

# Chemistry Assessment Handbook

First Edition: Shayne Fuller (2000)

Second Edition: Shara Cohn (2002)

Third Edition: Joanne Lee (2003)

Fourth Edition: David Kuperstein, Spencer Orey (2004)

Fifth Edition: Kelly Nissen, Jon Spaulding (2005)

Sixth Edition: Alex Chang, Beth Griffiths (2006)

Seventh Edition: Annie Tsay, Gopal Lalchandani (2008)

## Objective:

The objective of the Chemistry Assessment is to collect monthly samples from both a riffle and a pool within the boundaries of each site at Arcade Creek and to test those samples for the presence of various chemicals. Samples must be collected from both the riffle and pool once a month, ideally at the same times, locations, and even depths. This data can be used to assess creek health and anthropogenic threats to the creek. These results help to illustrate the ability of the creek to support life and maintain a healthy ecosystem.

## General Terminology:

**Pollution:** Anything that affects the condition of the water. This is not limited to toxic waste. It can include soil erosion, flooding, etc.

**Organic pollutants:** Come from decomposition of living organisms and their byproducts. They release both nutrients and toxins into the water.

**Inorganic pollutants:** Suspended and dissolved solids that are usually natural in origin

**Toxic pollutants:** Heavy metals and lethal chemicals (usually dumped by industry).

**Thermal pollutants:** A change in average temperature caused by human influence. Change in water temperature can have drastic effects on aquatic life.

**Non-point source pollution:** Exact origin of pollution cannot be determined

**Point source pollution:** Pollution traced to a single origin

**Cultural Eutrophication:** Human caused enrichment of the water with nutrients, usually phosphorous, sometimes nitrates

**Riffle:** An area of the creek where the water is running and breaking the surface

**Pool:** An area of the creek where the water is not moving or breaking the surface and is at least two feet deep

**Run:** A stretch of straight stream

**Reach:** A section of the creek composed of a pool, a riffle, and a run

**Eddy:** A current of water moving in an opposite direction of the main current that generally goes in a circular motion

THM: an organic molecule in which hydrogen is replaced by elements from the electronegative Halogen family, usually chlorine and bromine

Human Disturbance: Human disturbance can be trash, waste from Haggin Oaks Golf Course (such as the lawn preparation of the Haggin Oaks Golf Course), etc.

## **Creek Protocol:**

The leader of each group must contact his/her group members several days before the testing date to make sure all members will be present. The leader must also coordinate with the other leaders because there are a limited number of kits. Before actually leaving Mira Loma, make sure you have signed out all equipment.

### *Materials to bring to the creek:*

Waders  
2 containers for water samples (one for pool, one for riffle)  
Dissolved Oxygen (DO) kit with 2 DO bottles  
Record sheet  
Gloves

### *Creek Methodology:*

- ONLY VISIT THE CREEK IN GROUPS OF THREE OR MORE!!! If a group is found to have sampled with fewer than three people, there will be severe consequences.
- Do not sample if water conditions are too extreme.
- All groups must sample on the second week of the month before Wednesday.
- Record the weather, temperature, time, and any other observations such as unusual changes.
- Find the markers for the site. It may be helpful to go with a long mapper first to locate your site
- Sample from a riffle and pool within the site. Leaders will show you where they are located. If possible, sample from the same riffle and pool every time.
- When wading in the creek, move upstream, so as to not create bubbles or stir up other chemicals in the creek.
- Avoid taking samples soon after other groups have been trampling around your sampling site.
- Remember to take an extra pool sample for Bio Assay.
- Run the DO tests on-site.
- You may run into some unexpected difficulties during your fieldwork. For example, during the rainy season, there may be no riffle. If such is the case, record and elaborate as much as possible in the comments box. Doing so will make your contribution to this project much more effective.
- Wear appropriate apparel (i.e. close toed shoes)
- For humans the water is considered to be unsafe for contact at 200 colonies per 100 milliliters of water. Arcade Creek has considerably higher levels than this, so try to limit your time playing in the water!

Once you return to Mira Loma, make sure you check all equipment back in. Do not take anything home. Fill out the log sheet along with the data table each time your group conducts tests on the creek. Clean you DO kit if it has become messy. NOTIFY LEADERS IF THE KITS NEED REPLACEMENTS.

## **Lab Protocol:**

### *Lab Materials:*

Samples from the pool and riffle  
All the kits (Hardness, Chlorine, Phosphate, Ammonia, Alkalinity, Nitrate, pH, Fecal Coliform)  
Pipettes

Droppers  
Calculator  
Goggles  
Aprons  
Gloves  
Distilled Water

*Lab Methodology:*

- The tests you will be conducting are standardized tests of the Water Quality Index (WQI).
- Perform the low range tests first. If the sample yields a high value for the low range test, then proceed with the high range test.
- Test the water sample for Total Chlorine before testing for Free Chlorine because Total Chlorine already accounts for the amount of Free Chlorine in the sample.
- Clean all glassware and work sites. Remember that the lab is a classroom during the day.
- Wash your hands thoroughly and any other part of your body that came into contact with the creek water or the chemicals we work with.
- Help maintain the re-order list as the year progresses (things that have been broken or used up).
- QAQC (Quality Assurance/Quality Control) each other. It helps ensure that the data is accurate. Run the test first yourself, and then have your partner run it without previously telling him/her your result. Compare and discuss your results. Hopefully they will be the same.
- Do not make up data. Run all possible tests and record all tests that could not be performed and why. Inform your leaders and managers when this happens. When you falsify data you undermine everything this project stands for.

*Lab Efficiency:*

- While accuracy should not be sacrificed for efficiency on data collection days, efficiency during data collection days is still a major concern. Using the following format, it is possible to be done with testing in about thirty minutes.
- For groups of three:
  - Person A: Nitrates and Hardness while waiting during the Nitrates test
  - Person B: Phosphates and Chlorines
  - Person C: Ammonia and Alkalinity
- For groups of four:
  - Person A: Alkalinity and Phosphates
  - Person B: Hardness and Chlorines
  - Person C: Ammonia
  - Person D: Nitrates

**Test Information:**

*Dissolved Oxygen (DO):* Atmospheric O<sub>2</sub> mixed in the water available for biological consumption

- an indicator of the water's ability to support life
- DO is attributed to photosynthesis and direct mixing of atmospheric O<sub>2</sub> with the water surface. Direct mixing requires a rough substrate, bottom, and a quick current velocity. Arcade Creek rarely exhibits these two properties, so its primary source of O<sub>2</sub> is photosynthesis.
- Photosynthesis is dependent on sunlight. There will be fluctuations of dissolved oxygen content throughout a 24-hour period, with more in the day and less at night.
- DO usually reaches its peak at 4 P.M., decreasing to as low as 4 mg/L before dawn.
- DO values may change while in the sample bottle because of algae that are continuing photosynthesis, air bubbles, and microorganisms that are using oxygen. It is best to perform the DO on site.
- DO is dependent on temperature, location (depth), and flow.
- When taking samples, record the appearance and flow of the water, weather, and temperature. A high temperature results in less oxygen.
- Healthy DO: saturation greater than ninety percent, approximately 9.5 mg/L

- Changes in dissolved oxygen are attributed mainly to the build up of organic wastes. Aerobic organisms must consume oxygen to decompose organic matter.
- Biochemical Oxygen Demand (BOD) is the oxygen required to decompose organic matter and sustain the aerobic organisms living in the water. It is inversely related to DO.
- Temperature and oxygen content are inversely related.

*Free and Total Chlorine:* When in contact with water, small amounts of hypochlorous acid (HClO) and hydrochloric acid (HCl) form.

- Hypochlorous acid: Agent responsible for puncturing the cell walls of bacteria and other organisms. It can break down further into its respective ions of  $H^+$  and  $ClO^-$
- HClO and  $ClO^-$  are the molecules measured as free chlorine.
- Total chlorine measures the free chlorine and all the chlorine containing compounds. High amounts are considered harmful because they indicate the presence of carcinogenic byproducts, known as trihalomethanes or THM's.
- THM: an organic molecule where hydrogen is replaced by elements from the electronegative Halogen family, usually chlorine and bromine.
- Because chlorine is used as a disinfectant for sewage, it is usually present in the wastewater effluent, treated water that has been dumped back into the environment. No such effluent is pumped into Arcade creek so spikes in chlorine level could possibly be due to cultural eutrophication.
- This tests for the efficiency of the disinfecting process in wastewater treatment plants.
- A healthy range for drinking water is between 0.2-2.0 mg/L of  $Cl_2$  of free chlorine

*Phosphates:* the most common form of phosphorous in natural waters

- Essential element for life, especially for plants
- Beneficial only when present in minute amounts
- In typical aquatic systems, plants grow until phosphates are used up. Thus, it is a limiting nutrient.
- Phosphates are fixed by algae and tied up in the sediment at the bottom on the creek. If the creek is stirred up too much, this can affect phosphate level. We only test for the ionic form ( $PO_4^{3-}$ ).
- Scarcity is attributed to phosphorous' attraction to anionic soil particles and organic matter.
- Excessive phosphorous facilitates extensive algal growth called "harmful algal bloom" (HAB).
- Natural abundance of phosphorous is rare; it is usually caused by cultural eutrophication.
- Human sources of phosphorous include inorganic detergents, fertilizers, human waste, industrial waste, and human disturbance of the land.

*Nitrates:* effects of nitrogen similar to phosphorous

- It is a plant nutrient.
- Excess amounts of nitrogen result in algal bloom.
- Nitrate has a negative charge ( $NO_3^-$ ).
- Nitrates will leak into the water table and can contaminate drinking water.
- High amounts of nitrates do not affect aquatic organisms because phosphates limit their growth.
- Methemoglobinemia in infants prevents the baby's blood from carrying  $O_2$ .

*Ammonia:* breakdown creates nitrates and nitrogen

- Byproduct of decay and protein hydrolysis
- It is extremely toxic to gilled organisms.
- Added through cultural eutrophication, where the nitrogen cycle is disrupted
- The toxicity is higher when pH is higher.
- The higher the temperature, the more ammonia can convert to its ionic form ( $NH_3 \rightarrow NH_4^+$ )
- Sources include fertilizer, cleaning agents, cow/horse excrement
- Perform test quickly after sampling

*Alkalinity*: the ability of water to resist acids that can cause drastic change in pH

- Created by buffers, it is measured as acid neutralizing capability in terms of calcium carbonate.
- Fish and multicellular organisms are the most sensitive to fluctuations in pH because of their complexity, while bacteria and protozoa are the most tolerant.

*Hardness*: a measure of the cations in the water, specifically the calcium ions

- It indicates the source of water and what it has been in contact with, including rocks and sediments.
- Soft water is less than 60 parts per million.
- Fluctuations in calcium hardness are a sign of human involvement. Ions naturally stay in a relatively stable state.
- It affects other ions and the toxicity of metal ion, especially copper. Copper kills aquatic mammals and is the most toxic element from storm water runoff.
- It is visually detected as competitive inhibition. Soap competes for dissociation with calcium and magnesium, which are less soluble.
- Magnesium and calcium compete with toxic metals for placement on gills.

*pH*: most organisms adapt to a certain pH, a ratio of hydrogen ions to hydroxide ions

- Extremely acidic water releases heavy metals such as copper and aluminum.
- Typical pH of natural water is between 6.5-7.5.