Advanced Water Quality Monitoring and Analysis
Life Science: Grades 7-12

Enduring Understandings

1. Understand and be able to list and describe important water quality factors (temperature, transparency, pH, electrical conductivity, alkalinity, nitrate, dissolved oxygen) and describe natural conditions and human activities that affect each factor.
2. Understand that water quality factors are interrelated and change over time as a result of both natural and anthropogenic conditions.
3. Understand that water quality affects aquatic life and human uses of water.
4. Accurately implement scientific protocols and use scientific equipment and technology to accurately collect data and communicate results to appropriate audiences.
5. When appropriate, use protocols learned in the laboratory to conduct water quality fieldwork at a nearby riparian area and analyze and interpret data and communicate results to appropriate audiences.

<table>
<thead>
<tr>
<th>Enduring Understanding(s)</th>
<th>Activity</th>
<th>Concept(s)</th>
<th>Arizona Education Standards</th>
<th>Materials Needed</th>
</tr>
</thead>
</table>
| 1, 2, 3                   | The GLOBE Program, the Hydrologic Cycle and Riparian Areas | Hydrologic cycle, Riparian areas, Watersheds, Ecosystems, Surface Water – Temporary or Permanent, Aquatic Life, Impacts on riparian areas, Factors affecting riparian areas | **Language Arts**
R-E1
R-E2
R-E5
W-E1
**Science**
Strand 1: Concept 1
Strand 3: Concept 1, 2
Strand 6: Concept 1
**Social Studies**
3SS-E7
3SS-E8
3SS-P2
3SS-P4 | Student Manual
Transparency of the hydrologic cycle
GLOBE Special Topics video (GLOBE Program Overview) |
| 2, 3                      | The Blue Traveler (Discover a Watershed, p. A simulation of the movement of water within and between | **Language Arts**
WE-1 | 9 Natural system game boards and explanation cards
9 Natural system station cards |
15) **natural and constructed systems. Understanding water’s movement on the planet supports water conservation measures.**

**Science**
- Strand 2: Concept 1, 2
- Strand 3: Concept 1, 2
- Strand 5: Concept 1
- Strand 6: Concept 1

**Social Studies**
- 3SS-E7
- 3SS-P4

19 natural/constructed system game boards and explanation cards
19 natural/constructed system station cards
19 dice
*Water Journey Map, Part I* (one per student)
*Water Journey Map, Part II* (one per student)
*Water Molecule Movement* (one per student)

| 1, 2, 3, 4 5 – if use field site | **Water Temperature** | Temperature allows us to better understand other hydrology measurements such as pH, dissolved oxygen, and conductivity. Temperature influences the amount and diversity of aquatic life. Water temperature is important for understanding local and global weather patterns. | **Language Arts**
- R-E1
- R-E2
- R-E5
- W-E1

**Science**
- Strand 1: Concept 1, 2, 3, 4
- Strand 2: Concept 2
- Strand 3: Concept 1, 2

**Mathematics**
- 1M-E5 (PO2)

Student Manual
- Transparencies: Optimal Temperature Ranges for Aquatic Life, Hot Discussion Topic – Thermometers
- GLOBE Water Temperature Protocol Field Guide – 2 for each group
- 7 Thermometers
- 7 Beakers of water at room temperature labeled 1-7
- Clock or watch

| 1, 2, 3, 4 5 – if use field site | **Electrical Conductivity and pH** | Fresh water has many natural impurities. These impurities include salts or minerals we cannot always see or smell. We call the amount of mineral and salt impurities in the water the total dissolved solids (TDS). One way to measure impurities in water is to find out if it conducts electricity. pH measures the acid content of water. Solutions with a pH greater than 7.0 are classified as basic and ones with a pH less than 7.0 are classified as acidic. | **Language Arts**
- R-E1
- R-E2
- R-E5
- W-E1

**Science**
- Strand 1: Concept 1, 2, 3, 4
- Strand 2: Concept 2
- Strand 3: Concept 1, 2

**Mathematics**
- 1M-E5

Student Manual
- GLOBE Electrical Conductivity Protocol Field Guide – 2 for each group
- GLOBE Using a pH Protocol Field Guide (both EC greater than 200 µS/cm and the EC less than 200 µS/cm) – 2 for each group
- 4 pH meters
- 4 EC meters
- 7 Thermometers
- 14 labeled cups
- 7 wash bottles with distilled water
than 7.0 as acidic. pH affects most chemical and biological processes in water. pH has a strong influence on what can live in the water.

<table>
<thead>
<tr>
<th>1, 2, 3, 4 5 – if use field site</th>
<th>Alkalinity</th>
<th>Alkalinity is the measure of the pH buffering capacity of the water. Alkalinity comes from dissolved rocks, especially limestone and soils. When water has high alkalinity, it resists a decrease in pH when acidic water enters it. When water has low alkalinity, it cannot resist a decrease in pH when acidic water enters it.</th>
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<td>Animals that live in water need molecular oxygen to breathe. The amount of dissolved</td>
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<td><strong>GLOBE Alkalinity Protocol Field Guide</strong> – 2 for each group</td>
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<td><strong>GLOBE Using a pH Meter Protocol Field Guide (EC greater than 200 µS/cm) – 2 for each group</strong></td>
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<td><strong>GLOVE Using a pH Meter Protocol Field Guide (EC greater than 200 µS/cm) – 2 for each group</strong></td>
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<td>8 alkalinity kits 4 pH meters 1 EC meter</td>
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<td>8 labeled cups filled with different water samples (see teacher manual) 8 wash bottles with distilled water 8 waste water containers 2 liters distilled water (be sure pH is close to 7) Gloves and goggles Salt, baking soda, vinegar Eye dropper Clock or watch</td>
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Oxygen in the water determines what can live there. The amount of dissolved oxygen the water will hold is called the solubility of dissolved oxygen. Cold water can dissolve more oxygen than warm water. Factors affecting the solubility of dissolved oxygen include water temperature, atmospheric pressure, and salinity. It is also affected by what lives in the water.

Nitrate is the most important inorganic form of nitrogen because it is an essential nutrient for the growth and reproduction of many algae and other aquatic plants. Often called a “limiting nutrient” because in low amounts, plants use up all the available nitrogen in the water and cannot grow or reproduce anymore. It “limits” the amount of plants in the water. The nitrate form of nitrogen found in natural waters comes from the atmosphere in rain, snow, fog, and groundwater inputs.
<table>
<thead>
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<th>4</th>
<th>Hitting the Mark (Healthy Water Healthy People, p. 49)</th>
<th>Investigate the concepts of accuracy and precision in data collection, and learn the importance of writing detailed procedures.</th>
<th>Language Arts</th>
</tr>
</thead>
</table>
| | | Strand 2: Concept 2  
Strand 3: Concept 1, 2 | Accuracy and Precision  
Illustrations Teacher Copy Page – one copy for each group or made into overhead for class to see.  
Clay – enough for each group to have at least a 3”x1”x1” piece.  
Target Student Copy Page – one for each group.  
Meter stick or tape measure  
Pencils and paper  
Colored pencils, markers, or crayons (at least 3 different colors for each group. |  
Mathematics |
| | | 1M-E1  
1M-E3  
1M-E5  
1M-E6  
3M-E8  
5M-E1  
5M-E3  
6M-E1 | demonstrate to whole class)  
Approximately 1 kg (2.2 pounds) of sand, sugar, or salt (1 kg per group, or 1 kg to demonstrate to whole class).  
Business card with at least 25 tiny pieces cut out of it.  
Water Quality Measurement  
Student Copy Page – one for each student.  
Comparison of International Drinking Water Guidelines Student Copy Page – one for each student. |  
Science |
| | | Strand 1: Concept 1, 2  
Strand 2: Concept 2  
Strand 3: Concept 1, 2 | |  
| 1, 2, 3, 4 | A Snapshot in Time (Healthy Water Healthy People, p. 61) | Explore the concept of watershed and apply to watershed monitoring. Discern the differences in value between an individual data set collected at one place and time on a watershed versus a series of water quality data sets collected at various points along a watershed over time. Graph watershed data then analyze, compare, and summarize trends in water quality. | Language Arts |
| | | Strand 1: Concept 1, 2, 3, 4  
Strand 2: Concept 2  
Strand 3: Concept 1, 2 | |  
Math |
| | | 2M-E1  
2M-P4 | |  
Science |
| | | 2M-E1  
3M-E4  
3M-E7  
2M-P6 | |  
| 1, 2, 3, 4 | Turbidity or Not Turbidity (Healthy Water Healthy People) | Explore the effects of sediment on turbidity, compare turbidity of muddy and clear water. | Language Arts |
| | | Strand 1: Concept 1  
Strand 2: Concept 2  
Strand 3: Concept 1 | |  
Math |
| | | 2M-E2  
3M-E4  
3M-E7  
2M-P6 | |  
Science |
| | | 2M-E2  
3M-E4  
3M-E7  
2M-P6 | |  
| | | Pencils  
Graphing paper  
Cooper River Watershed Map – one for each student  
Watershed Data Summaries Worksheet – one for each student  
Cooper River Water Data Cards – laminated |  
| | | Clear plastic (or glass) quart jar filled with assorted rocks, gravel, soil, sand, and water |
| People, p. 83) | simulate environmental conditions that cause erosion, and investigate ways to reduce erosion that leads to turbidity in adjacent waterways | R-E5  
W-E1  
Science  
Strand 1: Concept 1, 2, 3, 4  
Strand 2: Concept 2  
Strand 3: Concept 1, 2  
Math  
2M-E2  
3M-E7  
2M-P7  
3M-P1  
Social Studies  
3SS-E7  
3SS-E8  
3SS-P4  | Copies of Turbidity Test Student Copy Page – one for each group  
Turbidity test materials  
Flat-bottomed test tubes (preferred) or clear juice glasses (one per group)  
Fine-grained soil (e.g., silt) or milk (see Warm Up: Part 11 - Preparation for amounts to make turbid water)  
Sample of clear water (at least 1 liter)  
Sample of local surface water for comparison (at least 1 liter)  
Optional: eyedropper, coffee filter  
Rope or string (about 15 meters)  
200 tokens (acorns, leaves, twigs, packaging peanuts, balls, other)  
Pencils  
Paper |
|---|---|---|
| 1, 2, 3 | There Is No Point To This Pollution (Healthy Water Healthy People, p. 136) | The leading source of water quality degradation is nonpoint source (NPS) pollution, which occurs when runoff carries pollutants to surface water bodies.  
Common NPS pollutants include sediments, nutrients, pesticides, and petroleum products.  
Steps can be taken to reduce the amounts of NPS pollutants that reach surface water bodies. | Language Arts  
R-E1  
R-E2  
R-E5  
R-P1  
W-E1  
W-P1  
Science  
Strand 1: Concept 1, 2, 3, 4  
Strand 2: Concept 2  
Strand 3: Concept 1, 2  
Math  
2M-P1  
2M-P2  
3M-P2  
Social Studies  
3SS-E4  
3SS-E7  
3SS-E8  
3SS-P1  
3SS-P2  
3SS-P4  | Large clear bowl, 2-liter bottle with top cut off, jar, or baking dish  
Water  
Clear plastic cups  
Assorted food coloring  
Powdered cocoa or hot chocolate mix  
Cooking oil  
Eyedropper  
Copies of Loop Lake Worksheet, Loop Lake Map, Water Quality Data, and Water Quality Graphs (1 of each per group) |
| 1, 2, 3 | Water Quality Windows | Every species has a habitat that | Language Arts  
One copy of Organism Cards |
is most favorable to its survival.
Aquatic organisms vary in their
tolerance of different ranges in
temperature, dissolved oxygen, salinity, and pH.

**Science**
Strand 1: Concept 1, 2, 3, 4
Strand 2: Concept 2
Strand 3: Concept 1, 2

**Social Studies**
3SS-E7
3SS-E8
3SS-P4