

# Runoff Water from Grass and Artificial Turf Soccer Fields: Which Is Better for the Soccer Player, the City and the Environment?



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## MOTIVATION

It feels different to run or kick a ball when playing soccer on a grass field or an artificial turf field.

Playing on grass fields you come home muddy. Playing on artificial turf you bring home rubber crumbs in your socks and shoes.

As a soccer player and environmentalist, I wanted to learn what is in the water runoff from both grass and synthetic turf soccer fields in San Francisco.




Increasingly, many cities are replacing their grass soccer fields with synthetic turf soccer fields. More than 3,500 such fields have been installed throughout the U.S. according to the Synthetic Turf Council. Sports field grasses need to have dense, thick sod in order to withstand repeated use. Fertilization, watering, re-seeding, mowing, line-painting and pest-abatement are necessary to keep grass productivity at its best. Artificial turf is designed for all-weather playability, low maintenance, low water need, and unlimited playing time. It is meant to look, feel and play like grass, but it is made of synthetic materials and rubber crumbs.



## RESULTS

1. Lycée Français la Perouse, San Francisco, CA, USA.
2. IMS, UCSC, Santa Cruz, CA, USA.
3. Kids Science Challenge, New York, NY, USA.

### What Are the Costs and Benefits of Synthetic Turf Soccer Fields?

Costs	Benefits
<b>Money</b> – Close to \$1 million per field for installation of drainage, foundation, synthetic turf and lighting structure.	<b>Money</b> – Big reductions in gardening and maintenance costs, fertilizer, seed, soil, mowing and irrigation - the city of San Francisco saves 30,000 gallons of water per day on just one field.
<b>Health</b> – Human exposure to potentially toxic substances in synthetic (plastic) turf and “crumb rubber” tire infill, including high levels of zinc, lead, PAHs.	<b>Health</b> – Increased and extended playing time (from 50% to 100% more playing time available) for children and adults; safe, uniform playing surface (fewer injuries from gopher holes, sprinkler heads) Decreased exposure to herbicides, pesticides and fertilizers needed on grass fields.
<b>Environment</b> – Plant and animal exposure to chemicals from plastic synthetic turf and “crumb rubber” infill through water runoff. Loss of grass habitat for city biota (birds, squirrels).	<b>Environment</b> – Less use of gas-powered gardening equipment required for grass fields and less use of water for irrigation. Less nutrient input to runoff water and other water resources.
<b>Recycling</b> – Synthetic turf itself does not biodegrade and will end up in landfill after 10 to 15 years of use.	<b>Recycling</b> – “Crumb rubber” infill on synthetic turf fields uses 25,000-45,000 per field of old tires that would otherwise end up in landfill.
<b>Climate</b> – Turf field temperatures have been found to reach over 165 °f on warm days, contributing to the “heat island” effect. They are produced from fossil fuel (petroleum) thus contribute to increased atmospheric CO <sub>2</sub> and related impacts (global warming, acidification).	

## DISCUSSION

If these pollutants move into the Bay or the ocean through storm drains or surface runoff, my study shows that they probably could harm plant and aquatic life. There are at least 100 chemicals and heavy metals that have been identified in crumb rubber. Apparently some of them did not agree with *Daphnia*, and could pose a threat to other aquatic life. The high nutrient inputs to the Bay or ocean may result in increase growth of algae, loss of water clarity, uptake of oxygen (as the algae decompose) and result in eutrophication and dead zones like those found in the Mississippi River Delta. Toxic algal blooms (red tides) occurrences may also increase.

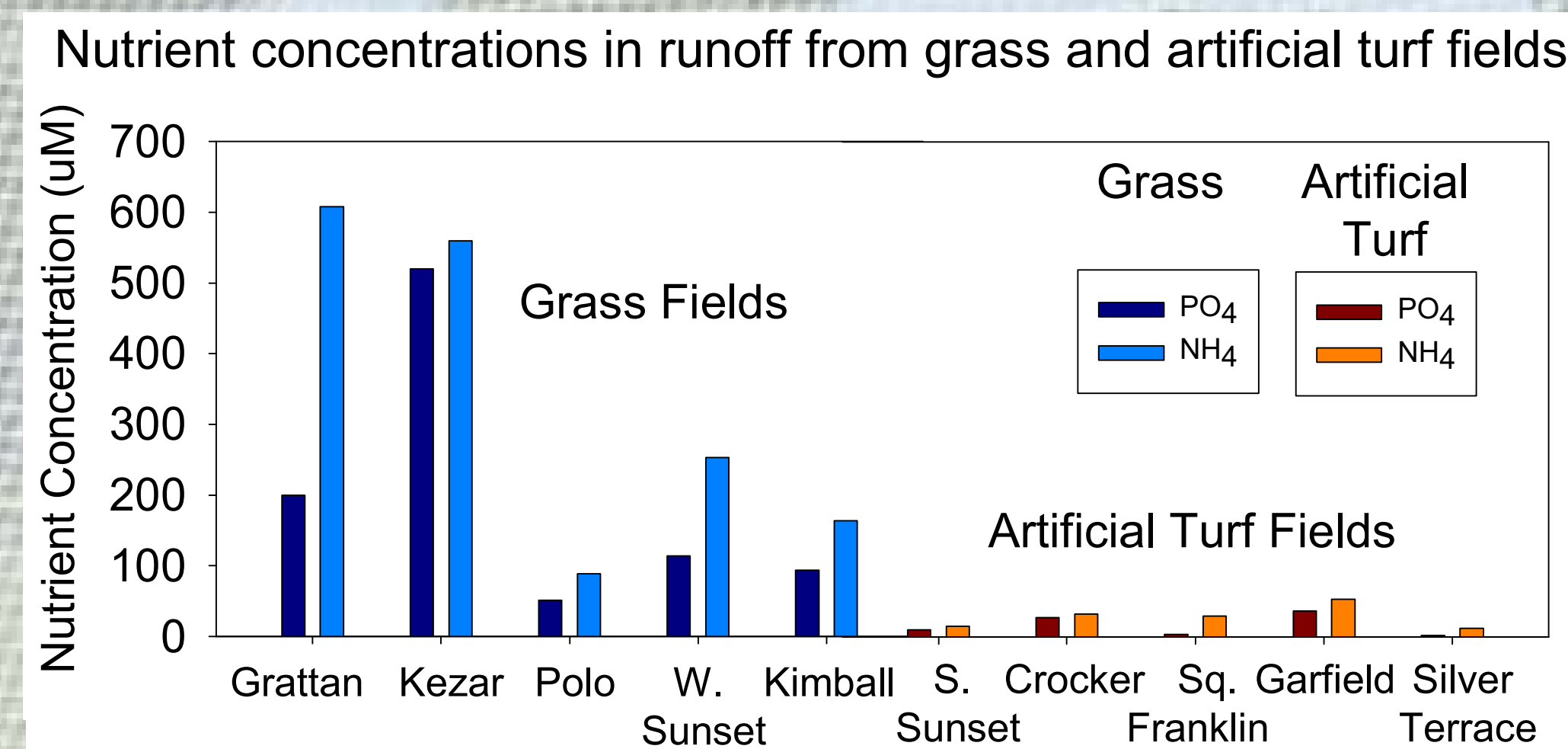
## CONCLUSIONS

When viewed all together, this study shows that we need to be very careful where we put soccer fields.

They must not be close to water bodies like the bay and ocean to avoid the potential negative effects of pollutant in runoff from entering these waters and impacting life.

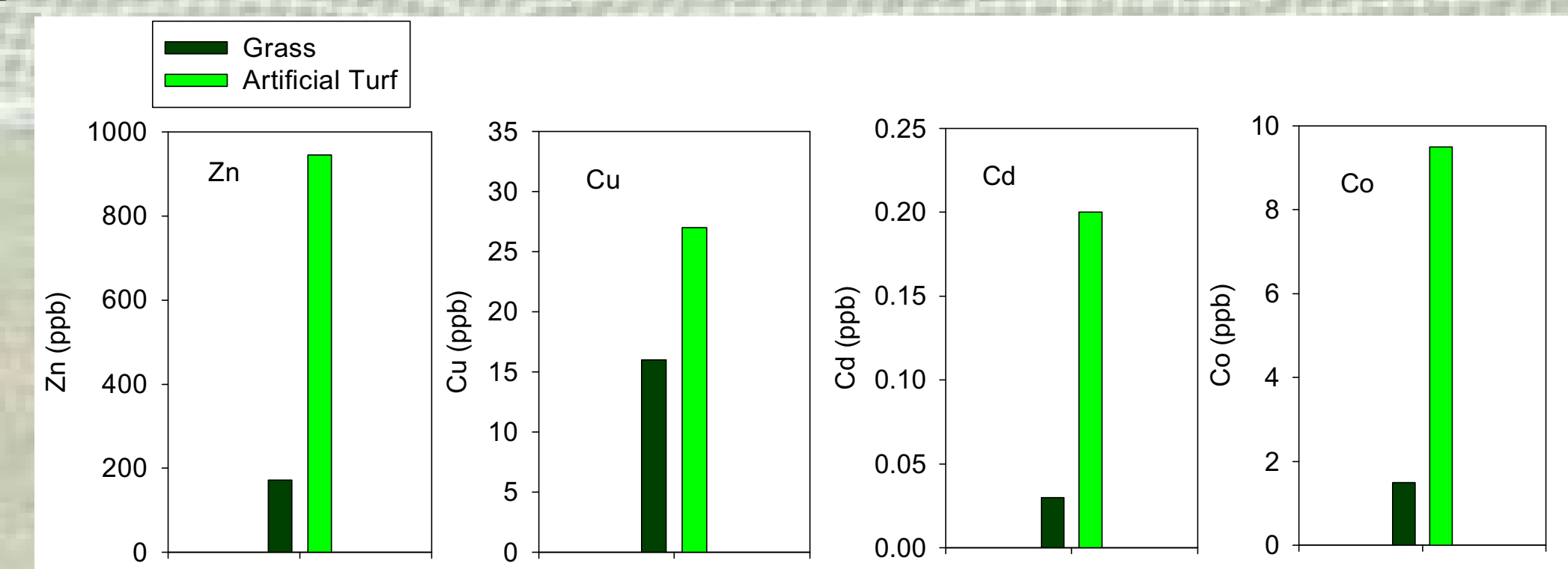
Grass fields should not be over fertilized and should be maintained in a sustainable (natural pest control) way.

Runoff from soccer fields must be tested regularly, and players should be informed that they need to clean any part of their skin that comes in contact with artificial turf as soon as they get off the field.

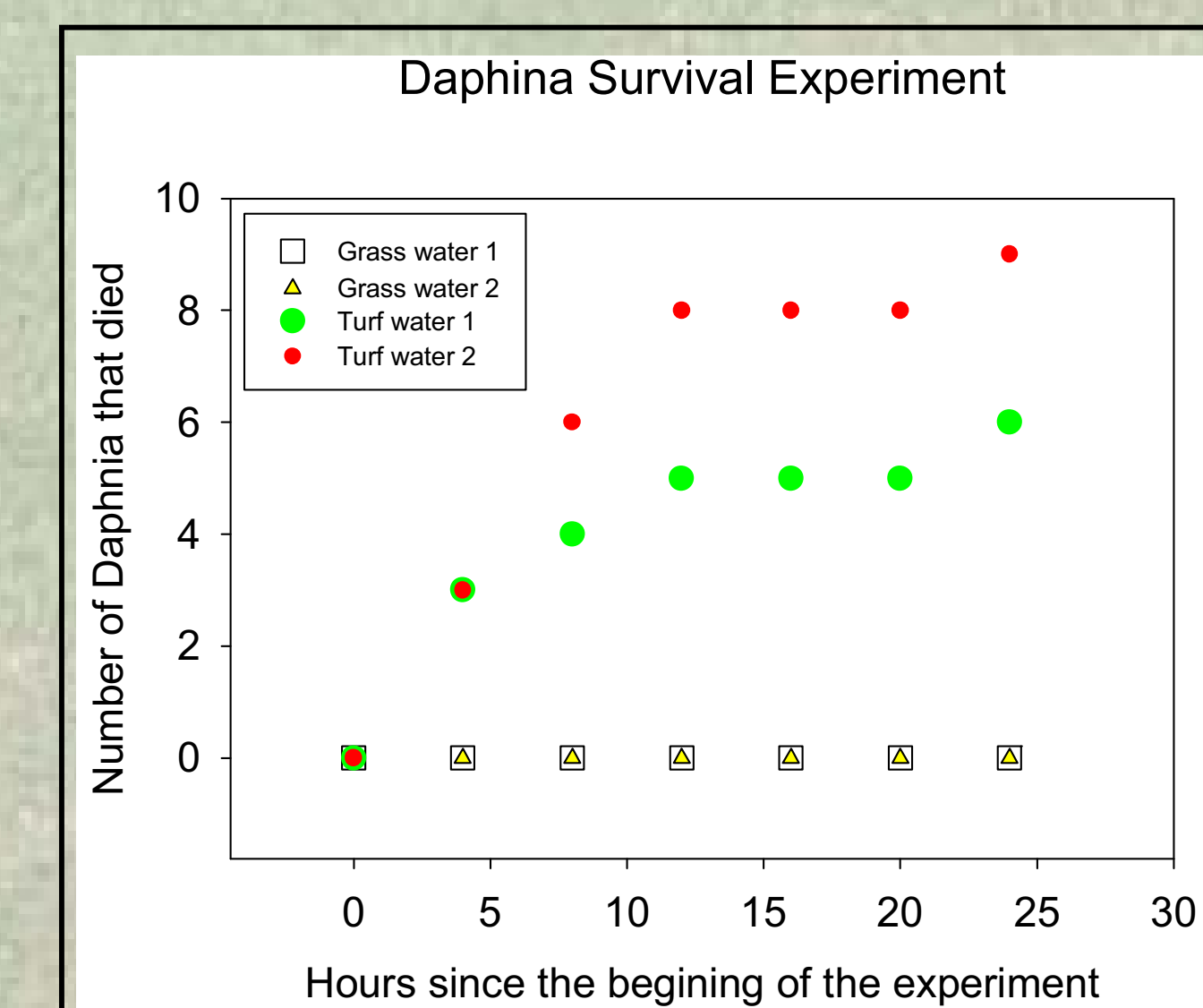


All the grass samples runoff had high levels of ammonium and phosphate most likely from the use of fertilizers in the field. The EPA drinking water standards for ammonium is < 2 mg/L and for phosphate is <0.1 mg/L.

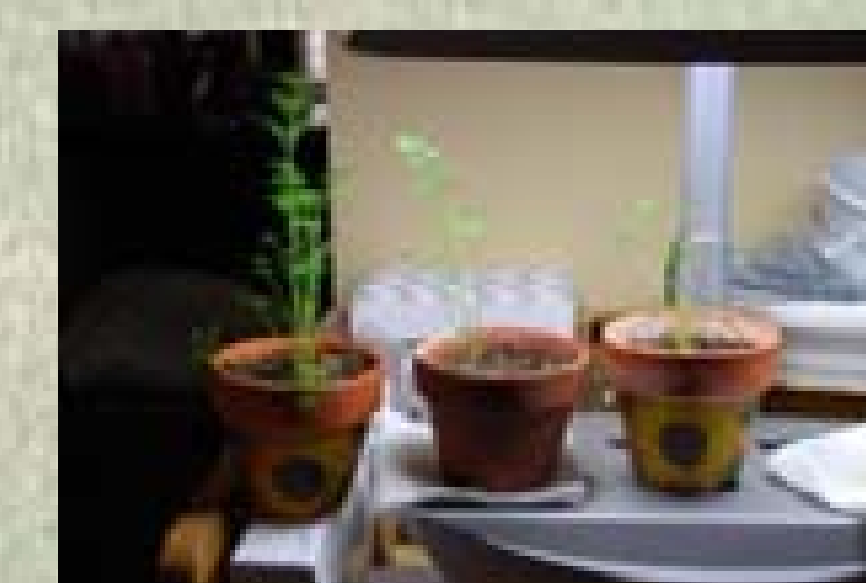
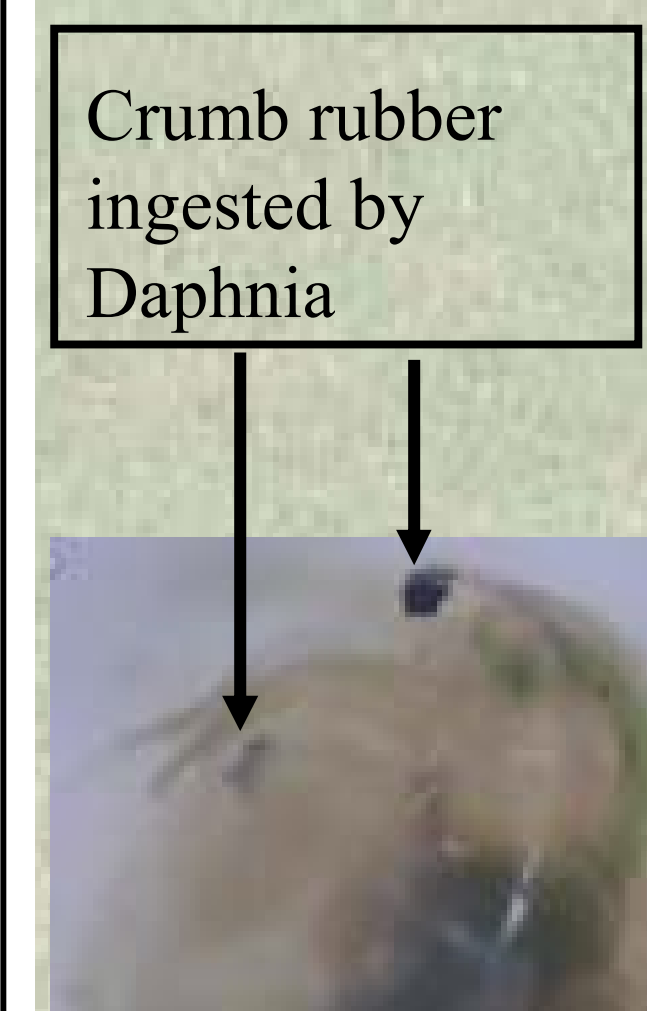
### Average Concentration of Certain Trace Metals in the Different Fields



Synthetic turf water samples had zinc levels of 1000s of ppb and copper levels typically above 20ppb. These samples always exceeded the Monterey Bay Basin Plan Water Quality Objective for copper (< 30 ppb) and zinc (< 200 ppb) and at times the EPA drinking water levels as well. Cadmium and cobalt were also higher in the artificial turf runoff than in grass runoff and levels exceed runoff targets in some samples but not all.



Within 24 hours about 80% of the *Daphnia* died in synthetic turf water; within 36 hours all of the turf-exposed *Daphnia* were dead. The *Daphnia* in the grass field runoff and the spring water all lived over 36 hours.



To understand how the different types of water might affect plants, I used the runoff water from the grass, synthetic turf and also tap water to grow carrots from seed (in the same soil). The healthiest plants and the biggest carrots grew with the tap water treatment. The synthetic turf-water carrots came out with the smallest and lightest carrots.

## APPROACH

Runoff samples from five grass and five artificial turf fields in the city of San Francisco were collected throughout the year (110 samples) and analyzed for nutrient content and trace metal concentrations.

Data was assimilated for cost-benefit analysis.

The effects of the grass and synthetic turf runoff on carrot growth and on *Daphnia* Magnus survival were conducted.

