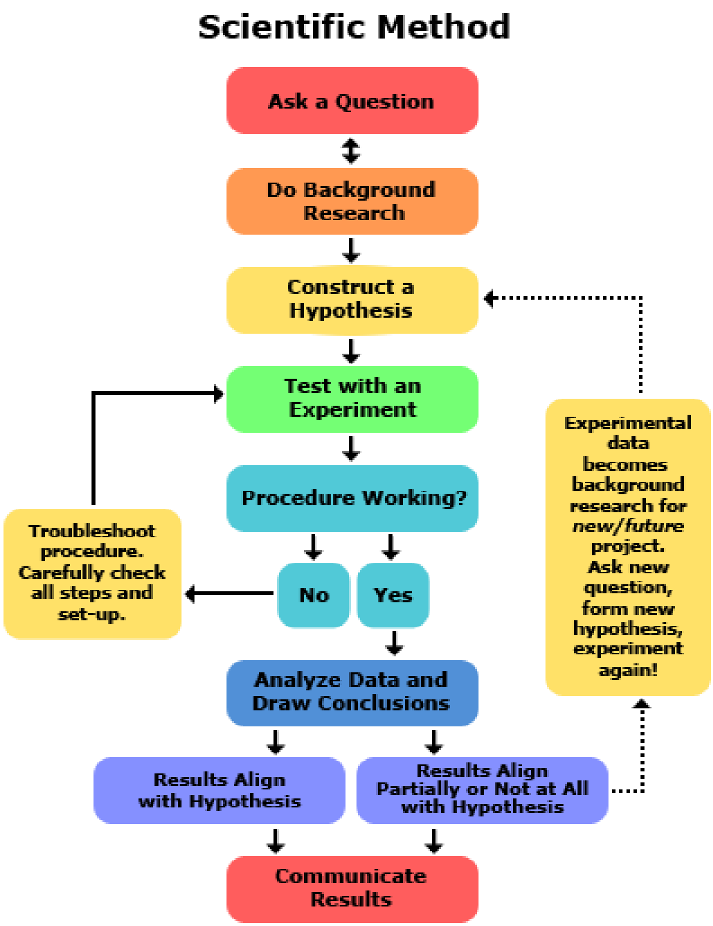
Engineering in Nature

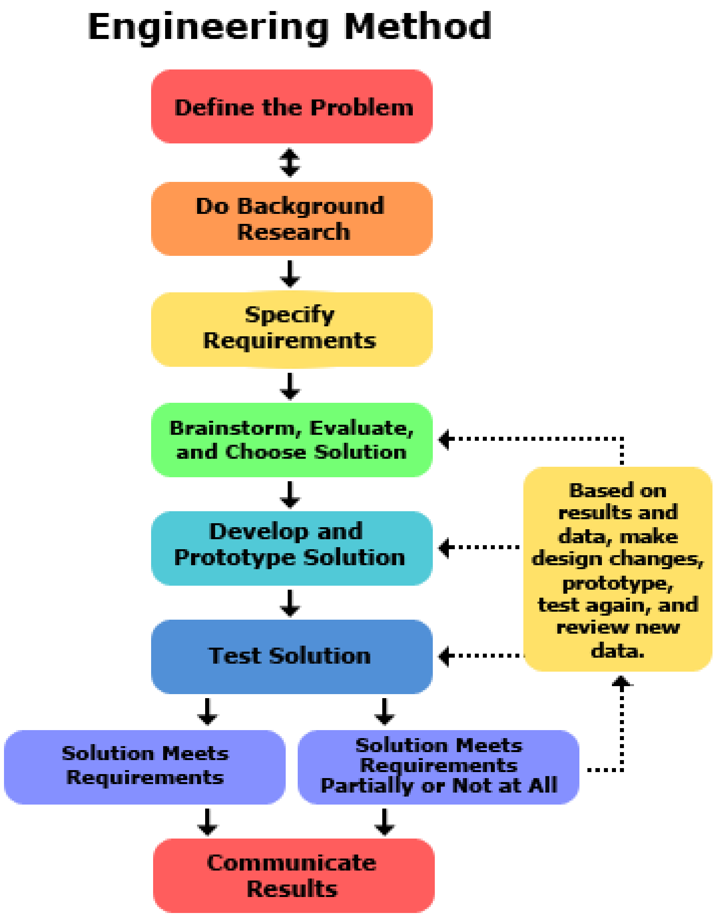
- How to Bring Engineering into Life and Biological Sciences

Science vs Engineering –

- Science is . . . linear, more natural: was the hypothesis accepted or rejected, explanation of the natural world
- Engineering is . . . circular, more man-made: when problem isn't solved, back to the drawing board

Science Buddies

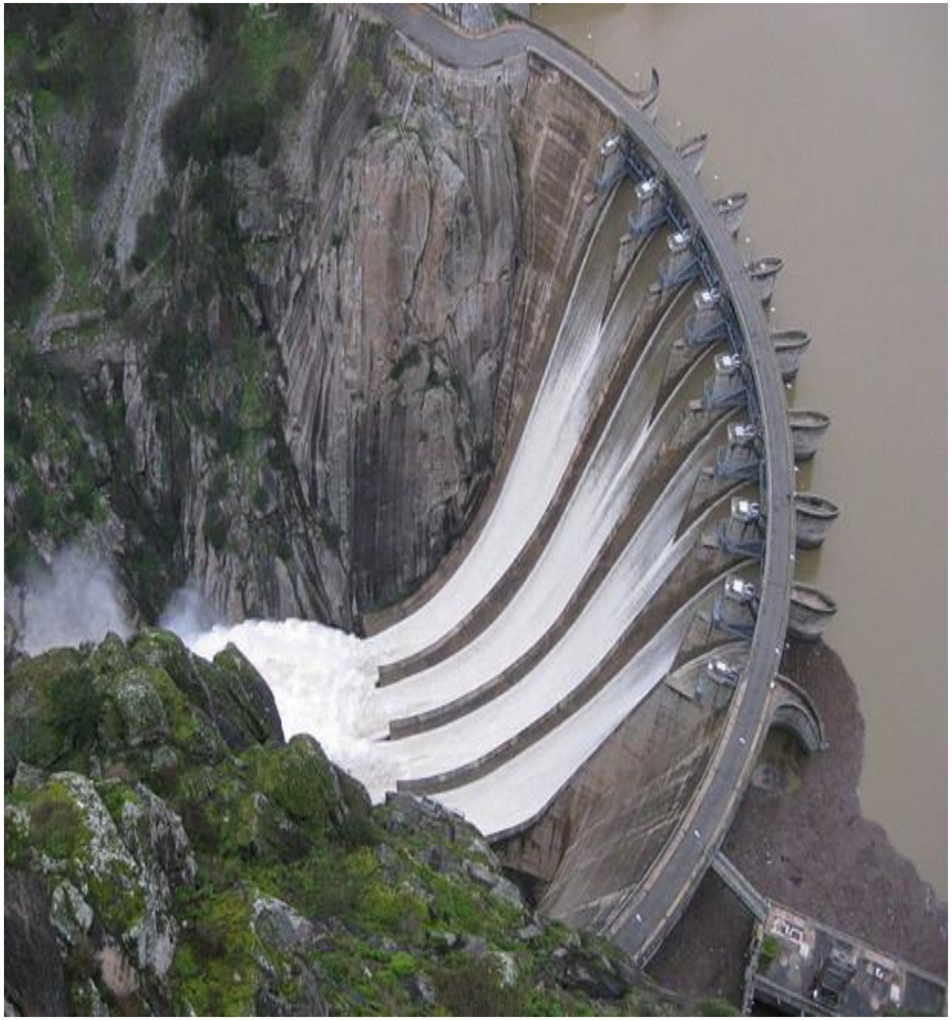




Next Generation Science Standards

- Infused Engineering into the standards
- Allow for Project Based Learning – like the good old days!

- We know STEM, What about STEAM – do you see the art in both science and engineering?

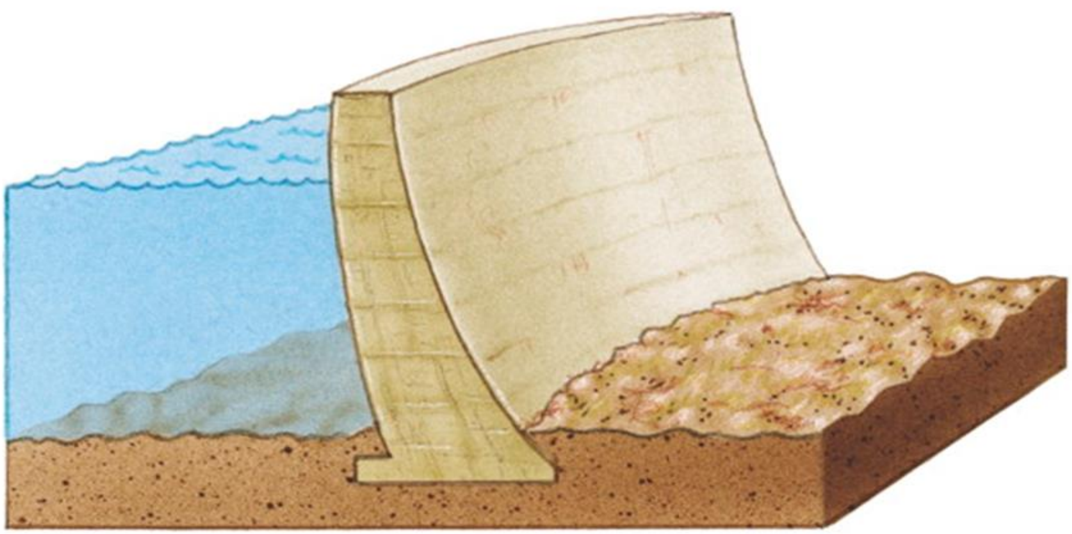


Beaver Dams

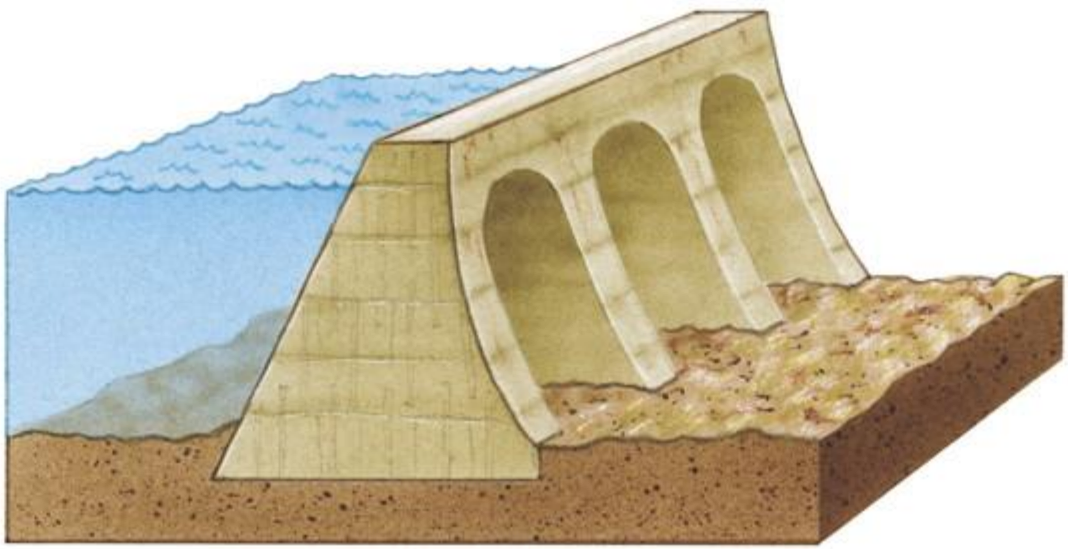
- Beaver work tirelessly
- Why do they build dams?
- What benefits from a beaver dam?
- Native Americans –
- What have we learned from wildlife and natural dams?
- Have you ever observed dam structures?

General Types of Dams

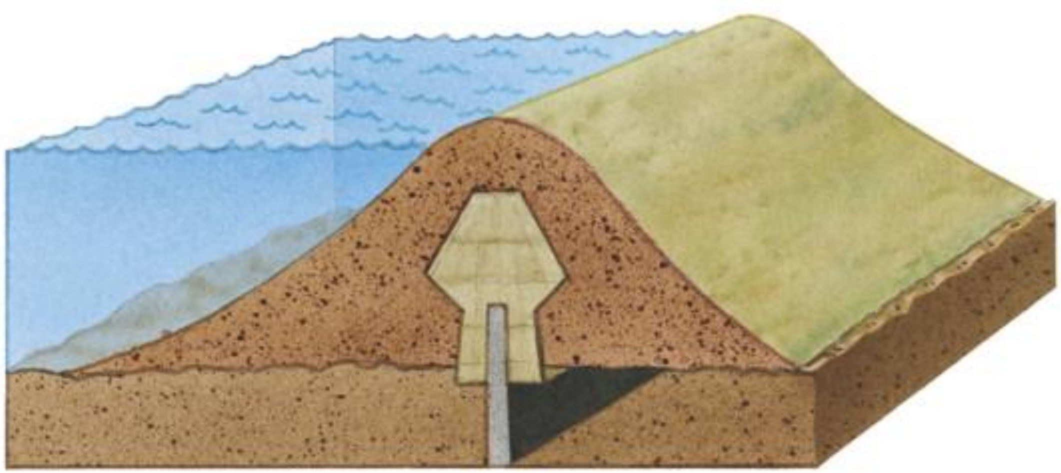
- **Arch dam**
  Best for narrow rocky ravines with steep walls strong enough to support the structure, these are solid concrete structures that curve upstream, forming an arch. The pressure from the water is distributed evenly for structural integrity, similar to an arch bridge. The weight of the dam pushes it into the ground, helping to reinforce it. Examples that are double-curved horizontally and vertically are referred to as dome dams.



- **Buttress dam**
  Buttress dams are used when the surrounding rock is not strong enough to provide a solid foundation. A series of solid concrete buttresses lined along the downstream face of the dam provide the strength needed to hold it in place. Buttresses add weight to the structure, pushing towards the ground and anchoring the dam even further. Since most of the support comes from the buttresses, the dam wall can either be flat or curved.



- **Embankment dam**
  Made from a bank of earth, these dams rely on their intense weight and sloped shape to hold the water back. There may be an impervious layer of concrete, plastic or other material on the upstream face if the particle sizes in the earth are big enough for water to seep through. Earth-filled dams can be made completely from one type of material, but may need a layer that collects and drains seep-water to ensure the structure stays intact.



Wyandotte County Lake

- Part of the WPA: Works Progress Administration - President Franklin D. Roosevelt,

CONSTRUCTION OF THE WYANDOTTE COUNTY LAKE DAM

- **CHRONOLOGICAL HISTORY**
- **1936**

- **January 15**
- Dam construction began with dredging of mud and debris from Marshall Creek Channel.
- **May 29**
- It was anticipated when construction was begun that the **layer of blue clay** on which the dam was being built **would be impervious to water** and that it would **make an acceptable base** for the dam, but after excavation was started it was **found that the stratem might cause leakage**. The US Army Engineers were consulted and they **prescribed that an immense piling be driven into the bedrock** to key the construction. Evidently, the ends of the original dam were built on solid rock.

Troubles for the Dam

- **1937**

- **August 25**
- **One million cubic yards of earth and stone** were used in the original dam.
  September 19
- **Dam collapsed. The dam was 90% completed** at the time of the collapse. Several sightseers were driving across the top of the dam. A crack appeared, but the people reached safety before the collapse. The dam was estimated to weigh approximately 2 million tons. The part, which fell, was **estimated to weigh 300,000 pounds, and it fell 50 feet**. The drop caused the **land to the north to shift completely closing a 16-foot drainage ditch**. The **highway north of the spillway was made impassable** when the dirt shifted. There were no quakes, which caused the dam to fall; however**, the falling of the dam did cause an average-sized earthquake within the territory**.

- **1938**

- **January 25**
- The Army engineers recommended the **broadening of the base of the dam** in order to prevent reoccurrence of the collapse of the dam.

DAM AND SPILLWAY INFORMATION

- The dam is rolled earth core with hydraulic fill sand shell.
- The length of the dam is 1700 feet.
- Base width is 1000 feet.
- Crest width is 30 feet.
- The original depth after construction was 84 feet by the dam.
- Spillway length is 279 feet and is 16 feet in diameter.

Wyandotte County Lake

Spillway

More Modern Dams

- Perry

Life Sciences

- MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- **MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.**
- MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

- **Science and Engineering Practices**

- **Developing and Using Models**
- Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and
- design systems.
- ▯ Develop a model to describe phenomena. (MS-LS2-3)

Earth’s Systems

- MS-ESS2-1. Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.
- **MS-ESS2-4. Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.**
- MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.

• Science and Engineering Practices

- **Developing and Using Models**
- Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (MSESS2-1)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Human Impacts

- **MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.**
- **MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.***
- **MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.**

• Science and Engineering Practices

- **Constructing Explanations and Designing Solutions**
- Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and
- theories.
- Apply scientific principles to design an object,
- tool, process or system. (MS-ESS3-3)

Engineering Design

- **MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**
- **MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**
- **MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**
- **MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**

Engineering Design
Science and Engineering Practices

- **Asking Questions and Defining Problems**
- Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.
- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)
- **Developing and Using Models**
- Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to generate data to test ideas about designed
- systems, including those representing inputs and outputs. (MSETS1-4)

Lesson Plans

- On handout: Activities
  - Dam Forces
  - Dam Pass or Fail

    Do have to go online to get activity pages

Interdisciplinary Approaches

- What types of writing exercises could you have students produce?

- We have talked about some social aspects of dams, can you think of others?
  - Historically – Lewis and Clark
  - Are there issues locally you can think of?

Building a Watershed Model

- You need:
  - Tray
  - Aluminum Foil
  - Recyclables for topography: bottles, paper, bubble wrap
  - Sandwich Baggies
  - Modeling Clay
  - Walnut Shell Medium – coarse and fine