Final Report

Project: Raising Awareness of Hexavalent Chromium Contamination in Drinking Water of Disadvantaged communities.

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Hexavalent chromium (Chrome 6) contamination in groundwater has been well described before (Loyaux-Lawniczak, Lecomte, & Ehrhardt, 2001). Its effects on the human body are also well documented (Pellerin & Booker, 2000). California itself has had more than a few brushes with the contaminant. Of 12,237 wells tested, 4,156 tested positive for chrome 6, of which 406 tested above the maximum contaminant level (MCL) of 10µg/L (State Water Resources Control Board, 2016). According to the State Water Resources Control Board (SWRCB), Los Angeles County has the highest number of wells, 57, surpassing the legally defined maximum concentration of chrome 6.

To summarize the effects of chrome 6, we must understand the chemical compound itself. Chrome 6 is the +6 oxidation state of chromium. It is by far, the most common form of chromium occurring in nature. By itself it is stable and non-hazardous to humans. However, chrome 6 from a macro-molecular prospective is similar in size to sulfate an important constituent of proteins. Sulfate channels readily uptake the chrome 6 which is reduced in a series of steps to chromium-III. This compound readily interacts with hydrogen peroxide in the cells to give off hydroxyl radicals. The chromium-III itself can adhere to DNA and proteins; it can then alter important cell molecule shapes or create breaks in DNA with chromium-III's own structure. The hydroxyl radicals given off can also cause DNA breaks. These breaks cause DNA degradation. If the damage is done at the correct sequence, the cell will become immortalized and can cause a cancerous tumor to form. This whole process takes years or even decades to complete. (Salnikow & Zhitkovich, 2008).

Next, we must understand how chrom-6 enters the water supply and how it can be removed. Chrome 6 is a naturally occurring metal ore and finding chrome that has seeped into groundwater in non-dangerous quantities is not unexpected. Where the danger lies is in mass extraction and processing of chrome. Chrome is used in countless chemical and industrial processes. It can be used as or to make: catalysts, dyes, alloyed metals, and far more. Waste chrome materials can leech their chrome into the groundwater. Mining activities can also spread chromium away from its naturally occurring veins contaminating more of the water table. Removal is done primarily by reverse-osmosis as ion-exchange may not work in many circumstances with chrome. This beneficial as reverse osmosis (RO) is a common water purification technique. The main drawback is that reverse osmosis plants are large and expensive for one simple reason. The process does not purify the water itself, it merely concentrates the contaminants into a portion of the water that must be disposed of or found a use for. This means that to recover the water, part of the water must be lost as waste. Typically, this wasted water is around 25% of the original volume; this however is only true for large industrial scale plants. Household reverse osmosis machines waste more water than they purify (Johnson & Scherer, 2013).

If there exists a contaminant and a filtration technology that will remove it from the water there usually is no problem. While RO is effective at removing chrome, apparatuses capable of running RO at industrial scales are designed for massive communities; these have the best efficiency. Smaller apparatuses exist but they have increasing percentages of waste water produced as the apparatus becomes smaller due to technological constraints. As such, RO is infeasible for a smaller or less economically competitive communities. As we learned from our field research, the communities that cannot employ an RO filter simply blend the water with unpolluted water from the already endangered Colorado river to force the water's concentration below legal limits. Both techniques require using water wastefully in a drought prone area of the country.

Our project was aimed at understanding and raising awareness of chrome-6. To do this, we visited the Coachella valley, which has a substantial problem with chrome-6. The community members we interacted with had no knowledge that their water had been repeatedly reported by the SWRCB to have chrome-6 above what is legally allowed. This is not unexpected as the effects of chrome-6 are so gradual that residents would not notice a change in their body. We visited the water infrastructure of the communities, saw their wells and treatment plants. What we noticed was a fusion of older installations and newer ones. This could be from the local casinos and economy, as they create enough business to uplift parts of the community. We spoke at numerous conferences to raise awareness of the issue. Including a trip to the National Collegiate Honors Council (of which CSU Pomona is a member) annual summit at Seattle Washington to discuss our work. We also spoke at various WRPI and Cal Poly's own conferences. From this we gained a greater understanding of the scientific field and the process of creating and publishing scientific work. We also gained a greater understanding of how scientific projects are funded and ran. These lessons will prove invaluable later when students enter the workforce.

Works Cited

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