

**PROBLEM BASED LEARNING
EDUCATING FOR SUSTAINABILITY.**



SNOWPACK COLLECTION

SNOWPACK 103

How Water Managers use SNOTEL Data to Make Decisions

Written for Middle School and High School Courses
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PHOTO SOURCE: Tom Reese, Sustainability Ambassadors, WSDOT

PROBLEM STATEMENT

How do scientists, water resource managers, and policymakers use SNOTEL data to make timely decisions that affect multiple stakeholders in our current water year as well as decades into our future?

SUMMARY

This lesson can be used in concert with **Snowpack 101 and 102**. In Snowpack 103, students learn about the critical importance of SNOTEL data in making timely decisions that affect multiple stakeholders including all of us who depend on water flowing out of our taps whenever we want it.

Who are the scientists, water resource managers, and policymakers that use this information? What types of decisions need to be made and on what timescale? Daily? Weekly? What needs to happen in each of the four seasons; winter, spring, summer, fall? What kinds of decisions do we need to plan for over the next decade?

Students will analyze the role of climatologists, statisticians, dam operators, water utility managers, salmon biologists, watershed managers, flood control managers, farmers, and local tribes. They will recognize that

there can be competing interests among these diverse stakeholders, and, with the expected impacts associated with reduced snowpack, it will be critical to develop and practice a collaborative decision making process.

Learning Objectives

1. I understand the basic science behind projected climate impacts in our bioregion.
2. By understanding a range of competing stakeholder perspectives and needs, I can reach consensus on the most effective compromise.



Formative Assessment

Menu of possibilities...

1. Graphic organizer showing the relationships among diverse stakeholders.
2. Notes on how to read and interpret SNOTEL data tables and graphs.
3. Research notes in preparation for role playing stakeholder perspectives based on different scenarios.

Summative Assessment

Roleplay water supply challenge scenarios with the goal of coming to the best possible consensus for all stakeholders.

A reflective commentary on what I learned, how I feel about it, and what actions I can take.

ACADEMIC STANDARDS

NGSS: HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

[Clarification Statement: Examples of key natural resources include: access to fresh water... Examples of natural hazards can be, floods, and droughts. Examples of the results of changes in climate that can affect populations or drive mass migrations include... regional patterns of precipitation.]

NGSS: MS-LS2-1. Construct an argument supported by empirical evidence that changes to physical or biological co

[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations...]

BIG PICTURE

[NGSS Global Climate Change](#)

[NGSS Human Sustainability Standards](#)

[OSPI Environmental Sustainability Standards](#)

[OSPI Social Studies Standards](#)

[College, Career, and Civic Life \(C3\)](#)

[Common Core State Standards](#)

COMMUNITY CONTEXT

My family's sustainable practices

My Neighborhood Association

Nonprofits focused on this issue

My School and School District

My City Climate Action Plan

My City Equity Strategy

My County Climate Action Plan

My County Equity Strategy

My Energy and Water Utility

My Waste, Recycling, Compost Company

Watershed Salmon Recovery Plan

Puget Sound Regional Council

Puget Sound Vital Signs

Washington Dept of Ecology

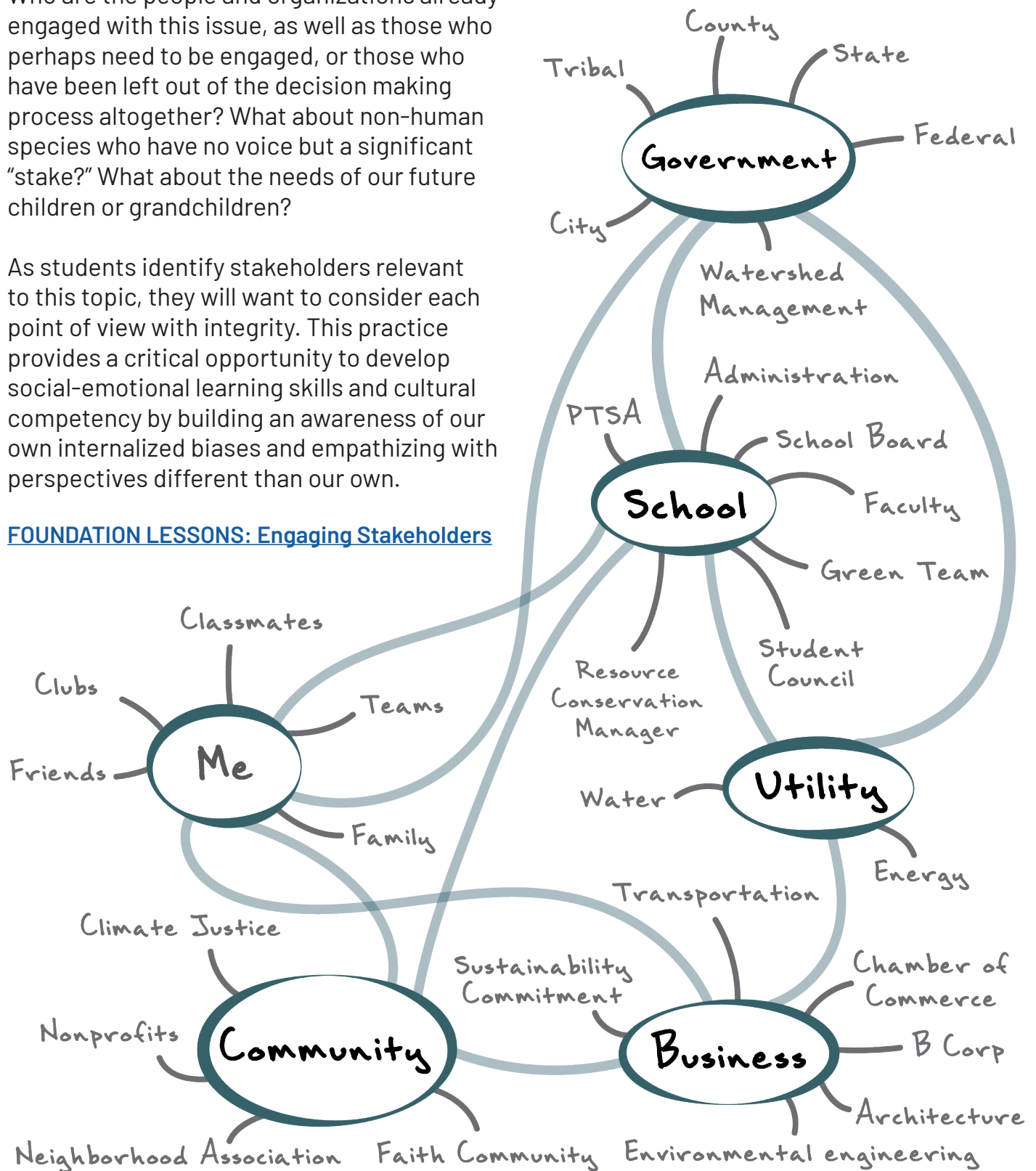
Tribal Treaty Rights

Stakeholders

Who are the people and organizations already engaged with this issue, as well as those who perhaps need to be engaged, or those who have been left out of the decision making process altogether? What about non-human species who have no voice but a significant "stake?" What about the needs of our future children or grandchildren?

As students identify stakeholders relevant to this topic, they will want to consider each point of view with integrity. This practice provides a critical opportunity to develop social-emotional learning skills and cultural competency by building an awareness of our own internalized biases and empathizing with perspectives different than our own.

FOUNDATION LESSONS: Engaging Stakeholders



BACKGROUND

We Depend on Snowpack

We have built our economy, here in the Pacific Northwest, around the assumption of a sustained snowpack. **Our snowpack is shrinking** due to human-caused climate change.

Get the latest science from the University of Washington [Climate Impacts Group](#).

Study the [Climate Change infographics series](#) from King County.

We depend on snowpack. Over the last hundred years, we have constructed dams across a number of our cascade alpine canyons to hold water in huge man-made reservoirs that serve the water supply needs of millions of people. In our region it rains a lot, especially at the higher elevations. This rain can be captured and held in our system of reservoirs.

What is not known by most people, is that we have been depending on a certain depth of snowpack each year to serve as a **second, natural reservoir** of water... **A frozen one.** This is important, because as we enter the summer months with little or no rainfall until October, our reservoirs would be drained by the water consumption demands of millions of people if not for our snowpack. The snow that packs down through the long winter will **slowly melt through the summer.** We count on this phenomena to supplement and sustain water levels in our reservoirs. We drink snow in August.

But with a shrinking snowpack over the next several decades, water resource managers, policy makers, and each of us within our own families, schools, and cities, need to make critical decisions about how to conserve water right now.

The same amount of precipitation. Part of this strange new reality is that we will actually have the same amount of annual precipitation. The water cycle will continue to lift vapor from Puget Sound and the Pacific Ocean and drop it across the landscape. But the science points to a much different annual pattern.

We can expect **much more rain in the winter** (when we don't need it) along with bigger storm events, which can cause flooding and mudslides. And we can expect **much less rain in the summer** (when we do need it) which can lead to droughts, forest fires, parched streams for salmon, and dangerous heat waves for humans. We will experience the same total amount of precipitation. It's just that, as each decade continues to bring warmer temperatures, less of this precipitation will be held in the form of snow. Diminished snowpack throughout the winter means diminished water supply late in the summer.

At the same time that we are grappling with how to adapt to our shrinking snowpack, we will need a **thousand good ideas** for how to slow, stabilize, and reverse the effects of climate change. This will take a century or more. It is critical to understand the science and make wise decisions together at all scales right now. We are all stakeholders in this challenge.

SNOTEL stations. Water resource managers carefully monitor our snowpack by analyzing daily and weekly data reports from a series of remote sensing SNOTEL stations built on ridgelines throughout the Cascades. The Natural Resource Conservation Service manages a [Snow Survey Program](#) that provides “mountain snowpack data and streamflow forecasts for the western United States. Common applications of snow survey products include water supply management, flood control, climate modeling, recreation, and conservation planning.”

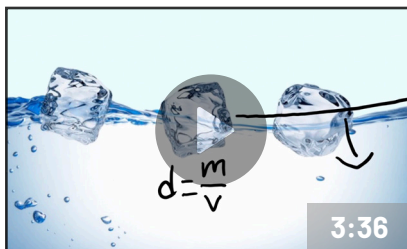
The Washington Snow Survey website includes **snow survey data, products, and reports** that students can use to understand the science and math behind the need to monitor our snowpack and make critical decisions for the current season as well as 10-30 years out.

Inquiries Across the Curriculum

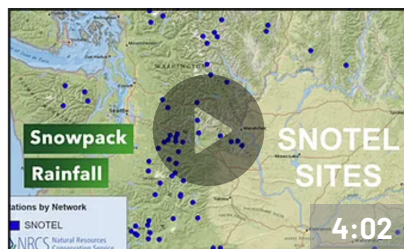
To understand more about the breadth and depth of curricular concepts using snowpack as catalyst, explore a rich set of [additional inquiries](#).

Youth-voiced tutorials

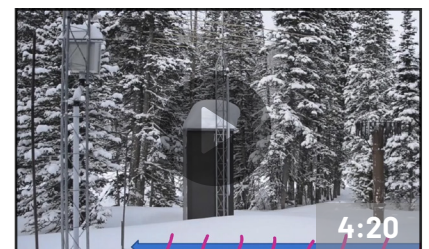
For additional support, student teams with Sustainability Ambassadors have researched and produced a series of [short videos on snowpack issues](#). All of these videos are voiced by students.



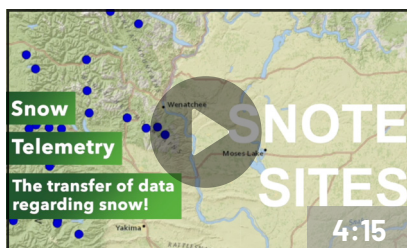
[What is Snow Water Equivalent?](#)
[Harini Baskar](#)



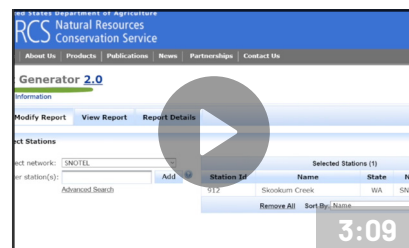
[Introduction to SNOTEL](#)
[Rishi Hazra](#)



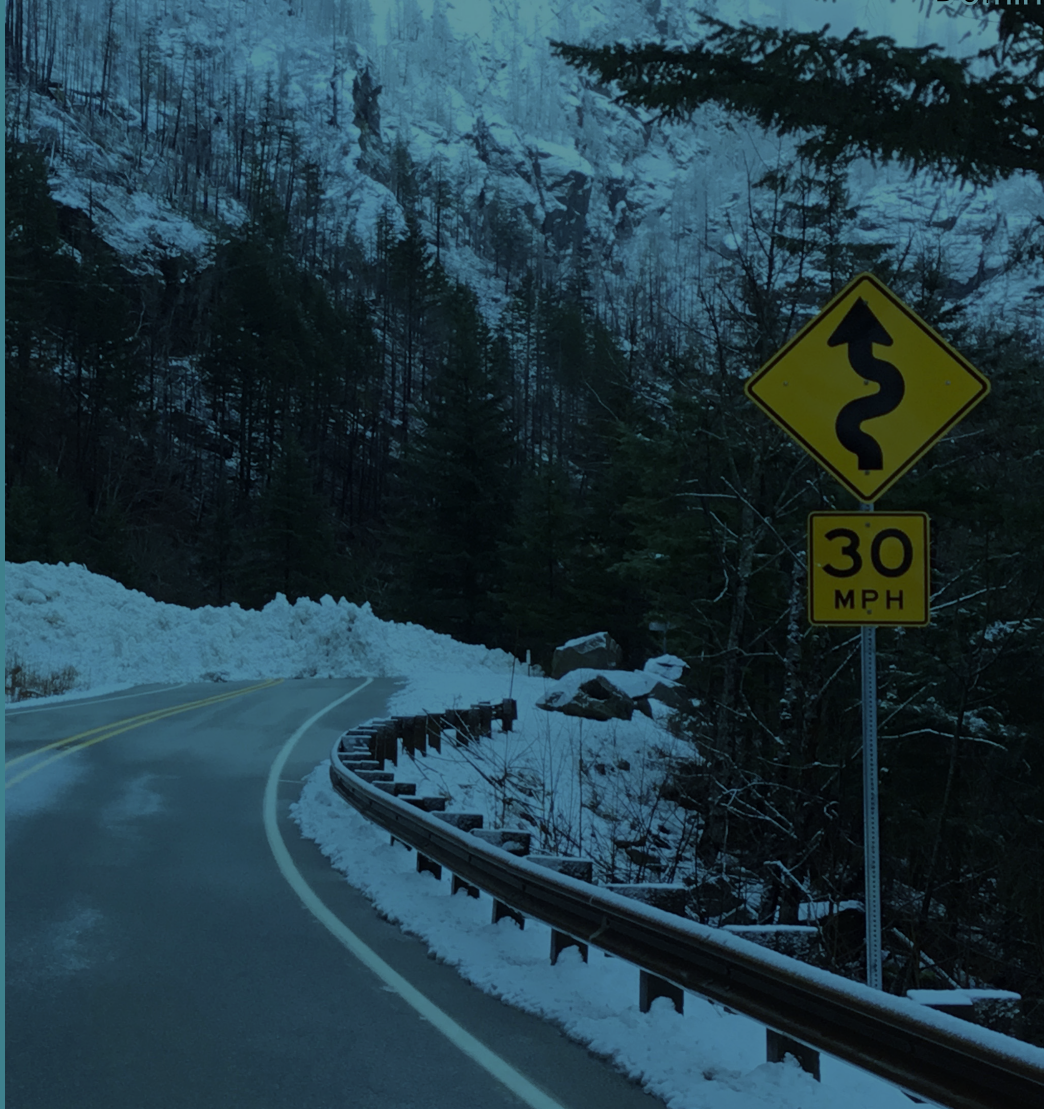
[How do SNOTEL Sites Work?](#)
[Santoshi Pisupati](#)



[Locate Your SNOTEL Station](#)
[Rishi Hazra](#)



[Generating SNOTEL Data Reports](#)
[Rishi Hazra](#)



LESSON OUTLINE

Materials Needed

Internet Access

Time Needed

2-3 class periods

ENTRY EVENT

To set up an initial scenario challenge, share with students the following information about how climate change is already altering the hydrological cycle in our bioregion.

The science on climate change impacts in our bioregion points to the strange new reality that we will actually have the same amount of annual precipitation as we have always experienced, its just that, due to higher temperatures, less of it will come in the form of snow.

We can expect much more rain in the winter (when we don't need it) along with bigger storm events, which can cause flooding and mudslides. And we can expect much less rain in the spring, summer, and fall (when we do need it) which leads to droughts, lower water tables for irrigating farms, forest fires, parched streams for salmon, and dangerous heat waves for humans.

With this background information in mind, students work in small teams with the challenge to make the wisest possible decision based on the following scenario.

SCENARIO CHALLENGE: *It's only December. More rain is expected. As the team responsible for operating the dam that maintains water levels in the reservoir up in the mountains, serving the water supply needs for over a million people, what do we do today if climatologists forecast a major rain storm within the next week to ten days and the reservoir level behind the dam is already at capacity?*

Inform students that they will have 20 minutes to solve this challenge as best they can but that they must solve it. The consequences are critical. At this stage of their knowledge acquisition, however, it is just as important to develop a thorough list of all the questions they don't have answers to, reinforcing the discipline of asking questions and framing the problem from different stakeholder points of view.

"If I had an hour to solve a problem, and it was very challenging, and my life depended on it, I would spend the first 55 minutes framing the problem, and the last 5 minutes thinking about solutions."

Adapted from – Albert Einstein

Some useful prompts... if needed

What do we know about the safety of the dam to hold just a bit more water?

Should we run the reservoir down now, in anticipation of a massive new inflow from the pending rainstorm?

How do we avoid flooding the farmland and cities down below?

With the sudden increase in the volume and velocity of stream flow, how do we avoid scouring out salmon spawning beds where the eggs have just been deposited for this season?

Can we let out smaller amounts of water over the next 48 hours in planned releases of low volume?

Who are all of the stakeholders we need to consider in making this decision right now?

Planning ahead, can we mitigate these kinds of major rainstorm events by building more storage capacity downstream?

If we draw down the reservoir this summer but the expected rain storms don't materialize in the fall and winter? What kind of a situation will that create for us next summer?

Activity 1

Who are the stakeholders?

Students take time to read and discuss a set of [brief stakeholder descriptions](#) related to water supply management. Invite students to conduct additional keyword searches to flesh out their knowledge of these roles.

For extended lesson ideas and graphic organizers for tracking the relationship among a range of stakeholder groups, see [FOUNDATION LESSONS: Engaging Stakeholders](#).

Additional prompts of stakeholder identification...

Who has a right to clean abundant water?

Do we have enough water for everyone to get their needs met?

What do each of these stakeholders do when we have too much water in the winter? Or too little water in the summer?

Who is responsible for managing water supply?

What are the legal rights provided to local tribes through treaties signed more than 170 years ago?

How do all these stakeholder groups communicate? How do they collaborate on solving problems related to too much or not enough water? What if they can't agree? talking about drought, or higher water bills for irrigation?

Activity 2

Role Play

With this background knowledge, students form teams to role play one or more water supply challenge scenarios with the goal of coming to the best possible consensus for all stakeholders.

Here are a few possible scenario challenges. You may also want to write your own scenario that is most relevant to your watershed. Or have student teams write original scenarios for other teams to tackle based on shared criteria for reaching consensus using both science and civics frameworks.

What do we do if climatologists forecast a major rain storm in the last week of December and the reservoir level behind the dam is already at capacity?

ONE: *How do we avoid floods in the lower valley during the winter and droughts in the summer but still have enough water flowing for salmon?*

TWO: *How do we prepare for a forest fire that rages through the watershed that feeds our reservoir behind the dam?*

THREE: *How do we ensure that water temperatures in our local river are not too warm for salmon to survive?*

FOUR: *New building codes have been passed by a coalition of local cities that require rainwater harvest on all new constructed homes, apartment buildings, schools and commercial buildings. How does this policy breakthrough offset water supply challenges from our shrinking snowpack?*

FIVE: *Invent your own scenario and challenge another team to tackle it.*

Activity 3

Get Involved in your local watershed

Students are invited to explore the work of the Watershed Council leading salmon recovery efforts in their area and to identify ways in which they can help with the efforts.

EXAMPLES

[Green-Duwamish and Central Puget Sound Watershed](#) - WRIA 9

[Lake Washington/Cedar/Sammamish Watershed](#) - WRIA 8

[Snoqualmie/Skykomish Watershed](#) - WRIA 7

[Puyallup/White River Watershed](#) - WRIA 10

[What's a WRIA?](#)



ACKNOWLEDGEMENTS



Thank you to our **Washington State Legislature** for funding the **ClimeTime Proviso**. Your investment in climate science education is vital for engaging the next generation in applied learning for a sustainable future that benefits everyone. We thank you for your vision and commitment.



Thank you **Cascade Water Alliance** for supporting student and teacher research on SNOTEL data analysis as a foundational understanding for water resource management decision making. And for supporting the original design of the PBL Curriculum Design Lab and Teacher Fellows Program.



Thank you **King County WaterWorks Grant Program** for supporting additional partnership building and curriculum design related to water quality.

About Sustainability Ambassadors

Sustainability Ambassadors is a professional development program for student leaders, teacher leaders and community leaders committed to rapidly advance a sustainable future by aligning classroom rigor with community relevance for real world impact.

We support a year-round training program for over 60 highly motivated youth, a paid Equity Advocacy Internship, a Green Jobs Youth Pathways Portal, and a Teacher Fellows Program, working with hundreds of educators to design new models of problem-based, place-based learning around a shared vision of **educating for sustainability**.

We focus on middle school and high school youth, the teachers and school districts that guide their learning, and the community stakeholders, local government and business leaders who are relying on the next generation to be engaged voters, informed taxpayers, conscious consumers, and employees who can create and lead sustainability initiatives.

Visit: <https://www.sustainabilityambassadors.org/>

