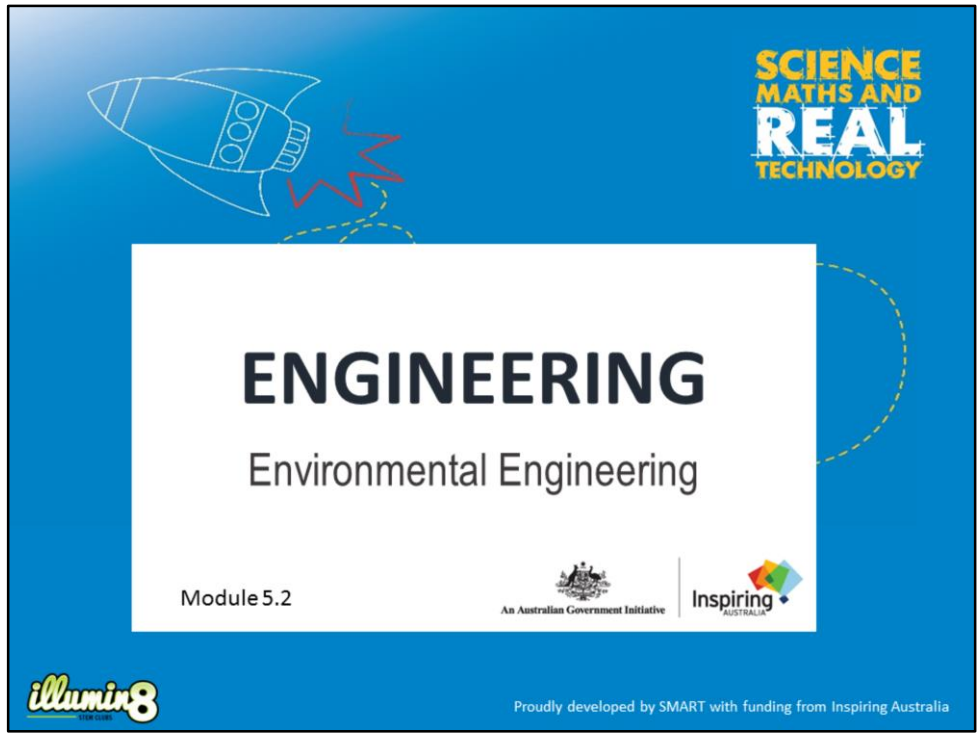

In our last session we started to explore the many different types of engineers. In this session, we'll take a closer look at environmental engineering.

Environmental engineers are concerned with assessing and managing the effects of human and other activity on the natural and built environment. It is an important branch of engineering responsible for protecting the environment and keeping the planet safe for us to live in.

Environmental Engineers use maths, science and problem solving skills. They design, plan and deliver new ways to control waste and pollution, and minimise use of natural resources. They work with other engineers, architects, planners and regulatory authorities to ensure new buildings, roads, and other infrastructure has minimal impact on our natural environment.

Can you think of some projects environmental engineers may be involved in?

Environmental engineers work for all sorts of companies and industries to help solve problems which impact on the environment. There are many different problems which environmental engineers are asked to solve. For example, designing solutions to **prevent damage** to the environment from human activities (e.g. mining, boating, factory waste, sewage and rubbish waste). Environmental engineers also design ways to **limit the damage of something that has already happened,** like an environmental disaster. Environmental disasters could be caused by an explosion occurred in a factory, releasing harmful chemicals into the air, or, may be from an oil spill in an ocean.

What problems might engineers need to solve after an environmental disaster?

Examples:

- air pollution
- soil and water contamination
- the effect on wild life in the area
- the effect on humans
- any long term effect which might be seen in plants and animals
- safe disposal of contaminated material

The list goes on! There are a huge number of things which environmental engineers, scientists and other professionals would need to consider in this situation.

In Module 3.3, we looked at some Natural Disasters and their impact on the environment and man-made structures. Environmental disasters can be both natural and man-made. What were some of the natural disasters we explored?
What might be considered a man-made environmental disaster, any ideas?
An oil spill is an example of a man-made environmental disaster.
Oil rigs drill and collect oil from under the sea, and big ships transport oil around the planet for use as fuel and in their engine systems. Oil rigs and ships are potential sources of pollution for our oceans. While careful design and operation minimises the chances of oil spills, oil spills can happen because of accidents, or faults when oil is being collected from sources under the sea or being shipped around the globe.

If an oil rig were to spring a leak or an oil ship were to crash and release its cargo into the ocean... The impact on the environment is can be widespread and take many years to clean up. As oil is less dense than water, it floats on the surface of the ocean. This means it can wash onto beaches and into estuaries (the connections between rivers and oceans). It also means that many animals that live on beaches and the ocean surface are going to be covered in oil. Birds' feathers become matted and stuck together when they are covered in oil. This means they can't regulate their body temperature and they swallow a lot of oil as they are cleaning themselves. Many different animals such as sea turtles and dolphins are also badly effected by oil spills. The effects of an oil spill can disrupt and damage whole ecosystems.

Environmental engineers work alongside biologists, ecologists as well as other scientists and engineers, on solutions to contain and remove spilled oil from the ocean and beaches. The worst oil spill to date happened in 1991 during the Gulf War.

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Extension information for facilitators:

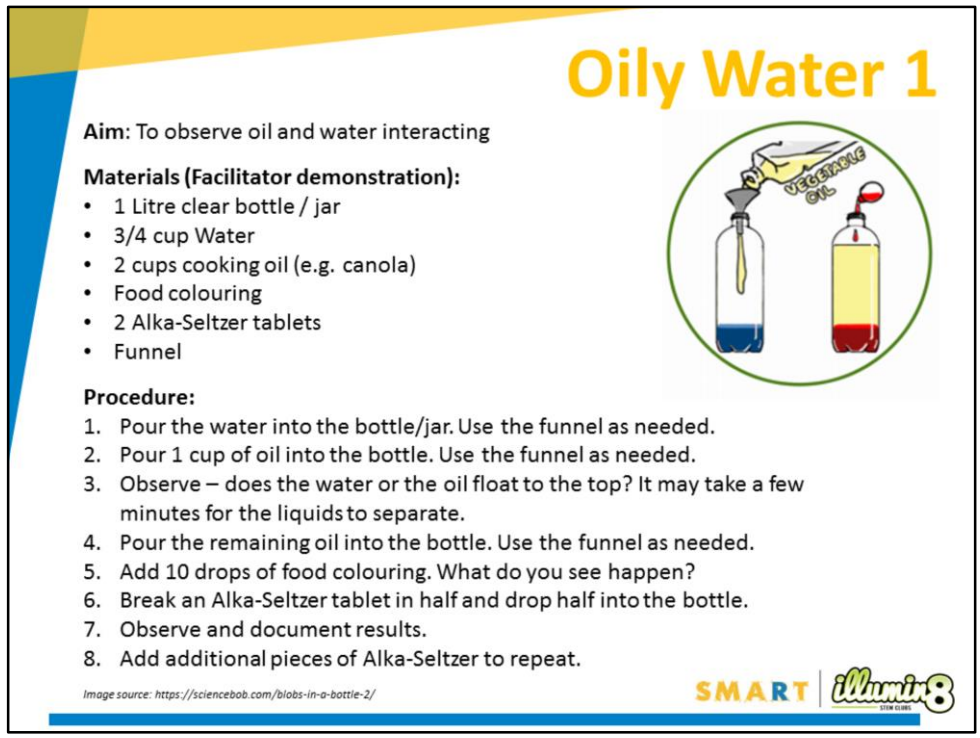
Pollution in the Gulf

https://www.iaea.org/sites/default/files/35205980913.pdf

Environmental impacts of the Gulf War 1991

http://pure.iiasa.ac.at/7427/

https://www.britannica.com/event/Persian-Gulf-War



Let's take a look at how oil and water interact.
Refer to coordinator notes for Activity 5.2.1 and risk assessment for Module 5.
Discuss hypotheses with students before you begin. What do they think will happen?
Discuss what happened after the activity. Were hypotheses correct, or were they surprised?

Video Demonstrations:
Surfing Scientist: http://splash.abc.net.au/home#!/media/103836/make-a-lava-lamp-model-using-oil-and-water
Kidspot: https://youtu.be/PnoLa1z8FKU

Oily Water 2

Aim: To observe oil and water interacting

Materials (per group):

- Clear plastic bottle or jar
- Water (to almost fill bottle / jar)
- 3 tablespoons cooking oil (e.g. canola)
- Food colouring
- Salt (approx. 3 teaspoons)

Procedure:

1. Pour the water into the bottle until it is almost full.
2. Sprinkle in a few drops of food colouring.
3. Add 3 – 5 tablespoons of oil into the bottle.
4. Sprinkle salt onto the oil bubble, until you see oil bottles start to sink.
5. Observe and document your results.

Optional: shine a torch light on the bottle as you add the salt.

Extensions:

- Try the experiment with two bottles, one with icy cold water and one with warm water (max 40 degrees Celsius). Is there a difference in how the oil reacts?
- What happens if you use less water, and more oil?

https://busybugs.co/2013/01/diy-lava-lamps.html

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Let's take a closer look at how oil and water interact.
Refer to coordinator notes for Activity 5.2.2 and risk assessment for Module 5.
Discuss hypotheses with students before you begin. What do they think will happen?
Discuss what happened after the activity. Were hypotheses correct, or were they surprised?

Video demonstration:
https://www.youtube.com/watch?v=kXEyFPxq3GI
……..
How does an actual (electric) lava lamp work?
The light bulb heats the waxy substance floating in the liquid, which causes it to expand and become buoyant so that it floats – after sufficient
cooling, the waxy substance shrinks and becomes less buoyant again so that it sinks – the process repeats as long as the lamp is on.

Oil spills have been happening for decades, causing lots of problems in oceans and ecosystems around the world.

Some of the devices and techniques which have been used by engineers include:

- Booms (form barriers around spills to stop them spreading)
- Skimmers (scoop oil and debris / rubbish from the surface of water)
- In-situ burning (burning the oil in the location of the spill, to turn it into a gas so it evaporates)
- Sorbents (materials that soak up liquids)
- Chemicals (break up or “disperse” the oil)

Engineers and scientists have been working on new ways to make it easier to control the damage oil spills cause.

Video: Current techniques for oil spill clean up
https://www.youtube.com/watch?v=3DbSlAg3F3A

There is a growing need for better oil spill clean up techniques. Many scientists and engineers are currently researching new ways to solve this problem. One of these researchers is American Physicist, Arden Warner. Arden's research is focussed on developing a way to organically magnetise oil, so it can be drawn out of water using a magnetic field.

How? **Magnetite**, also known as **iron oxide**, is the most naturally occurring magnetic mineral. Iron oxide is commonly found in beach sand. Warner has found that magnetite can stick to oil, and make the oil magnetic. Warner has tested his method in over 100 types of oil, including heavy oil, and found that magnetite clings better to more vicious (thicker) oil. One of the most interesting aspects of the use of magnetite is that it even seems to remove oil from bird feathers.

Warner has patented a design consisting of a containment boom with an electromagnetic current, which creates a magnetic gradient that pulls the magnetised oil in. Once the oil moves across the boom, it reaches a conveyor belt that is also magnetic. The excess water drips off the belt, and the oil falls into a separation container with a magnetic bottom. The magnetite goes to the bottom of the container, where it sticks, while the oil and remaining water are separated, allowing the magnetite to be reused, and the oil to be removed, contained and reused.

Booms are commonly used to contain oil spills. They are long floating devices, which act as a barrier to the oil.
They are often used to protect sensitive areas of coastline, or to help gather oil in a confined location so other techniques can be used to remove the oil from the water.
Booms consist of:
-An above-water **barrier** which stops the oil spreading due to waves and wind.
-A **floatation** device to hold the device on the surface of the water.
-An under-water **skirt** which stops oil from spreading underneath the boom.
-A **support** which runs along the bottom of the skirt for extra support.
Pros and cons of booms for cleaning up / containing oil spills:

Pros (positives)

They do not alter the chemical make up of the oil or add any further chemicals to the ocean.
They can be reused many times and can be left in the environment till a spill is cleaned up.

Cons (negatives)

Waves and wind can easily cause oil to spill over the boom
They also need to be set up immediately or oil will have spread already.

Skimmers are devices which collect oil from the surface of the water. There are different types of skimmers which work best in different conditions. They can be self-propelled, dragged behind a boat or used from the shore. Skimmers work best in calm water conditions. The are also seen in swimming pools!

Pros and cons of skimmers for cleaning up / containing oil spills:

Cons

Waves and choppy water mean the skimmer collects a lot of water.

They also need to be used with a containment device so oil doesn't spread while it is being collected.

Pros

They do not alter the chemical make up of the oil or add any further chemicals to the ocean.

When conditions are calm many designs suck up very little water with the oil.

Once oil has been contained in a device such as a boom, controlled burning can be used to remove it from the water.
Oil which is thick enough (1-2mm) will burn if it is ignited. The burning (combustion) of the oil turns it into gasses and smoke, removing most of it from the water.
Pros and cons of in-situ burning for cleaning up / containing oil spills:

Cons

Burning can only be done once oil is contained in a boom away from the main oil spill.
The oil spill has to be at least 1-2mm thick for it to ignite.
Smoke and gasses pollute the atmosphere and could be a threat to our health.

Pros

Burning is quick and can be done at the location of the spill.
Up to 99% of the oil can be removed from the water.

Materials which soak up oil and other substances are called **sorbents,** and these can be used to help with oil spill clean ups. There are both natural and man-made (synthetic) sorbent materials.

Natural Sorbents: Natural substances can act as sorbents. Organic fibres like peat moss, straw, saw dust and feathers can be used. Inorganic substances like clay, volcanic ash, sand or glass wool can also be used. These sorbents are often loose fibres, so they need to be contained in mesh or another material to make it easier to collect them once they've soaked up the oil.

Synthetic Sorbents: Man-made materials, like different types of plastic, can also be used to collect oil. Some of these materials will **ad**sorb to (bond to) oil and some will **ab**sorb (soak up) oil. They can be specially designed to collect up to 70 times their own weight in oil.

Pros and cons of sorbents for cleaning up / containing oil spills:

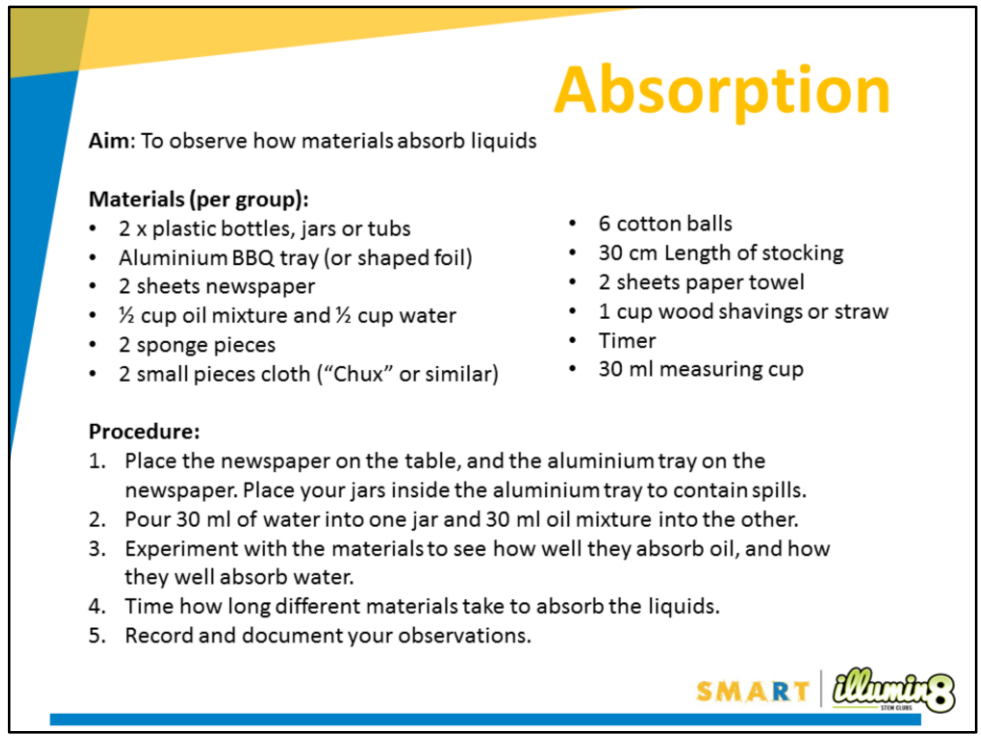
Cons: *Materials can be hard to collect after use if they are not packaged into mesh.*

Materials can sink once they have soaked up oil and water.

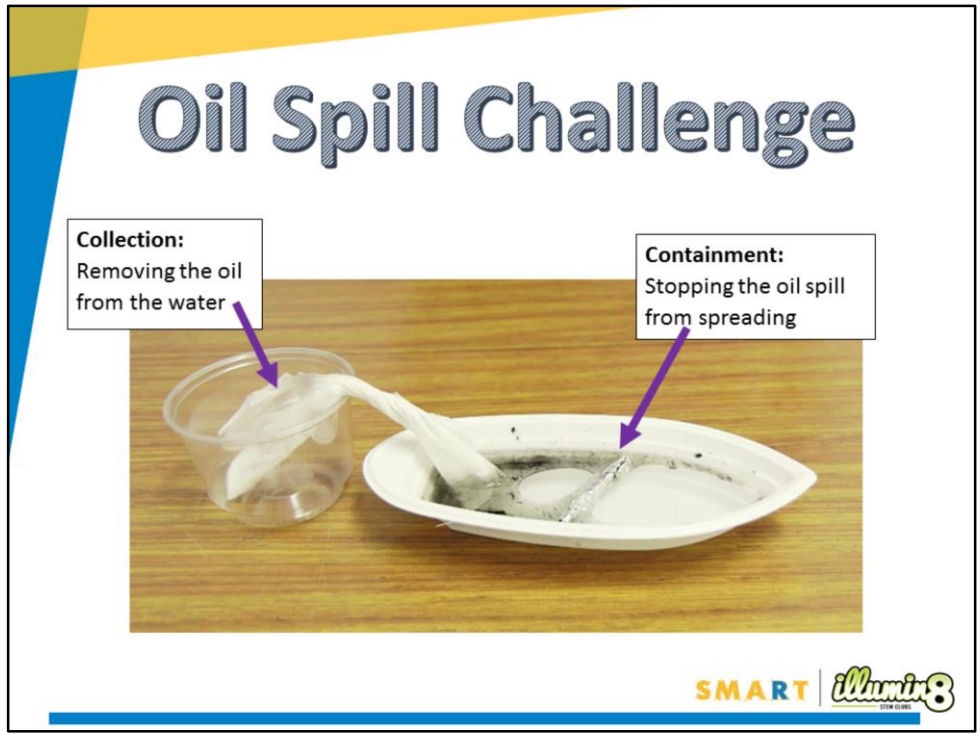
Sorbent material needs to be disposed of along with the oil.

Pros: *Sorbents don't change the chemical composition of the oil*

They can be useful in removing small amounts of oil left in the water.

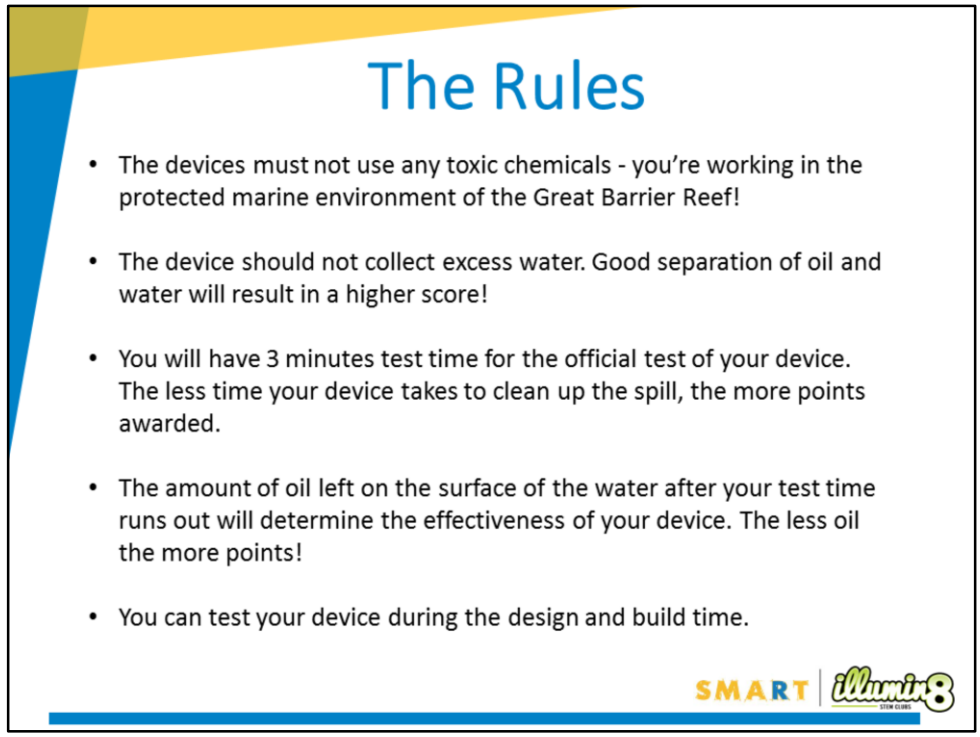


Refer to coordinator notes for Activity 5.2.3 and risk assessment for Module 5.
Discuss hypotheses with students before you begin. What do they think will happen?
Discuss what happened after the activity. Were hypotheses correct, or were they surprised?
Ask students:
During your experimentation what did you notice?
Did the materials absorb oil?
Were some materials better at absorbing oil than others? Which ones were best?
Did some materials soak up a lot of water too?
Did any of the materials float?

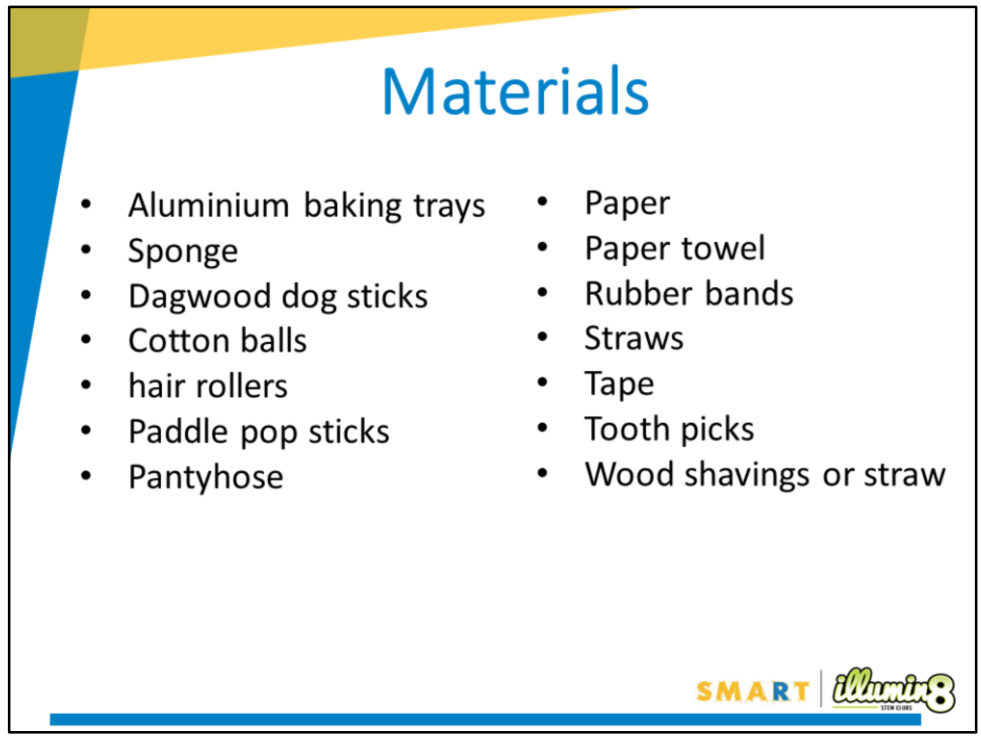


In this weeks challenge you will step into the role of an environmental engineer! You will be tasked with designing and building a device to clean up an oil spill. Put your engineering hat on, and find a new solution to help reduce the effect of oil spills in the ocean!

Containment: Stopping the oil spill from spreading.
Collection: Removing the oil from the water.



Invite groups to give a short explanation of their designs before the official testing. After testing, ask the group if their design worked as intended. Do they think your design could be scaled up to use in a real life oil spill?



Cleaning up oil spills in the ocean is a big, messy job. But some simple household materials do a surprisingly good job at absorbing oil from water.

You will supplied with the following materials. Before building your final devices, take some time to re-experiment with the different materials to see how well they absorb oil spill.

References

Oil spill experiments

- How to make fake oil for a spill https://www.youtube.com/watch?v=6CCgiD16jfM
- https://kids.imo.org/downloads/OilSpillExperiment.pdf
- https://www.scientificamerican.com/article/sorbent-science-cleaning-oil-spills/
- Video: Steve Spangler https://www.youtube.com/watch?v=kQl5YFDteEI

Oil spill containment techniques:

- https://www.amsa.gov.au/marine-environment
- DNews Video: https://www.youtube.com/watch?v=3DbSIAg3F3A
- http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/spill-containment-methods.html
- Magnetic Oil Spill Clean Up https://www.youtube.com/watch?v=lYM324yDH-Q

Environmental Engineering

https://www.engineersaustralia.org.au/

http://www.mybigtomorrow.com.au/careers/details/environmental-engineer

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