I. Introduction

Arizona Project WET (APW) entered into a 1-year Intergovernmental Agreement (IGA) with Arizona Department of Water Resources in 2018 to educate K-12 students about Arizona’s interconnected water resources and their importance to our future in support of Tucson AMA’s statutory goal of safe yield.

The Scope of Work defined in the IGA encompasses a multi-day Engineering Academy for teachers, expansion of existing Direct Student Outreach and Arizona Water Festival programs, and continuation of Equipment Loan Program for classrooms.

Arizona Project WET (APW), an arm of the University of Arizona (UA) Cooperative Extension, develops and delivers targeted programs to accomplish two overarching goals through three pathways. APW develops water stewardship and STEM (Science, Technology, Engineering and Math) literacy by: 1) providing teacher professional development to evolve instructional practices and deepen content knowledge, 2) direct student outreach to deliver or extend classroom learning, and 3) community engagement to effectively involve adults in K-12 education.

II. Teacher Professional Development

Arizona Project WET Teacher Academies offer professional development that evolves teachers’ instructional practice and water-related content mastery through STEM integration, student-directed learning, real-world and relevant application, and collaborative work. Academies provide the support that teachers need to adopt instructional practices that encourage students to apply their learning by developing ideas, designing solutions, and communicating recommendations. As a result of our academies, students will be taught to think critically, gain deeper understanding, and evaluate, prioritize and apply knowledge to find solutions. APW’s multi-day Teacher Academies and one-day workshops help teachers meet the goals of the Arizona College and Career Ready Standards and the Science and Engineering Practices from the NGSS Framework.

APW delivered the second Underwater Robotics and Engineering Design Academy on July 10-13th at the University of Arizona. During the Academy 20 teachers 1) investigated Central Arizona Project (CAP) operations, 2) gained an understanding of how Remotely Operated Vehicles (ROVs) are used in the water industry, 3) engaged in the engineering design, building and testing of underwater ROVs, and 4) developed an understanding of buoyancy, hydrodynamics, forces, energy, electrical circuitry, wiring, soldering and control systems.

Over the course of the academy teachers designed built and tested 1) a pumping system to deliver water uphill across a distance simulating the operation of the CAP canal and 2) an ROV to accomplish tasks similar to those performed by ROV operators on the CAP canal. A portable pool was used for intermediate design testing. On the last day, teachers showcased their designs in a final competition at the University of Arizona Recreation Center pool. The agenda is included in the Appendix. This workshop
was delivered using a combination of curriculum from both APW and Marine Advanced Technology Education (MATE), the underwater ROV design and training company.

The teachers posted learning gains in all areas of the workshop as measured using the following equation:

\[
\frac{(\text{Post Survey Avg} - \text{Pre Survey Avg})}{\text{Pre Survey Avg}} \times 100\%.
\]

Teachers reported an overall learning gain of 135% for the topics related to understanding Central Arizona Project operations and the use of ROVs in the water industry. Other overall learning gains achieved were 61% in engineering design topics, and 44% in Electrical Skills. Details are outlined in the following graphs.
**2018 Engineering Design & Underwater Robotics Academy**

Rate your skill level in these areas pertaining to Remotely Operated Vehicles (ROVs)

<table>
<thead>
<tr>
<th>Task</th>
<th>Before Workshop</th>
<th>After Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point out all the parts of an ROV and functions they provide</td>
<td>3.20</td>
<td>8.15</td>
</tr>
<tr>
<td>Explain the usage of ROVs in industry and research</td>
<td>4.15</td>
<td>8.00</td>
</tr>
<tr>
<td>Describe the operation of the Central Arizona Project (CAP)</td>
<td>3.10</td>
<td>7.50</td>
</tr>
<tr>
<td>Build a functioning, shallow diving ROV</td>
<td>2.60</td>
<td>7.85</td>
</tr>
<tr>
<td>Understand buoyancy and explain why ROVs strive for near-neutral buoyancy</td>
<td>4.15</td>
<td>3.40</td>
</tr>
<tr>
<td>Calculate the buoyancy necessary to make any device neutrally buoyant</td>
<td>6.65</td>
<td>2.25</td>
</tr>
<tr>
<td>Build a marine collection device with moving pieces</td>
<td>2.25</td>
<td>7.35</td>
</tr>
</tbody>
</table>

![Figure 1 – Understanding of CAP and ROV Topics](image)

**2018 Engineering Design & Underwater Robotics Academy**

Rate your comfort level with the Engineering Design Process

<table>
<thead>
<tr>
<th>Task</th>
<th>Before Workshop</th>
<th>After Workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the engineering design process</td>
<td>5.05</td>
<td>7.95</td>
</tr>
<tr>
<td>Using the engineering design process in your instruction</td>
<td>4.50</td>
<td>7.60</td>
</tr>
<tr>
<td>Facilitating students in employing the engineering design process</td>
<td>4.55</td>
<td>7.80</td>
</tr>
<tr>
<td>Making the engineering design process relevant to real-world events</td>
<td>5.65</td>
<td>8.50</td>
</tr>
</tbody>
</table>

![Figure 2 – Engineering Design Process](image)
### Define current, voltage, and resistance, explain relationship to Ohm’s Law

- Before Workshop: 5.05
- After Workshop: 7.75

### Draw a complete circuit

- Before Workshop: 5.70
- After Workshop: 8.25

### Summarize the operation of a switch

- Before Workshop: 6.10
- After Workshop: 8.30

### Safely operate electrical tools: soldering iron, desoldering pump, multimeter

- Before Workshop: 4.80
- After Workshop: 8.55

### Discuss how a battery works and how long your vehicle can run on a given battery

- Before Workshop: 5.40
- After Workshop: 7.65

### Describe how an electric DC motor works

- Before Workshop: 5.60
- After Workshop: 7.15

### Identify a method for changing the direction of rotation of a DC motor

- Before Workshop: 5.15
- After Workshop: 7.70

### Describe what a short circuit is and the purpose of a fuse

- Before Workshop: 5.50
- After Workshop: 7.85

### Describe the difference between energy and power

- Before Workshop: 5.80
- After Workshop: 7.70

---

**Figure 3 – Electrical Knowledge**

**2018 Underwater Robotics & Engineering Design Workshop Evaluation Results**

% of Responses "Strongly Agree/Agree"

<table>
<thead>
<tr>
<th>Statement</th>
<th>Before Workshop %</th>
<th>After Workshop %</th>
</tr>
</thead>
<tbody>
<tr>
<td>The workshop met my expectations and had an impact on me.</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>The facilities and amenities (setting, breaks, etc.) were suitable for the</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>purposes of the workshop.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The information, strategies and instructional methods presented during</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>the workshop were helpful to me.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The workshop was well organized.</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>The facilitators were enthusiastic and pleasant.</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>The facilitators were well prepared.</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>The objectives of the workshop were stated and fulfilled.</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>This workshop was excellent—one of the best I have ever attended.</td>
<td>95%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Figure 4 – Workshop Evaluation**
Overall, the teachers deemed the academy a huge success! Post-academy, APW requests that teachers evaluate the workshops utility and efficacy using a standard set of questions rated on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). In this workshop, the majority of questions received 99% responses of “Strongly Agree” or “Agree.”

Teachers were very enthusiastic about this academy. “One of the best, if not the best professional development courses I have participated in. Not only will I be applying what I learned for my robotics club but I will also be improving some of my energy curriculum with it as well.”

“Great workshop. One of the best I have ever attended. Came in knowing next to nothing and I am leaving feeling confident to share information with students and successfully build a ROV.”

Teachers are moving forward with the integration of underwater ROVs in their instruction. APW is checking out demonstration ROV equipment for teachers to use with their students as an introduction to the material. The excitement generated by this workshop is infectious and teachers are recommending it to their colleagues, “This was by far one of the BEST PD things I have ever taken in 11 years of teaching! THANK YOU! I want to come back next summer and help out!”

Many teachers are creating teams of students to participate in the Arizona Regional MATE Competition on April 27, 2019, provided by Arizona Project WET at the University of Arizona Recreation Center. Arizona Project WET would like to build on this success by continuing to deliver the Engineering Design and Underwater Robotics Academy in the summer of 2019. This exciting program engages students in the engineering design process while building valuable STEM and problem-solving skills within the context of understanding water resources and management in Arizona.

III. Direct Student Outreach

3rd Grade Sweetwater Wetlands Water Festival
The Sweetwater Wetlands Water Festival is an event designed to strengthen students’ conceptual understanding of water in the environment. The Sweetwater Festival consists of lessons on the Water Cycle, Water Conservation Technology and Watersheds, which have been adapted from the Arizona Water Festival model. During the fourth lesson, students explore the Sweetwater Wetland ecosystem and reflect on the uniqueness of the place. In 2018, APW Tucson provided 8 Sweetwater Wetlands Water Festivals reaching 511 3rd grade students from 8 schools, and 26 classes.

Teachers administer pre-assessments to students prior to their Sweetwater visit. Pre-assessments are provided to teachers when APW educators come into the classroom to deliver the groundwater flow model presentation. The corresponding post-assessment is administered during the festival after each
lesson via a booklet that students wear around their neck on a lanyard. Copies of the assessment instrument are available in the attachments section. Overall, student learning increased 53% as measured by the percentage of correct responses in the pre- and post-assessments.

This year’s assessment, as in the past, showed that 3rd grade students often understand how individual actions can conserve water, prior to the water conservation lesson. The lesson was modified two years ago to introduce the use of technology as a means of saving water. Students showed a 148% gain in learning about using technology to conserve water, compared to an average 4% learning gain for the concept that individual actions can conserve water. This demonstrates the need to expand the existing knowledge of the students to incorporate technology as a means of conserving water.

For the concepts that a Watershed is a land area that drains to a low point, and water in a watershed moves because of gravity, student scores showed an average learning increase of 217%. Students gained 233% in their understanding of the concept, The wetlands provide food, shelter and water. Understanding of the water cycle increased by 82%.

3rd Grade Groundwater Presentations

A one-hour classroom presentation facilitated by APW Water Educators is an integral part of the 3rd grade water curriculum in Tucson and Flowing Wells Unified School Districts. Using the individual groundwater models, Water Educators build foundational knowledge by asking questions and facilitating learning. Students learn that: 1) Groundwater is between the grains of sand and gravel, 2) Groundwater moves through sand and gravel due to gravity, 3) Groundwater is connected to surface water, 4) Groundwater is part of the water cycle, and 5) We use groundwater. Student learning is facilitated using hands-on exploration with a 3-D model and then associating that experience to a visual representation of the concepts in a 2-D model using a whiteboard. Lesson scripts are available upon request. APW Water Educators conducted 23 in-classroom presentations for 529 3rd grade students and 26 teachers at 10 schools. The assessment consists of matching the big idea statements with a visual representation of the statement. It is administered prior to the presentation and revisited following the lesson. The assessment requires students to make connections between illustrations and the text as outlined in the Arizona English Language Arts/Literacy standards. Overall students’ knowledge gain averaged 54%. The highest gains in learning were for the concepts: 81% gains on Groundwater is connected to surface water and 65% gains on Groundwater moves through sand and gravel due to gravity.

6th Grade Groundwater Presentations

Sixth grade Arizona Science Standards focus on earth science and water concepts. APW Water Educators provide a 1-hour groundwater presentation to 6th grade classrooms as an integral part of their science curriculum. The science standards were written to have older students spiral back to important concepts to build on the foundational knowledge acquired in earlier grades. For APW, first and foremost, that content is groundwater, the least understood and least taught part of the hydrologic cycle. In 2018, APW Water Educators facilitated 16 classroom presentations, reaching 438 students and 11 teachers in 6 schools throughout Tucson.
The middle school groundwater lesson introduces systems thinking into the teaching and in addition to the learning objectives at the primary grades adds the concept that *The Colorado River water that we receive in the Tucson AMA is managed through groundwater.* Students use *ThinkBlocks®* to build a conceptual model of the groundwater system including the parts of the system, labeling inputs and outputs, describing the relationships of the parts of the system, and connecting the groundwater system to other systems.

The assessment was modified for the 2018-19 school year to encourage students to visually represent the key concepts of the lesson. **The students, taking the new assessment, averaged a 50% increase in overall learning.** The greatest gains were in understanding that *we use groundwater (98%), groundwater is part of the water cycle (164%), and The Colorado River water we receive in Tucson AMA is managed through the groundwater system (222%).*

### School Water Audit Program

The School Water Audit Program (SWAP) is unlike the hundreds of audit programs found online. Most are simple inventories of water use. Students in the SWAP collect real data (e.g. measuring flow rate) using a scientifically replicable process, and grapple with that data to find meaning. The curriculum units on both the indoor and outdoor audits move students through a thinking process, which is designed to teach them to apply their learning by asking their own questions and designing a means to find the answer. They use their data as evidence to make claims about their understanding and take action to implement changes or make recommendations for solutions.

The SWAP is specifically designed to improve critical thinking and problem-solving skills through a focused and innovative educational program that yields water savings through technological and behavioral change. In each module, applied mathematics is utilized to analyze data collected by the students and make claims, arguments and recommendations based on that data. The SWAP offers a perfect union of real world, rigorous and relevant STEM learning while also addressing Arizona’s growing water deficit through water efficiency and conservation.

**APW facilitated bathroom faucet audits at 2 schools with 215 students, changing out 74 aerators for a projected water savings of 601,053 gallons/year.**

### Discovery Program

Participants in the Sweetwater Wetlands Discovery Program utilize an iPad App to explore the wetlands through the lens of a hydrologist, botanist, ornithologist or wildlife biologist. Students hypothesize, record observations and data, and draw conclusions based upon their evidence utilizing the *Explain Everything* iPad App to document their learning. The hydrology journey investigates the surface water-groundwater connection at Sweetwater Wetlands utilizing measurement instruments. Students have the opportunity to physically measure the depth-to-groundwater and compare that with data from a data logger.

Student groups are engaged using the iPad for the Discovery Program as they follow the journey through the wetlands and have the ability to add audio-visual components to their documentation. The *Discovery Program* iPad App, like the QR code program used in Phoenix, requires students to input a 3-item summary of their investigations. This data continues to show student learning. A student summarized the *Botany Journey*, “*The trees closer [to the water] have more leaves. The trees farther away were darker. They both carry life.*” **In 2018, 195 students from 9 classes in 3 field trips participated in the Discovery Program.**

### IV. Arizona Water Festivals

Arizona Water Festivals (AWF) instill a deeper understanding of water in the earth system and Arizona’s water resources through a community water festival event, teacher professional development workshop, and extensive volunteer and community involvement. The AWF program first engages teachers in professional development that builds understanding about water and water resources, knowledge not
covered in a primary grade teacher’s preparation. After attending the workshop, teachers implement the standards-aligned curriculum modeled in the workshop, which prepares students for the water festival. The curriculum also deepens students’ investigatory learning subsequent to the water festival. To deliver the Community Water Festival, APW trains volunteers from the community to facilitate learning about the groundwater system, watersheds, water conservation technology, and the water cycle using inquiry and exploration.

The water festival program in the Tucson metropolitan area reaches school districts that do not bring their students to Sweetwater Wetlands as part of their curriculum in 3rd grade. In its third year, the Marana Water Festival was held on November 15, 2018 at Crossroads Park. The Marana Water Festival served 470 students, from 18 4th grade classrooms in 9 schools of the Marana School District.

IV. Water Quality Testing

APW provides support to teachers who implement drinking and riparian water quality testing with their students. Training on the use of the drinking water kits is offered at the Tucson STEM Academy, and the riparian kits training is provided at the Living River Academy. Teachers check out testing kits and report back as to their use with their students. Tucson Water Quality reports, data tables, directions, and APW’s How To videos are available for drinking water kits. APW supported 1 classroom and 1 teacher in the use of the water quality kits totaling 180 students.
# Appendix

## Task 1: Teacher Multi-Day Academy Agenda

Underwater Robotics and Engineering Design Academy  
Arizona Project WET  
MATE Summer Institute

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Tuesday July 18, 2017</th>
<th>Location</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME</td>
<td>ACTIVITY</td>
<td>AME Room #</td>
<td></td>
</tr>
</tbody>
</table>
| 8:30 – 9:45 am | Goals for the course and logistics  
*Participant Expectations: What do you want out of this?* | S-324 | Betsy |
| 9:45 – 11:40 am | What is an Engineer & Exploring different designs with ROV in a Bag | S-324 & practice pool | Matt |
| 11:40 – 12:00 pm | Engineering Design Process | S-324 | Jim |
| 12:00 – 1:00 pm | LUNCH | S-324 | |
| 1:00 – 3:30 pm | Pump it Up! – Engineering the CAP canal | S-324 & Courtyard | Betsy, Mary Ann |
| 3:45 – 4:15 pm | ROV 101 and Mission Brief (based on CAP) | | Matt |
| 4:15 – 5:00 pm | Review frame section and design your frame | | Matt, Jim |

**Homework:**

**Entrepreneurial Exercise:** Come up with a company name, ROV name, and tagline.  
Develop a project management schedule.

S-324 is classroom  
N-231 is shop space

<table>
<thead>
<tr>
<th>Day 2</th>
<th>Wednesday July 19, 2017</th>
<th>Location</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME</td>
<td>ACTIVITY</td>
<td>AME Room #</td>
<td></td>
</tr>
<tr>
<td>8:30 – 9:00 am</td>
<td>Share company name, ROV name, and tagline</td>
<td>S-324</td>
<td>Matt</td>
</tr>
</tbody>
</table>
| 9:00 – 10:15 am | Electronics:  
- Multi-meters  
- Simple Circuits  
- Batteries, fuses, and power | S-324 & N-231 | Matt, Jim |
| 10:30 – 12:00 PM | Soldering Skills  
- Basic soldering of wires and waterproofing  
  - **Power System**  
- Soldering Components to a PCB | N-231 | Matt |
<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
<th>Location</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 – 8:45 am</td>
<td>Questions and Comments</td>
<td>S-324</td>
<td>Matt</td>
</tr>
<tr>
<td>8:45 – 9:00 am</td>
<td>Introduction to System Integration Design</td>
<td>S-324</td>
<td>Jim</td>
</tr>
<tr>
<td>9:00 – 11:00 am</td>
<td>Finish building the ROV</td>
<td>N-231</td>
<td>Everyone</td>
</tr>
<tr>
<td>11:00 – 12:00 pm</td>
<td>Hydraulics</td>
<td>S-324</td>
<td>Matt</td>
</tr>
<tr>
<td>12:00 – 1:00 pm</td>
<td>LUNCH</td>
<td>S-324</td>
<td></td>
</tr>
<tr>
<td>1:00 – 1:30 pm</td>
<td>Shroud Design</td>
<td>S-324</td>
<td>Jim</td>
</tr>
<tr>
<td>1:30 – 5:00 pm</td>
<td>Buoyancy and Ballast Testing ROVs</td>
<td>N-231</td>
<td>Everyone</td>
</tr>
</tbody>
</table>

Homework: Density, Buoyancy, and Force Diagrams - PhET Lab
SeaMATE Store and Kits
Student Learning Outcomes

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Location</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:45 – 3:30 pm</td>
<td>How to get started</td>
<td>S-324</td>
<td>Jim</td>
</tr>
<tr>
<td>3:30 – 4:30 pm</td>
<td>Wrap-Up &amp; Post-Evaluation</td>
<td>S-324</td>
<td>Everyone</td>
</tr>
</tbody>
</table>

Funding Provided by:

For more information about Arizona Project WET contact:

**Betsy Wilkening**  
The University of Arizona  
Water Resources Research Center  
350 N. Campbell Ave.  
Tucson, AZ 85719  
**Phone:** (520) 621-8673  
**Email:** ewilkening1@email.arizona.edu

**Mary Ann Stoll**  
The University of Arizona  
Maricopa County Cooperative Extension  
4341 E. Broadway Rd  
Phoenix, AZ 85040  
**Phone:** (602) 827-8233  
**Email:** mastoll@email.arizona.edu

**APW website:**  
http://arizonawet.arizona.edu/

**APW Facebook Page:**  
https://www.facebook.com/ArizonaProjectWET/  
“Like” us!

**Twitter:**  
Follow @AZProjectWET

For more information about MATE contact:

**The MATE Center**  
Monterey Peninsula College  
980 Fremont St.  
Monterey, CA 93940  
**Phone:** (831) 645-1393

**MATE website:**  
https://www.marinetech.org/

**MATE Facebook Page:**  
https://www.facebook.com/materovcompetition/  
“Like” us!

**Twitter:**  
Follow @MATEcenter
Underwater Robotics & Engineering Design
Arizona Project WET and MATE

Arizona Project WET in collaboration with Marine Advanced Technology Education (MATE) is providing this exciting offering for 5th-12th grade educators!

**Using MATE & APW materials:**
- Investigate the Central AZ Project delivery system
- Understand how ROVs are used in the water industry
- Engage in the engineering design, building, and testing of marine ROVs
- Develop an understanding of buoyancy, hydrodynamics, forces, energy, electrical circuitry, wiring, soldering, and control systems
- Integrate ROVs into a class or club

**Dates**
July 10-13, 2018
4-day Academy
8:30 AM – 5:00 PM
University of Arizona

**Benefits**
- Build the skills and confidence you need to teach engineering design of ROVs to students
- Receive $400 worth of tools, an ROV kit, and lessons
- Your students will be eligible to participate in a scrimmage, similar to regional MATE competitions, in Spring 2019

**REGISTER NOW**
- $200 registration fee required
- Register at [https://arizonawet.arizona.edu/18ROV](https://arizonawet.arizona.edu/18ROV)

Questions? – Contact Betsy Wilkening ewilkening1@email.arizona.edu or Mary Ann Stoll mastoll@email.Arizona.edu
Task 2: Direct Student Outreach Marketing

Field Trip to Sweetwater Wetlands

We are so glad that you are joining us, Arizona Project WET and Tucson Water, to come out and experience the Sweetwater Wetlands (SWWL)! At the Sweetwater Wetlands, students are given a unique opportunity to discover more about groundwater and watershed processes through hands-on learning. They also get a chance to explore the wetlands!

You may schedule a field trip any day of the week. Typically, buses arrive between 8:30am-9:30am, and 2.5 hours are needed to rotate through all of the stations and get everyone back on the bus.

In preparation for your visit, please see the below items:

CHECKLIST PRIOR TO TRIP:
- Administer the Sweetwater Wetlands Pre-Test and bring the Pre-Tests with you.
  - You should receive these handouts during your Groundwater Flow Model Presentation.
  - If you have not received any Pre-tests, please contact Miriam Aleman at apwscheduling@gmail.com before your trip and we will get them to you.
- One week before your scheduled date, a water educator will contact you to confirm field trip information.
- Water bottles, appropriate clothing (close-toed shoes) and nametags are encouraged.
- Have students (from all classes combined) divided into 4 equal groups before arriving.
  - Example: Three classes (25 students, 32 students, 27 students) divided into four groups of 21.

RESOURCES FOR TRIP:
- Miriam Aleman, Program Assistant, apwscheduling@gmail.com 520-626-9939 or 520-975-7158
- Betsy Wilkening, Program Coordinator, ewilkening1@email.arizona.edu 520-621-8673

Questions? Miriam Aleman at apwscheduling@gmail.com or 520-626-9939.

Sponsored by:
Interactive Groundwater Presentations
Your students explore this hidden part of the Water Cycle

Fourth Grade Arizona State Science Standards target the identification of sources of water within the environment and its distribution. Arizona Project WET's (APW) groundwater presentation, engages pairs of students through interactions with individual 3-D groundwater models. They explore the system and make observations. APW facilitators assist students in relating the 3-D model to a visual representation of the system (2-D model) while connecting both models to the real-world groundwater system. The AZ ELA/Literacy and Science standards are met with this hands-on presentation.

The groundwater system is the most misunderstood part of the water cycle, yet is extremely important. There is more liquid water beneath the land surface than on the earth's surface. The models bring relevancy to how the city of Tucson, and many other water providers, manage their water supply using recharge basins and pumping systems.

APW's in-class groundwater flow model presentations provide students with an opportunity to discover the groundwater system through exploration and inquiry. Students will discover that groundwater:

- is between the grains of sand and gravel
- moves due to gravity
- is connected to surface water
- is part of the water cycle
- is important because we use it!

Scheduling is easy! Go online [here](#).

- Choose a presentation date
- Include the times for each presentation. We can accommodate all of the classes at a school on the same day. Presentations last for 50 minutes with 15 minutes needed between presentations to reset equipment. Our educators need one room that they can remain with equipment in while the students rotate in and out.
- A field trip to the Sweetwater Wetlands is also available for students.

Questions? Miriam Aleman at [apwscheduling@gmail.com](mailto:apwscheduling@gmail.com) or 520-626-9939.

Sponsored by:
Overview:
The Discovery Journey program challenges students to think through the scientific process while exploring the natural environment at Sweetwater Wetlands (SWWL). Students choose to engage as a wildlife biologist, botanist, ornithologist or hydrologist and proceed in groups. Using an iPad, students use the Discovery Journey App to follow directions as they explore the wetlands and answer a scientific question using systematic thinking, their senses and observation skills.

Each journey starts with an inquiry question and then poses a series of questions to discuss as they walk to their next color-coded prompt. Those questions include:
- What do I need to know?
- What do I need to do?
- How will I record my observations?
- What is my scientific conclusion?

Students use the Explain Everything App as a field notebook to record evidence of their observations; incorporating audio, video or photos that document their thinking and discussions.

Added Opportunity:
Arizona Project WET has set up a US National Phenology Network Trail that utilizes Nature’s Notebook App to engage students in citizen science. Students discover more about the vegetation at the wetlands by making detailed observations of selected plant species related to seasonal changes (such as: type and number of leaves, condition of fruits or flowers, etc.) Students’ input data is uploaded to a national database and is available for use in your classroom. Students also explore scientific instruments that are used to collect water data, including an infiltrometer, rain gauge, and evaporation pan.

Optimizing Learning:
Students must be held accountable for their conclusion summaries and notes (3 sentences in the Discovery Journey App and a field notebook file documenting their journeys in the Explain Everything App). These are made available to the teacher for use in their assessment of student learning.

Scheduling: Please let us know
- How many classes, # of students, # of teachers and # of chaperones you’d like to bring (Approximate is fine.) Parent chaperones for each group are advised.
- Divide students into 6 equal groups. Within each group, students should be assigned smaller (3-5 students) collaborative groups to work with. A maximum of 3 collaborative groups will share an iPad within each larger group. We can accommodate a maximum of 90 students.
- What time you plan to arrive and leave SWWL.

Sample rotation schedule (45 minute blocks for a total of 2 hours and 15 minutes):

<table>
<thead>
<tr>
<th>Group</th>
<th>Rotation 1</th>
<th>Rotation 2</th>
<th>Rotation 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Hydrology</td>
<td>Phenology/Instr</td>
<td>Ornithology</td>
</tr>
<tr>
<td>Group 2</td>
<td>Phenology/Instr</td>
<td>Botany</td>
<td>Wildlife Biology</td>
</tr>
<tr>
<td>Group 3</td>
<td>Instruments/Phenology</td>
<td>Ornithology</td>
<td>Botany</td>
</tr>
<tr>
<td>Group 4</td>
<td>Botany</td>
<td>Instruments/Phenology</td>
<td>Hydrology</td>
</tr>
<tr>
<td>Group 5</td>
<td>Ornithology</td>
<td>Wildlife Biology</td>
<td>Phenology/Instr</td>
</tr>
<tr>
<td>Group 6</td>
<td>Wildlife Biology</td>
<td>Hydrology</td>
<td>Instruments/Phenology</td>
</tr>
</tbody>
</table>

Reminder: Students should wear comfortable clothing and closed-toed shoes; and bring a water bottle, hat and sun block. You may plan to eat lunch at the wetlands after our program. There are no picnic tables, but a bottle filler, drinking fountain, and bathrooms are available.
Interactive Groundwater Presentations
Students explore with UA Facilitators this hidden part of the Water Cycle

Conceptual understanding of the processes acting on the Earth and their interaction with Earth systems is a 6th grade learning objective. Students should be able to identify where water is in the earth system and explain how water is cycled through those earth systems: the atmosphere, lithosphere and hydrosphere. Groundwater is found in the lithosphere.

The groundwater system is the most misunderstood part of the water cycle, yet is extremely important for the Southwest US. There is more liquid water beneath the land surface than on the earth’s surface. The City of Tucson, and many other water providers, utilize the groundwater system to manage their water supply through the use of recharge basins, wells and pumping systems.

APW’s in-class groundwater flow model presentations use systems thinking and provide students with an opportunity to deepen their understanding of the groundwater system through exploration and inquiry using multiple models.

Students will discover that groundwater:
- Is in the pore spaces of the earth materials
- Moves due to gravity
- Is connected to surface water
- Is part of the water cycle
- Is important because we use it!

Scheduling is easy! Go online [here](#).

- Choose a presentation date.
- Include the times for each presentation. We can accommodate all of the 6th grade classes at a school on the same day. Presentations last for 50 minutes.
- Our educators require one room in which they can remain with equipment as the different classes rotate through.

Questions? Miriam Aleman at [apwscheduling@gmail.com](mailto:apwscheduling@gmail.com) or 520.626.9939.

Sponsored by:
Outreach – Assessments
3rd Grade Groundwater Assessment

Write the letter of the picture that best matches the sentence.

A  _______ Groundwater is between the grains of sand and gravel.

B  _______ Groundwater moves through sand and gravel due to gravity.

B  _______ Groundwater is connected to surface water.

C  _______ Groundwater is part of the water cycle.

D  _______ We use groundwater.
Sweetwater Wetlands Assessment

Name: ________________________ Date: __________________
Teacher: ________________________ School: __________________

This is a pre-test to see what you already know about water. Don’t worry if you don’t know all of the answers, just do your best!

1) What do wetlands provide for birds and animals to survive?

_____________________________________________________
_____________________________________________________
_____________________________________________________

2) Circle all of the actions that could save water.
   a) Leaving the water on when brushing your teeth
   b) Using technology
   c) Taking a shorter shower
   d) Using a hose to clean a porch

3) Circle the best answer(s) for each question.
   a) A **watershed** is a: ______ that drains to a(n):______.
        city          ocean
        land area    high point
        dam          low point
        lake         desert

   b) Water in a **watershed** moves because of:______.
        groundwater    wetlands    conservation    gravity

4) This diagram shows water moving through the water cycle. Fill in the blank ______ below the “?” with the place that water would have to go to get from an ocean to a lake.
Use the word bank below to help you.

Cloud  Groundwater  Plant  River

Ocean  Lake  Glacier  Animal  Soil
Pre-Assessment

1. Color in the area where you would expect to find groundwater.

2. Draw 2 pathways to show how water could get into the river.

3. What would need to be added to the picture to show how water gets out of the ground? Draw or write your answer.

4. In Tucson, what are the inputs to the groundwater system?
Volunteer with us

Join us for the 3rd Annual Marana Water Festival, an educational field day event that instills a deeper understanding of water in the earth system and Arizona's water resources to:

- Celebrate science and water stewardship
- Activate hands-on learning activities for students
- Contribute to your community

We need YOU!

We'll train you on November 8, 2018 on how the Water Festival works so you can feel confident when you teach the 4th grade students all about water.

Then, at the Water Festival event on November 15, 2018 you will teach the lesson you were trained on. We will provide lunch and snacks throughout the day.

Interested? Sign up at https://arizonawet.arizona.edu/MaranaVol2018

Questions? Contact Nicole Kallman at nkallman@email.arizona.edu

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Marana Water Festival

Estimated attendance
- 700+ Marana Unified School District 4th grade student participants

Volunteer training date
- Thursday November 8, 2018
- 11:30 AM – 1:30 PM
- Training Room
- Marana Operations Center
- 5100 W Ina Road
- Tucson, AZ 85743

Actual event date
- Thursday November 15, 2018
- 7:30 AM - 2:30 PM
- Crossroads at Silverbell Park
- 7548 N Silverbell Road
- Tucson, AZ 85743