9	149.5
42	82.6	85.2	87.8	90.5	93.2	96.0	98.8	101.7	104.6	107.6	110.6	113.7	116.9	120.1	123.4	126.7	130.1	133.6	137.2	140.8	144.5	148.3	152.2	156.1	160.2
43	87.6	90.4	93.2	96.0	99.0	101.9	105.0	108.1	111.2	114.5	117.8	121.1	124.6	128.1	131.7	135.4	139.1	143.0	147.0	151.0	155.2	159.4	163.8	168.2	172.8
44	93.1	96.1	99.1	102.2	105.4	108.6	111.9	115.3	118.7	122.3	125.9	129.6	133.4	137.4	141.4	145.5	149.7	154.1	158.5	163.1	167.9	172.7	177.7	182.9	188.2
45	99.3	102.5	105.8	109.2	112.6	116.2	119.8	123.6	127.4	131.4	135.4	139.6	143.9	148.3	152.9	157.6	162.4	167.4	172.6	178.0	183.5	189.2	195.1	201.2	207.5
46	106.3	109.8	113.4	117.2	121.0	125.0	129.1	133.3	137.6	142.1	146.7	151.5	156.5	161.6	167.0	172.5	178.2	184.2	190.4	196.8	203.5	210.5	217.8	225.4	233.3
47	114.3	118.3	122.4	126.6	130.9	135.4	140.1	145.0	150.0	155.2	160.7	166.4	172.3	178.5	185.0	191.8	198.9	206.4	214.2	222.4	231.0	240.0	249.5	259.5	270.0
48	123.9	128.4	133.1	137.9	143.0	148.3	153.9	159.7	165.8	172.2	178.9	186.0	193.5	201.4	209.8	218.7	228.2	238.2	248.9	260.3	272.3	285.1	298.7	313.0	328.2
49	135.5	140.8	146.4	152.3	158.5	165.0	172.0	179.3	187.2	195.6	204.6	214.3	224.7	235.9	248.1	261.3	275.5	290.9	307.6	325.5	344.8	365.4	387.3	410.6	435.2

APPENDIX C: MOST PROBABLE NUMBER (MPN) TABLE CONT.

INDEXX Quanti-Tray® /2000 MPN Table (per 100ml) # Small Wells Positive

# Large Wells Positive	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
0	25.3	26.4	27.4	28.4	29.5	30.5	31.5	32.6	33.6	34.7	35.7	36.8	37.8	38.9	40.0	41.0	42.1	43.1	44.2	45.3	46.3	47.4	48.5	49.5
1	26.6	27.7	28.7	29.8	30.8	31.9	32.9	34.0	35.0	36.1	37.2	38.2	39.3	40.4	41.4	42.5	43.6	44.7	45.7	46.8	47.9	49.0	50.1	51.2
2	27.9	29.0	30.0	31.1	32.2	33.2	34.3	35.4	36.5	37.5	38.6	39.7	40.8	41.9	43.0	44.0	45.1	46.2	47.3	48.4	49.5	50.6	51.7	52.8
3	29.3	30.4	31.4	32.5	33.6	34.7	35.8	36.8	37.9	39.0	40.1	41.2	42.3	43.4	44.5	45.6	46.7	47.8	48.9	50.0	51.2	52.3	53.4	54.5
4	30.7	31.8	32.8	33.9	35.0	36.1	37.2	38.3	39.4	40.5	41.6	42.8	43.9	45.0	46.1	47.2	48.3	49.5	50.6	51.7	52.9	54.0	55.1	56.3
5	32.1	33.2	34.3	35.4	36.5	37.6	38.7	39.9	41.0	42.1	43.2	44.4	45.5	46.6	47.7	48.9	50.0	51.2	52.3	53.5	54.6	55.8	56.9	58.1
6	33.5	34.7	35.8	36.9	38.0	39.2	40.3	41.4	42.6	43.7	44.8	46.0	47.1	48.3	49.4	50.6	51.7	52.9	54.1	55.2	56.4	57.6	58.7	59.9
7	35.0	36.2	37.3	38.4	39.6	40.7	41.9	43.0	44.2	45.3	46.5	47.7	48.8	50.0	51.2	52.3	53.5	54.7	55.9	57.1	58.3	59.4	60.6	61.8
8	36.6	37.7	38.9	40.0	41.2	42.3	43.5	44.7	45.9	47.0	48.2	49.4	50.6	51.8	53.0	54.1	55.3	56.5	57.7	59.0	60.2	61.4	62.6	63.8
9	38.1	39.3	40.5	41.6	42.8	44.0	45.2	46.4	47.6	48.8	50.0	51.2	52.4	53.6	54.8	56.0	57.2	58.4	59.7	60.9	62.1	63.4	64.6	65.8
10	39.7	40.9	42.1	43.3	44.5	45.7	46.9	48.1	49.3	50.6	51.8	53.0	54.2	55.5	56.7	57.9	59.2	60.4	61.7	62.9	64.2	65.4	66.7	67.9
11	41.4	42.6	43.8	45.0	46.3	47.5	48.7	49.9	51.2	52.4	53.7	54.9	56.1	57.4	58.6	59.9	61.2	62.4	63.7	65.0	66.3	67.5	68.8	70.1
12	43.1	44.3	45.6	46.8	48.1	49.3	50.6	51.8	53.1	54.3	55.6	56.8	58.1	59.4	60.7	62.0	63.2	64.5	65.8	67.1	68.4	69.7	71.0	72.4
13	44.9	46.1	47.4	48.6	49.9	51.2	52.5	53.7	55.0	56.3	57.6	58.9	60.2	61.5	62.8	64.1	65.4	66.7	68.0	69.3	70.7	72.0	73.3	74.7
14	46.7	48.0	49.3	50.5	51.8	53.1	54.4	55.7	57.0	58.3	59.6	60.9	62.3	63.6	64.9	66.3	67.6	68.9	70.3	71.6	73.0	74.4	75.7	77.1
15	48.6	49.9	51.2	52.5	53.8	55.1	56.4	57.8	59.1	60.4	61.8	63.1	64.5	65.8	67.2	68.5	69.9	71.3	72.6	74.0	75.4	76.8	78.2	79.6
16	50.5	51.8	53.2	54.5	55.8	57.2	58.5	59.9	61.2	62.6	64.0	65.3	66.7	68.1	69.5	70.9	72.3	73.7	75.1	76.5	77.9	79.3	80.8	82.2
17	52.5	53.9	55.2	56.6	58.0	59.3	60.7	62.1	63.5	64.9	66.3	67.7	69.1	70.5	71.9	73.3	74.8	76.2	77.6	79.1	80.5	82.0	83.5	84.9
18	54.6	56.0	57.4	58.8	60.2	61.6	63.0	64.4	65.8	67.2	68.6	70.1	71.5	73.0	74.4	75.9	77.3	78.8	80.3	81.8	83.3	84.8	86.3	87.8
19	56.8	58.2	59.6	61.0	62.4	63.9	65.3	66.8	68.2	69.7	71.1	72.6	74.1	75.5	77.0	78.5	80.0	81.5	83.1	84.6	86.1	87.6	89.2	90.7
20	59.0	60.4	61.9	63.3	64.8	66.3	67.7	69.2	70.7	72.2	73.7	75.2	76.7	78.2	79.8	81.3	82.8	84.4	85.9	87.5	89.1	90.7	92.2	93.8
21	61.3	62.8	64.3	65.8	67.3	68.8	70.3	71.8	73.3	74.9	76.4	77.9	79.5	81.0	82.6	84.2	85.8	87.4	89.0	90.6	92.2	93.8	95.4	97.1
22	63.8	65.3	66.8	68.3	69.8	71.4	72.9	74.5	76.1	77.6	79.2	80.8	82.4	84.0	85.6	87.2	88.9	90.5	92.1	93.8	95.5	97.1	98.8	100.5
23	66.3	67.8	69.4	71.0	72.5	74.1	75.7	77.3	78.9	80.5	82.2	83.8	85.4	87.1	88.7	90.4	92.1	93.8	95.5	97.2	98.9	100.6	102.4	104.1
24	68.9	70.5	72.1	73.7	75.3	77.0	78.6	80.3	81.9	83.6	85.2	86.9	88.6	90.3	92.0	93.8	95.5	97.2	99.0	100.7	102.5	104.3	106.1	107.9
25	71.7	73.3	75.0	76.6	78.3	80.0	81.7	83.3	85.1	86.8	88.5	90.2	92.0	93.7	95.5	97.3	99.1	100.9	102.7	104.5	106.3	108.2	110.0	111.9
26	74.6	76.3	78.0	79.7	81.4	83.1	84.8	86.6	88.4	90.1	91.9	93.7	95.5	97.3	99.2	101.0	102.9	104.7	106.6	108.5	110.4	112.3	114.2	116.2
27	77.6	79.4	81.1	82.9	84.6	86.4	88.2	90.0	91.9	93.7	95.5	97.4	99.3	101.2	103.1	105.0	106.9	108.8	110.7	112.7	114.7	116.7	118.7	120.7
28	80.8	82.6	84.4	86.3	88.1	89.9	91.8	93.7	95.6	97.5	99.4	101.3	103.3	105.2	107.2	109.2	111.2	113.2	115.2	117.3	119.3	121.4	123.5	125.6
29	84.2	86.1	87.9	89.8	91.7	93.7	95.6	97.5	99.5	101.5	103.5	105.5	107.5	109.5	111.6	113.7	115.7	117.8	120.0	122.1	124.2	126.4	128.6	130.8
30	87.8	89.7	91.7	93.6	95.6	97.6	99.6	101.6	103.7	105.7	107.8	109.9	112.0	114.2	116.3	118.5	120.6	122.8	125.1	127.3	129.5	131.8	134.1	136.4
31	91.6	93.6	95.6	97.7	99.7	101.8	103.9	106.0	108.2	110.3	112.5	114.7	116.9	119.1	121.4	123.6	125.9	128.2	130.5	132.9	135.3	137.7	140.1	142.5
32	95.7	97.8	99.9	102.0	104.2	106.3	108.5	110.7	113.0	115.2	117.5	119.8	122.1	124.5	126.8	129.2	131.6	134.0	136.5	139.0	141.5	144.0	146.6	149.1
33	100.0	102.2	104.4	106.6	108.9	111.2	113.5	115.8	118.2	120.5	122.9	125.4	127.8	130.3	132.8	135.3	137.8	140.4	143.0	145.6	148.3	150.9	153.7	156.4
34	104.7	107.0	109.3	111.7	114.0	116.4	118.9	121.3	123.8	126.3	128.8	131.4	134.0	136.6	139.2	141.9	144.6	147.4	150.1	152.9	155.7	158.6	161.5	164.4
35	109.7	112.2	114.6	117.1	119.6	122.2	124.7	127.3	129.9	132.6	135.3	138.0	140.8	143.6	146.4	149.2	152.1	155.0	158.0	161.0	164.0	167.1	170.2	173.3
36	115.2	117.8	120.4	123.0	125.7	128.4	131.1	133.9	136.7	139.5	142.4	145.3	148.3	151.3	154.3	157.3	160.5	163.6	166.8	170.0	173.3	176.6	179.9	183.3
37	121.3	124.0	126.8	129.6	132.4	135.3	138.2	141.2	144.2	147.3	150.3	153.5	156.7	159.9	163.1	166.5	169.8	173.2	176.7	180.2	183.7	187.3	191.0	194.7
38	127.9	130.8	133.8	136.8	139.9	143.0	146.2	149.4	152.6	155.9	159.2	162.6	166.1	169.6	173.2	176.8	180.4	184.2	188.0	191.8	195.7	199.7	203.7	207.7
39	135.3	138.5	141.7	145.0	148.3	151.7	155.1	158.6	162.1	165.7	169.4	173.1	176.9	180.7	184.7	188.7	192.7	196.8	201.0	205.3	209.6	214.0	218.5	223.0
40	143.7	147.1	150.6	154.2	157.8	161.5	165.3	169.1	173.0	177.0	181.1	185.2	189.4	193.7	198.1	202.5	207.1	211.7	216.4	221.1	226.0	231.0	236.0	241.1
41	153.2	157.0	160.9	164.8	168.9	173.0	177.2	181.5	185.8	190.3	194.8	199.5	204.2	209.1	214.0	219.1	224.2	229.4	234.8	240.2	245.8	251.5	257.2	263.1
42	164.3	168.6	172.9	177.3	181.9	186.5	191.3	196.1	201.1	206.2	211.4	216.7	222.2	227.7	233.2	238.7	244.2	250.0	255.5	261.3	267.3	273.6	279.6	286.6
43	177.5	182.3	187.3	192.4	197.6	202.9	208.4	214.0	219.8	225.8	231.8	238.1	244.5	251.0	257.7	264.6	271.7	278.9	286.3	293.8	301.5	309.4	317.4	325.7
44	193.6	199.3	205.1	211.0	217.2	223.5	230.0	236.7	243.6	250.8	258.1	265.6	273.3	281.2	289.4	297.8	306.3	315.1	324.1	333.3	342.8	352.4	362.3	372.4
45	214.1	220.9	227.9	235.2	242.7	250.4	258.4	266.7	275.3	284.1	293.3	302.6	312.3	322.3	332.5	343.0	353.8	364.9	376.2	387.9	399.8	412.0	424.5	437.4
46	241.5	250.0	258.9	268.2	277.8	287.8	298.1	308.8	319.9	331.4	343.3	355.5	368.1	381.1	394.5	408.3	422.5	437.1	452.0	467.4	483.3	499.6	516.3	533.5
47	280.9	292.4	304.4	316.9	330.0	343.6	357.8	372.5	387.7	403.4	419.8	436.6	454.1	471.1	490.7	509.8	550.4	571.7	593.8	616.7	640.5	665.3	691.0	717.2
48	344.1	360.9	378.4	396.8	416.0	436.0	456.9	478.6	501.2	524.7	549.3	574.8	601.5	629.4	658.6	689.3	721.5	755.6	791.5	829.7	870.4	913.9	960.6	1011.2
49	461.1	488.4	517.2	547.5	579.4	613.1	648.8	686.7	727.0	770.1	816.4	866.4	920.8	980.4	1046.2	1119.9	1203.3	1299.7	1413.6	1553.1	1732.9	1986.3	2419.6	>2419.6

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