Electronic Supplementary Material (ESI) for Environmental Science: Water Research & Technology.


# Tracking copper, chlorine, and occupancy in a multi-story, new, institutional green building

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**SUPPLEMENTAL MATERIALS**

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Tables S1a-f: Brief summary highlighting important aspects of City of Tempe Consumer Confidence Report (CCR) adapted for this research.

Table S1a

| Substance | Unit | MCL | MCLG | Range | Violation (Yes or No) | Major Sources |
|---|---|---|---|---|---|---|
| Arsenic* | ppb | 10 | 0 | 1.6-62 | No | Erosion of natural deposits. |
| Barium | ppm | 2 | 2 | 0.043 - 0.11 | No | |
| Chlorine | ppm | 4 (MRDL) | 4 (MRDLG) | 0.06[a] - 1.29 | No | Disinfectant added to control microbial contaminants. |
| Chromium (Total) | ppb | 100 | 100 | ND - 12 | No | Erosion of natural deposits. |
| Fluoride | ppm | 4 | 4 | 0.12 - 0.53 | No | Erosion of natural deposits; water additive which promotes strong teeth. |
| Gross Alpha | pCi/L | 15 | 0 | 3.1 - 8.7 | No | Erosion of natural deposits. |
| Nitrate | ppm | 10 | 10 | 0.68 - 8.8 | No | Runoff from fertilizer use. |
| Selenium | ppb | 50 | 50 | ND - 2.1 | No | Leaching of natural deposits; discharge from metal refineries and mining. |
| Tetrachloroethylene | ppb | 5 | 0 | ND - 0.93 | No | Discharge from factories and dry cleaners. |
| Total Organic Carbon | ppm | TT | N/A | 0.7 - 3.5 | No | Naturally present in the environment. |
| Trichloroethylene | ppb | 5 | 0 | ND - 0.66 | No | Discharge from factories and dry cleaners. |
| Uranium | ppb | 30 | 0 | 0.90 - 5.6 | No | Erosion of natural deposits. |

* Range includes calculated running annual averages.

[a] The chlorine range near BDC never fell below 0.35 mg/L based on sample sites used by the City of Tempe.

Table S1b

| Substance | Unit | MCL | Highest Value | Lowest monthly % meeting limit | Violation (Yes or No) | Major Sources |
|---|---|---|---|---|---|---|
| Turbidity | NTU (Nephelometric Turbidity Units) | TT = 1; and not less than 95% < 0.3 NTU | 0.1 | 100% | No | Soil runoff into canals. |

Table S1c

| Substance | Unit | MCL | Highest Locational Running Annual Average | Range (single sample) | Violation (Yes or No) | Major Sources |
|---|---|---|---|---|---|---|
| Total Trihalomethanes (TTHM) | ppb | Running Annual Average of 80 | 76 | 16 - 110 | No | By-products of drinking water chlorination. |
| Total Haloacetic acids (HAA) | ppb | Running Annual Average of 60 | 17 | 4.6 - 22 | No | |

Table S1d

| Substance | Unit | Action Level | 90th Percentile Result | # of results above action level | Violation (Yes or No) | Major sources |
|---|---|---|---|---|---|---|
| Copper (2018) | ppm | 1.3 | 0.25 | 1 | No | Corrosion of household plumbing systems. |
| Lead (2018) | ppb | 15 | 12 | 3 | No | Corrosion of household plumbing systems. |

Table S1e

| Substance | Units | MRL | Average | Range |
|---|---|---|---|---|
| Total Organic Carbon | ppb | NA | 2950 | 1100 - 4400 |

Table S1f

| Substance | Units | Average Value | Range of Values |
|---|---|---|---|
| Alkalinity | ppm | 155 | 100- 360 |
| Aluminum | ppm | 0.121 | ND - 0.25 |
| Boron | ppm | 0.15 | 0.12 - 0.59 |
| Bromide | ppm | <0.05 | ND - 0.23 |
| Calcium | ppm | 57 | 46 - 110 |
| Chloride | ppm | 268 | 94 - 430 |
| Conductivity | µmhos/cm@25°C | 1339 | 784 - 2260 |
| Hardness | ppm | 238 | 203 - 485 |
| Hardness | grains /gallon | 13.9 | 11.8 - 28.4 |
| Hexavalent chromium (2017) | ppb | < 10.0 | ND |
| Iron | ppm | <0.05 | ND - 10.1 |
| Magnesium | ppm | 23 | 18 - 52 |
| Manganese | ppm | <0.001 | ND - 0.025 |
| Nickel | ppb | <5.0 | ND |
| pH | S.U. | 6.8 | 6 - 7.6 |
| Potassium | ppm | 5.3 | 3.4 - 6.5 |
| Radon (2008) | pCi/L | 346 | ND - 688 |
| Silica | ppm | 13 | 8.1 - 33.9 |
| Silver | ppb | <0.25 | ND |
| Sodium | ppm | 184 | 72.6 - 343 |
| Sulfate | ppm | 102 | 53 - 200 |
| Temperature | °F | 76 | 62 - 86 |
| Total Dissolved Solids | ppm | 773 | 400 - 1400 |
| Zinc | ppm | <0.02 | ND – 0.039 |

Table S2: Occupancy move-in count and summed daily occupancy count over duration of study

| Floor | Occupancy move-in count (May – Aug 2018) | Summed occupancy count for study duration |
|---|---|---|
| 1 | 0 | 31,648 |
| 2 | 25 | 7063 |
| 3 | 36 | 12024 |
| 4 | 17 | 5202 |
| 5 | 12 | 4103 |

Table S3: Nonparametric Steel-Dwass on daily occupancy by floor where floor is denoted by BDC (Biodesign C) and floor number

| Level | - Level | p-Value |
|---|---|---|
| BDC3 | BDC2 | 0.0005* |
| BDC4 | BDC2 | 0.9442 |
| BDC5 | BDC2 | 0.1738 |
| BDC5 | BDC4 | 0.0070* |
| BDC4 | BDC3 | 0.0006* |
| BDC5 | BDC3 | <.0001* |
| BDC3 | BDC1 | <.0001* |
| BDC2 | BDC1 | <.0001* |
| BDC4 | BDC1 | <.0001* |
| BDC5 | BDC1 | <.0001* |

Table S4: Spearman's ρ correlations between copper (Cu), Domestic Cold Water (DCW)[a] and occupancy[b] by floor denoted as the floor number and -B for breakroom. Cu draws were every Monday and Thursday for the duration of the study May 2018 – October 2018. DCW was measured starting 7/31/2018.

| Floor | First Draw Cu Concentrations Nonparametric: Spearman's ρ Occupancy and DCW | | | | Second Draw Cu Concentrations Nonparametric: Spearman's ρ Occupancy and DCW | | | |
|---|---|---|---|---|---|---|---|---|
| 1-B | Variable | by Variable | Spearman ρ | Prob>\|ρ\| | Variable | by Variable | Spearman ρ | Prob>\|ρ\| |
| | Occupancy | First draw Cu Concentration | -0.6608 | <.0001* | Occupancy | Second draw Cu Concentration | -0.6886 | <.0001* |
| | DCW | First draw Cu Concentration | -0.7106 | 0.0001* | DCW | Second draw Cu Concentration | -0.7971 | <.0001* |
| | DCW | Occupancy | 0.5840 | 0.0034* | DCW | Occupancy | 0.5840 | 0.0034* |
| 2-B | Variable | by Variable | Spearman ρ | Prob>\|ρ\| | Variable | by Variable | Spearman ρ | Prob>\|ρ\| |
| | Occupancy | First draw Cu Concentration | -0.4698 | 0.0017* | Occupancy | Second draw Cu Concentration | -0.5970 | <.0001* |
| | DCW | First draw Cu Concentration | -0.7038 | 0.0002* | DCW | Second draw Cu Concentration | -0.7161 | 0.0001* |
| | DCW | Occupancy | 0.6225 | 0.0015* | DCW | Occupancy | 0.6225 | 0.0015* |
| 3-B | Variable | by Variable | Spearman ρ | Prob>\|ρ\| | Variable | by Variable | Spearman ρ | Prob>\|ρ\| |
| | Occupancy | First draw Cu Concentration | -0.5587 | 0.0001* | Occupancy | Second draw Cu Concentration | -0.6217 | <.0001* |
| | DCW | First draw Cu Concentration | -0.7204 | 0.0001* | DCW | Second draw Cu Concentration | -0.7395 | <.0001* |
| | DCW | Occupancy | 0.5870 | 0.0032* | DCW | Occupancy | 0.5870 | 0.0032* |
| 4-B | Variable | by Variable | Spearman ρ | Prob>\|ρ\| | Variable | by Variable | Spearman ρ | Prob>\|ρ\| |
| | Occupancy | First draw Cu Concentration | -0.7168 | <.0001* | Occupancy | Second draw Cu Concentration | -0.7316 | <.0001* |
| | DCW | First draw Cu Concentration | -0.7210 | 0.0001* | DCW | Second draw Cu Concentration | -0.7461 | <.0001* |
| | DCW | Occupancy | 0.7201 | 0.0001* | DCW | Occupancy | 0.7201 | 0.0001* |
| 5-B | Variable | by Variable | Spearman ρ | Prob>\|ρ\| | Variable | by Variable | Spearman ρ | Prob>\|ρ\| |
| | Occupancy | First draw Cu Concentration | -0.5426 | 0.0002* | Occupancy | Second draw Cu Concentration | -0.5752 | <.0001* |
| | DCW | First draw Cu Concentration | -0.7500 | <.0001* | DCW | Second draw Cu Concentration | -0.7682 | <.0001* |
| | DCW | Occupancy | 0.6660 | 0.0005* | DCW | Occupancy | 0.6660 | 0.0005* |

a = DCW is volumetric daily gallons for day prior (Gallons Per Day GPD), b = Occupancy is the day prior sums (Count Per Day CPD),

Table S5: Wilcoxon signed rank test first draw Cu concentration versus second draw Cu concentration for duration of study (May 2018 – October 2018 every Monday and Thursday) where B represents the breakroom.

| Floor | First draw vs second draw Cu | | | | Wilcoxon-signed rank | |
|---|---|---|---|---|---|---|
| 1-B | Second draw Cu Concentration | 0.52253 | t-Ratio | -5.2952 | | |
| | First draw Cu Concentration | 0.6259 | DF | 39 | Test Statistic S | -331.00 |
| | Mean Difference | -0.1034 | Prob > \|t\| | <.0001* | Prob>\|S\| | <.0001* |
| | Std Error | 0.01952 | Prob > t | 1.0000 | Prob>S | 1.0000 |
| | Upper 95% | -0.0639 | Prob < t | <.0001* | Prob<S | <.0001* |
| | Lower 95% | -0.1429 | | | | |
| | N | 40 | | | | |
| | Correlation | 0.87755 | | | | |
| 2-B | Second draw Cu Concentration | 0.59543 | t-Ratio | -2.06159 | | |
| | First draw Cu Concentration | 0.65043 | DF | 39 | Test Statistic S | -231.50 |
| | Mean Difference | -0.055 | Prob > \|t\| | 0.0460* | Prob>\|S\| | 0.0011* |
| | Std Error | 0.02668 | Prob > t | 0.9770 | Prob>S | 0.9995 |
| | Upper 95% | -0.001 | Prob < t | 0.0230* | Prob<S | 0.0005* |
| | Lower 95% | -0.109 | | | | |
| | N | 40 | | | | |
| | Correlation | 0.85442 | | | | |
| 3-B | Second draw Cu Concentration | 0.57671 | t-Ratio | -3.95369 | | |
| | First draw Cu Concentration | 0.64505 | DF | 40 | Test Statistic S | -379.50 |
| | Mean Difference | -0.0683 | Prob > \|t\| | 0.0003* | Prob>\|S\| | <.0001* |
| | Std Error | 0.01729 | Prob > t | 0.9998 | Prob>S | 1.0000 |
| | Upper 95% | -0.0334 | Prob < t | 0.0002* | Prob<S | <.0001* |
| | Lower 95% | -0.1033 | | | | |
| | N | 41 | | | | |
| | Correlation | 0.92515 | | | | |
| 4-B | Second draw Cu Concentration | 0.61195 | t-Ratio | -2.72563 | | |
| | First draw Cu Concentration | 0.68149 | DF | 40 | Test Statistic S | -318.50 |
| | Mean Difference | -0.0695 | Prob > \|t\| | 0.0095* | Prob>\|S\| | <.0001* |
| | Std Error | 0.02551 | Prob > t | 0.9953 | Prob>S | 1.0000 |
| | Upper 95% | -0.018 | Prob < t | 0.0047* | Prob<S | <.0001* |
| | Lower 95% | -0.1211 | | | | |
| | N | 41 | | | | |
| | Correlation | 0.83559 | | | | |
| 5-B | Second draw Cu Concentration | 0.63461 | t-Ratio | -3.73162 | | |
| | First draw Cu Concentration | 0.68768 | DF | 40 | Test Statistic S | -321.00 |
| | Mean Difference | -0.0531 | Prob > \|t\| | 0.0006* | Prob>\|S\| | <.0001* |
| | Std Error | 0.01422 | Prob > t | 0.9997 | Prob>S | 1.0000 |
| | Upper 95% | -0.0243 | Prob < t | 0.0003* | Prob<S | <.0001* |
| | Lower 95% | -0.0818 | | | | |
| | N | 41 | | | | |
| | Correlation | 0.96125 | | | | |

Table S6: One-way ANOVA for first and second draw Cu concentrations by floor for duration of study (May 2018 – October 2018)

**First Draw Cu Concentrations**

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|---|---|---|---|---|---|
| Floor | 4 | 0.071604 | 0.017901 | 0.2051 | 0.9354 |
| Error | 204 | 17.803873 | 0.087274 | | |
| C. Total | 208 | 17.875477 | | | |

Tests that the Variances are Equal

| Test | F Ratio | DFNum | DFDen | Prob > F |
|---|---|---|---|---|
| O'Brien[.5] | 0.5743 | 4 | 204 | 0.6816 |
| Brown-Forsythe | 0.1625 | 4 | 204 | 0.9571 |
| Levene | 0.1596 | 4 | 204 | 0.9585 |
| Bartlett | 0.9496 | 4 | . | 0.4340 |

**Second Draw Cu Concentrations**

Analysis of Variance

| Source | DF | Sum of Squares | Mean Square | F Ratio | Prob > F |
|---|---|---|---|---|---|
| Floor | 4 | 0.291447 | 0.072862 | 1.2382 | 0.2960 |
| Error | 198 | 11.651246 | 0.058845 | | |
| C. Total | 202 | 11.942693 | | | |

Tests that the Variances are Equal

| Test | F Ratio | DFNum | DFDen | Prob > F |
|---|---|---|---|---|
| O'Brien[.5] | 1.4852 | 4 | 198 | 0.2081 |
| Brown-Forsythe | 0.8337 | 4 | 198 | 0.5052 |
| Levene | 0.8511 | 4 | 198 | 0.4944 |
| Bartlett | 1.9979 | 4 | . | 0.0919 |

Table S7: First draw Cu summary statistics for Summer and Fall denoted by floor and B for breakroom

| Summer (May – July) | | | | |
|---|---|---|---|---|
| 1-B | 2-B | 3-B | 4-B | 5-B |
| Quantiles | Quantiles | Quantiles | Quantiles | Quantiles |
| max 1.154 | max 1.639 | max 1.271 | max 1.722 | max 1.662 |
| Q3 0.95725 | Q3 1.142 | Q3 1.097 | Q3 0.937 | Q3 1.089 |
| med 0.799 | med 0.718 | med 0.782 | med 0.786 | med 0.797 |
| Q1 0.657 | Q1 0.672 | Q1 0.611 | Q1 0.706 | Q1 0.702 |
| min 0.471 | min 0.244 | min 0.558 | min 0.532 | min 0.482 |
| **Fall (August – October)** | | | | |
| 1-B | 2-B | 3-B | 4-B | 5-B |
| Quantiles | Quantiles | Quantiles | Quantiles | Quantiles |
| max 0.881 | max 0.888 | max 0.911 | max 0.953 | max 0.881 |
| Q3 0.71 | Q3 0.687 | Q3 0.608 | Q3 0.653 | Q3 0.581 |
| med 0.429 | med 0.524 | med 0.452 | med 0.482 | med 0.471 |
| Q1 0.335 | Q1 0.331 | Q1 0.335 | Q1 0.361 | Q1 0.35 |
| min 0.202 | min 0.285 | min 0.263 | min 0.266 | min 0.266 |

Table S8a: Temperature and pH values for first draw samples where # represents the floor, B represents the breakroom and -1 represents first draw

| | TEMPERATURE | | | | | pH | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **1-B-1** | **2-B-1** | **3-B-1** | **4-B-1** | **5-B-1** | **1-B-1** | **2-B-1** | **3-B-1** | **4-B-1** | **5-B-1** |
| 5/24/2018 | | 23 | 22.7 | 22.7 | 22.4 | | 7.63 | 7.72 | 7.61 | 7.76 |
| 5/29/2018 | 23.2 | 23.5 | 24.4 | 21.2 | 21.7 | 7.4 | 7.4 | 7.6 | 7.5 | 7.5 |
| 6/1/2018 | 24.4 | 24.1 | 24.1 | 24.3 | 24 | 7.5 | 7.4 | 7.5 | 7.6 | 7.5 |
| 6/4/2018 | 22.7 | 22.7 | 23.8 | 22.8 | 22.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| 6/7/2018 | 22.6 | 22 | 22.6 | 20 | 22.6 | 7.4 | 7.5 | 7.4 | 7.5 | 7.4 |
| 6/11/2018 | 21.7 | 22.2 | 21.6 | 23 | 23.6 | 7.4 | 7.4 | 7.5 | 7.5 | 7.5 |
| 6/14/2018 | 22.6 | 22 | 24.9 | 22.6 | 25.4 | 7.5 | 7.4 | 7.4 | 7.4 | 7.4 |
| 6/18/2018 | 21.5 | 20.8 | 22 | 24 | 23 | 7.4 | 7.5 | 7.6 | 7.6 | 7.6 |
| 6/21/2018 | 23 | 22.7 | 24 | 23.8 | 23 | 7.6 | 7.6 | 7.7 | 7.7 | 7.7 |
| 6/25/2018 | 23.7 | 23 | 26 | 23 | 22.4 | 7.5 | 7.5 | 7.6 | 7.5 | 7.6 |
| 6/28/2018 | 24.1 | 23 | 23.7 | 25.4 | 25 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| 7/1/2018 | 23 | 24.1 | 25.3 | 25.3 | 25.4 | 7.5 | 7.5 | 7.5 | 7.6 | 7.5 |
| 7/9/2018 | 23.7 | 23 | 27.4 | 24.7 | 24.8 | 7.5 | 7.6 | 7.7 | 7.6 | 7.8 |
| 7/12/2018 | 23.3 | 23.6 | 25 | 19.8 | 25 | 7.9 | 7.7 | 7.8 | 7.8 | 7.9 |
| 7/16/2018 | 22.6 | 23 | 21.5 | 23 | 23.2 | 7.8 | 7.8 | 7.8 | 7.9 | 7.9 |
| 7/19/2018 | 22.6 | 22.4 | 22.8 | 22.2 | 20.6 | 7.7 | 7.5 | 7.5 | 7.5 | 7.5 |
| 7/23/2018 | 22.6 | 22.6 | 25.6 | 22.4 | 25.5 | 7.8 | 7.8 | 7.7 | 7.6 | 7.7 |
| 7/26/2018 | 22 | 23 | 24 | 23 | 21.8 | 7.6 | 7.7 | 7.7 | 7.7 | 7.7 |
| 7/30/2018 | 22.4 | 22.9 | 23.7 | 21 | 24.5 | 7.6 | 7.7 | 7.7 | 7.6 | 7.7 |
| 8/2/2018 | 22.1 | 24.3 | 26.2 | 20.9 | 22 | 7.6 | 7.6 | 7.6 | 7.6 | 7.7 |
| 8/6/2018 | 22.4 | 23.3 | 24.4 | 23.2 | 22.9 | 7.5 | 7.6 | 7.6 | 7.6 | 7.6 |
| 8/9/2018 | 22.1 | 21.6 | 21.7 | 22.9 | 22.9 | 7.7 | 7.8 | 7.8 | 7.8 | 7.8 |
| 8/13/2018 | 24.6 | 23.8 | 24.7 | 23.7 | 24.4 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 |
| 8/16/2018 | 22 | 22 | 26 | 21.4 | 25.4 | 8 | 8 | 8 | 8 | 8 |
| 8/20/2018 | 23.2 | 22.2 | 24.5 | 24.4 | 22 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 8/23/2018 | 22.6 | 22 | 25.7 | 22.7 | 22.5 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 8/27/2018 | 23 | 22.4 | 26 | 23.9 | 24.3 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 8/30/2018 | 23.7 | 22.4 | 24.9 | 23 | 22.7 | 8.1 | 8 | 8.1 | 8.1 | 8.1 |
| 9/6/2018 | 22.5 | 23.6 | 23.6 | 23 | 22.5 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 |
| 9/10/2018 | 23.6 | 22.4 | 25.4 | 23.3 | 23.5 | 8 | 8 | 8 | 8 | 8 |
| 9/13/2018 | 23.7 | 22.7 | 26 | 23 | 23.1 | 8 | 7.9 | 8 | 8 | 8 |
| 9/20/2018 | 24 | 22.1 | 24 | 22.7 | 22.5 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 9/24/2018 | 23 | 22.5 | 25.7 | 24.7 | 23.1 | 8.2 | 8.2 | 8.3 | 8.3 | 8.3 |
| 9/27/2018 | 23.1 | 22.2 | 25.4 | 23 | 22.5 | 8.3 | 8.2 | 8.3 | 8.2 | 8.3 |
| 10/1/2018 | 23.4 | 22.2 | 25.8 | 22 | 22.3 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| 10/4/2018 | 24 | 23 | 22.6 | 22.4 | 22.7 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| 10/11/2018 | 22.6 | 23 | 22.7 | 20.9 | 22.3 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 |
| 10/15/2018 | 23 | 24.3 | 25.6 | 22.6 | 22.2 | 8.3 | 8.3 | 8.3 | 8.3 | 8.2 |
| 10/18/2018 | 22.6 | 23.6 | 24.2 | 22.6 | 22.5 | 8 | 8.1 | 8 | 8 | 8.1 |
| 10/22/2018 | 23 | 23.9 | 24.6 | 22.6 | 21.2 | | | | | |

Table S8b: Temperature and pH values for second draw samples where # represents the floor, B represents the breakroom and -2 represent ssecond draw

| | TEMPERATURE ( C ) | | | | | pH | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Date** | **1-B-2** | **2-B-2** | **3-B-2** | **4-B-2** | **5-B-2** | **1-B-2** | **2-B-2** | **3-B-2** | **4-B-2** | **5-B-2** |
| 5/24/2018 | | | 23.4 | 23.6 | 23 | | | 7.89 | 7.75 | 7.72 |
| 5/29/2018 | 23.9 | 23 | 24.5 | 21.7 | 22.8 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| 6/1/2018 | 25 | 24 | 25 | 25.6 | 24.4 | 7.6 | 7.6 | 7.5 | 7.5 | 7.5 |
| 6/4/2018 | 24.6 | 22 | 25 | 24.2 | 22.7 | 7.6 | 7.6 | 7.5 | 7.5 | 7.5 |
| 6/7/2018 | 24.4 | 21.4 | 21.7 | 21.7 | 23.2 | 7.5 | 7.5 | 7.4 | 7.5 | 7.4 |
| 6/11/2018 | 25.4 | 24 | 23 | 24.7 | 24.7 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| 6/14/2018 | 25.4 | 25.6 | 25.2 | 24.6 | 25.4 | 7.5 | 7.4 | 7.4 | 7.4 | 7.4 |
| 6/18/2018 | 25.1 | 24 | 23.6 | 25 | 25.4 | 7.7 | 7.7 | 7.6 | 7.7 | 7.6 |
| 6/21/2018 | 24.4 | 25.9 | 25.5 | 25.5 | 25.6 | 7.7 | 7.7 | 7.6 | 7.7 | 7.6 |
| 6/25/2018 | 27 | 25.6 | 27 | 25.6 | 25 | 7.6 | 7.6 | 7.5 | 7.6 | 7.6 |
| 6/28/2018 | 26.4 | 25.7 | 25 | 26.5 | 26.6 | 7.6 | 7.6 | 7.5 | 7.6 | 7.6 |
| 7/2/2018 | 26.4 | 28 | 27.4 | 27.1 | 27.6 | 7.5 | 7.6 | 7.5 | 7.5 | 7.5 |
| 7/9/2018 | 27.7 | 26 | 28.1 | 24.6 | 26.4 | 7.8 | 7.7 | 7.7 | 7.7 | 7.7 |
| 7/12/2018 | 26.4 | 26.7 | 26 | 22.7 | 25 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 |
| 7/16/2018 | 27 | 26.6 | 22.4 | 26.2 | 25.4 | 7.9 | 7.9 | 7.8 | 7.9 | 7.9 |
| 7/19/2018 | 26.6 | 25.6 | 25.7 | 24 | 24.3 | 7.5 | 7.5 | 7.4 | 7.5 | 7.5 |
| 7/23/2018 | 26 | 25.3 | 26 | 22.7 | 25 | 7.7 | 7.7 | 7.7 | 7.7 | 7.7 |
| 7/26/2018 | 24 | 25 | 25.6 | 23.5 | 23.8 | 7.7 | 7.8 | 7.7 | 7.7 | 7.7 |
| 7/30/2018 | 25.2 | 25.4 | 26 | 23.8 | 25 | 7.7 | 7.7 | 7.7 | 7.7 | 7.7 |
| 8/2/2018 | 25 | 26.7 | 26 | 23.4 | 24.6 | 7.7 | 7.7 | 7.6 | 7.7 | 7.7 |
| 8/6/2018 | 26 | 26.4 | 25.8 | 25.6 | 25.4 | 7.6 | 7.6 | 7.6 | 7.6 | 7.6 |
| 8/9/2018 | 26 | 23.4 | 24 | 24.9 | 25.4 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 |
| 8/13/2018 | 26.4 | 26.9 | 26.4 | 26.1 | 26.6 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 |
| 8/16/2018 | 27.4 | 24.4 | 26.6 | 24.6 | 26.4 | 8 | 8 | 8 | 8 | 8 |
| 8/20/2018 | 26.7 | 24 | 26.7 | 26 | 24.6 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 8/23/2018 | 26 | 23.6 | 26.1 | 25.6 | 25 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 8/27/2018 | 26 | 24 | 27.3 | 26.3 | 26.1 | 8 | 8.1 | 8 | 8 | 8.1 |
| 8/30/2018 | 26.8 | 24 | 25.9 | 24.4 | 24.1 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 9/6/2018 | 26 | 25.7 | 24.5 | 23.7 | 24 | 8 | 8 | 8 | 8 | 8 |
| 9/10/2018 | 27 | 23.7 | 26.3 | 24.1 | 25.3 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 9/13/2018 | 26 | 24 | 27.3 | 24.1 | 24.6 | 8 | 8 | 8 | 8 | 8 |
| 9/20/2018 | 26.5 | 23 | 25 | 23.6 | 24.5 | 8.2 | 8.1 | 8.1 | 8.1 | 8.1 |
| 9/24/2018 | 25.4 | 24.2 | 25.6 | 24 | 25 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| 9/27/2018 | 26.4 | 23.2 | 26 | 24 | 25 | 8.3 | 8.3 | 8.2 | 8.3 | 8.2 |
| 10/1/2018 | 25.9 | 23.7 | 25.8 | 24 | 24.2 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| 10/4/2018 | 26.4 | 22.9 | 24 | 24 | 24.5 | 8.4 | 8.3 | 8.3 | 8.3 | 8.3 |
| 10/11/2018 | 25.4 | 23 | 24 | 23.4 | 24.1 | 8.3 | 8.2 | 8.2 | 8.2 | 8.2 |
| 10/15/2018 | 26.4 | 26 | 25.7 | 25.5 | 24.4 | 8.3 | 8.3 | 8.3 | 8.3 | 8.3 |
| 10/18/2018 | 24.6 | 23.6 | 24 | 24 | 24 | 8.1 | 8.1 | 8.1 | 8.1 | 8.1 |
| 10/22/2018 | 26 | 25.5 | 25.1 | 24.7 | 25.1 | | | | | |

Table S9. Nonparametric Steel-Dwass for first draw temperature where floor is donated as the first number, B is for breakroom, and -1 represents the first draw

| Level | - Level | p-Value |
|---|---|---|
| 3-B-1 | 2-B-1 | <.0001* |
| 3-B-1 | 1-B-1 | <.0001* |
| 5-B-1 | 2-B-1 | 0.9317 |
| 4-B-1 | 2-B-1 | 0.9816 |
| 5-B-1 | 4-B-1 | 0.9998 |
| 5-B-1 | 1-B-1 | 0.9997 |
| 4-B-1 | 1-B-1 | 0.9990 |
| 2-B-1 | 1-B-1 | 0.8696 |
| 5-B-1 | 3-B-1 | 0.0009* |
| 4-B-1 | 3-B-1 | 0.0001* |

Table S10. Nonparametric Steel-Dwass for second draw temperature where floor is donated as the first number, B represents breakroom and -2 represents the second draw.

| Level | - Level | p-Value |
|---|---|---|
| 3-B-2 | 2-B-2 | 0.1393 |
| 5-B-2 | 4-B-2 | 0.3550 |
| 5-B-2 | 2-B-2 | 0.9521 |
| 4-B-2 | 2-B-2 | 0.9873 |
| 3-B-2 | 1-B-2 | 0.2241 |
| 5-B-2 | 3-B-2 | 0.1589 |
| 4-B-2 | 3-B-2 | 0.0137* |
| 2-B-2 | 1-B-2 | 0.0003* |
| 5-B-2 | 1-B-2 | <.0001* |
| 4-B-2 | 1-B-2 | <.0001* |

Table S11: Wilcoxon signed rank test first draw temperature versus second draw temperature for duration of study (May 2018 – October 2018 every Monday and Thursday) where B represents the breakroom

| Floor | First draw vs second draw Temperature | | | | Wilcoxon-signed rank | |
|---|---|---|---|---|---|---|
| 1-B | Second Draw Temperature | 25.9237 | t-Ratio | 22.35221 | | |
| | First Draw Temperature | 22.9421 | DF | 37 | Test Statistic S | 370.500 |
| | Mean Difference | 2.98158 | Prob > \|t\| | <.0001* | Prob>\|S\| | <.0001* |
| | Std Error | 0.13339 | Prob > t | <.0001* | Prob>S | <.0001* |
| | Upper 95% | 3.25185 | Prob < t | 1.0000 | Prob<S | 1.0000 |
| | Lower 95% | 2.7113 | | | | |
| | N | 38 | | | | |
| | Correlation | 0.46552 | | | | |
| 2-B | Second Draw Temperature | 24.6079 | t-Ratio | 9.205249 | | |
| | First Draw Temperature | 22.8079 | DF | 37 | Test Statistic S | 350.500 |
| | Mean Difference | 1.8 | Prob > \|t\| | <.0001* | Prob>\|S\| | <.0001* |
| | Std Error | 0.19554 | Prob > t | <.0001* | Prob>S | <.0001* |
| | Upper 95% | 2.1962 | Prob < t | 1.0000 | Prob<S | 1.0000 |
| | Lower 95% | 1.4038 | | | | |
| | N | 38 | | | | |
| | Correlation | 0.49293 | | | | |
| 3-B | Second Draw Temperature | 25.3282 | t-Ratio | 6.802398 | | |
| | First Draw Temperature | 24.4205 | DF | 38 | Test Statistic S | 340.000 |
| | Mean Difference | 0.90769 | Prob > \|t\| | <.0001* | Prob>\|S\| | <.0001* |
| | Std Error | 0.13344 | Prob > t | <.0001* | Prob>S | <.0001* |
| | Upper 95% | 1.17782 | Prob < t | 1.0000 | Prob<S | 1.0000 |
| | Lower 95% | 0.63756 | | | | |
| | N | 39 | | | | |
| | Correlation | 0.83515 | | | | |
| 4-B | Second Draw Temperature | 24.4359 | t-Ratio | 10.80841 | | |
| | First Draw Temperature | 22.8 | DF | 38 | Test Statistic S | 383.500 |
| | Mean Difference | 1.6359 | Prob > \|t\| | <.0001* | Prob>\|S\| | <.0001* |
| | Std Error | 0.15135 | Prob > t | <.0001* | Prob>S | <.0001* |
| | Upper 95% | 1.9423 | Prob < t | 1.0000 | Prob<S | 1.0000 |
| | Lower 95% | 1.3295 | | | | |
| | N | 39 | | | | |
| | Correlation | 0.66339 | | | | |
| 5-B | Second Draw Temperature | 24.8385 | t-Ratio | 11.52948 | | |
| | First Draw Temperature | 23.0667 | DF | 38 | Test Statistic S | 384.000 |
| | Mean Difference | 1.77179 | Prob > \|t\| | <.0001* | Prob>\|S\| | <.0001* |
| | Std Error | 0.15368 | Prob > t | <.0001* | Prob>S | <.0001* |
| | Upper 95% | 2.08289 | Prob < t | 1.0000 | Prob<S | 1.0000 |
| | Lower 95% | 1.4607 | | | | |
| | N | 39 | | | | |
| | Correlation | 0.6351 | | | | |

Table S12: Free chlorine values for first and second draw by floor. Floor and draw are denoted as: *floor* #-B-*draw* and B represents breakroom, ND is nondetect

| Date | 1-B-1 | 2-B-1 | 3-B-1 | 4-B-1 | 5-B-1 | 1-B-2 | 2-B-2 | 3-B-2 | 4-B-2 | 5-B-2 |
|---|---|---|---|---|---|---|---|---|---|---|
| 5/24/2018 | | ND | 0.02 | 0.02 | 0.04 | | | ND | 0.03 | 0.02 |
| 5/29/2018 | ND | 0.05 | ND | ND | ND | ND | ND | 0.02 | ND | ND |
| 6/1/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 6/4/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 6/7/2018 | ND | 0.02 | ND | ND | ND | ND | ND | ND | ND | ND |
| 6/11/2018 | ND | ND | ND | ND | 0.02 | 0.02 | ND | 0.02 | 0.02 | 0.02 |
| 6/14/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 6/18/2018 | ND | ND | 0.02 | ND | ND | ND | 0.02 | ND | ND | ND |
| 6/21/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 6/25/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 6/28/2018 | 0.02 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/1/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/9/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/12/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/16/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/19/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/23/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/26/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 7/30/2018 | ND | ND | ND | 0.02 | ND | ND | ND | ND | ND | ND |
| 8/2/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/6/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/9/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/13/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/16/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/20/2018 | ND | ND | ND | ND | ND | ND | 0.02 | ND | ND | ND |
| 8/23/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/27/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 8/30/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 9/6/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 9/10/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 9/13/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 9/20/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 9/24/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 9/27/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 10/1/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 10/4/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 10/11/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 10/15/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 10/18/2018 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Table S13: Spearman's ρ correlations between first draw copper (Cu), and occupancy[a] by floor denoted as the floor number and -B for breakroom. Cu draws were every Monday and Thursday for the duration of the study May 2018 – October 2018. Fall was August – October. Summer was May – July.

| Floor | Fall First Draw Cu Concentrations Nonparametric: Spearman's ρ Occupancy | | | | Summer First Draw Cu Concentrations Nonparametric: Spearman's ρ Occupancy | | | |
|---|---|---|---|---|---|---|---|---|
| 1-B | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** |
| | Occupancy | First draw Cu Concentration | -0.4586 | 0.0277* | Occupancy | First draw Cu Concentration | -0.3347 | 0.1746 |
| 2-B | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** |
| | Occupancy | First draw Cu Concentration | -0.5179 | 0.0114* | Occupancy | First draw Cu Concentration | 0.2227 | 0.3594 |
| 3-B | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** |
| | Occupancy | First draw Cu Concentration | -0.4269 | 0.0422* | Occupancy | First draw Cu Concentration | 0.1777 | 0.4668 |
| 4-B | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** |
| | Occupancy | First draw Cu Concentration | -0.6342 | 0.0012* | Occupancy | First draw Cu Concentration | -0.1824 | 0.4548 |
| 5-B | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** | **Variable** | **by Variable** | **Spearman ρ** | **Prob>\|ρ\|** |
| | Occupancy | First draw Cu Concentration | -0.5418 | 0.0076* | Occupancy | First draw Cu Concentration | 0.0045 | 0.9856 |

a = Occupancy is the day prior sums (Count Per Day CPD),

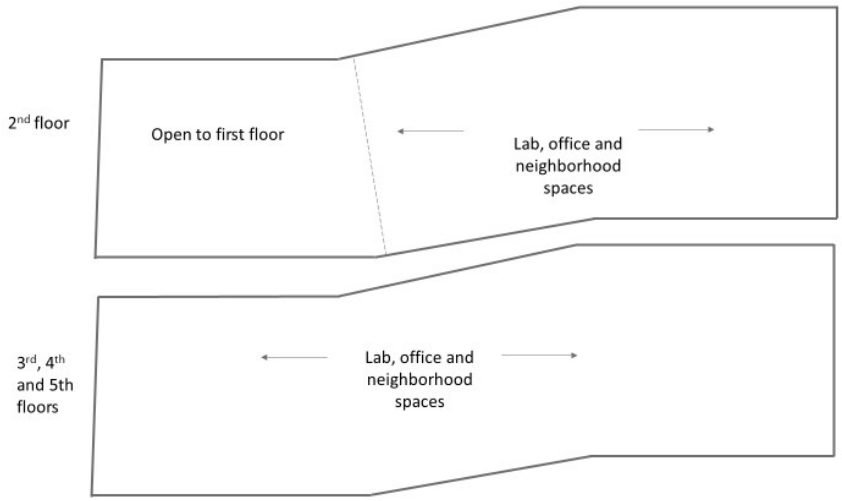


Figure S1: Biodesign C plan view of floor layouts for 2nd – 5th floors. 2nd floor is open to first floor while 3rd – 5th floors are all lab, office and neighborhood spaces.

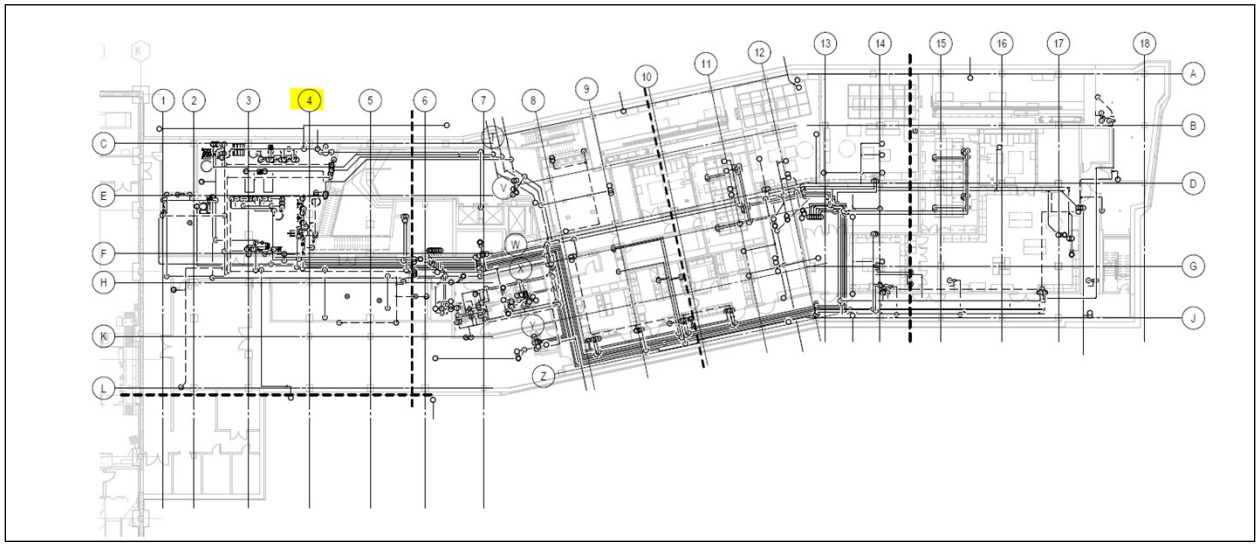

Figure S2: Biodesign C overall plumbing diagram of basement. Water supply enters at column line four and travels throughout building. Major risers are at columns 6 and 13 to feed lab spaces and a riser which is not shown in the figure above feeds the restrooms and breakroom sinks. This riser is between columns 6-7 and is shown in Figure S4a.

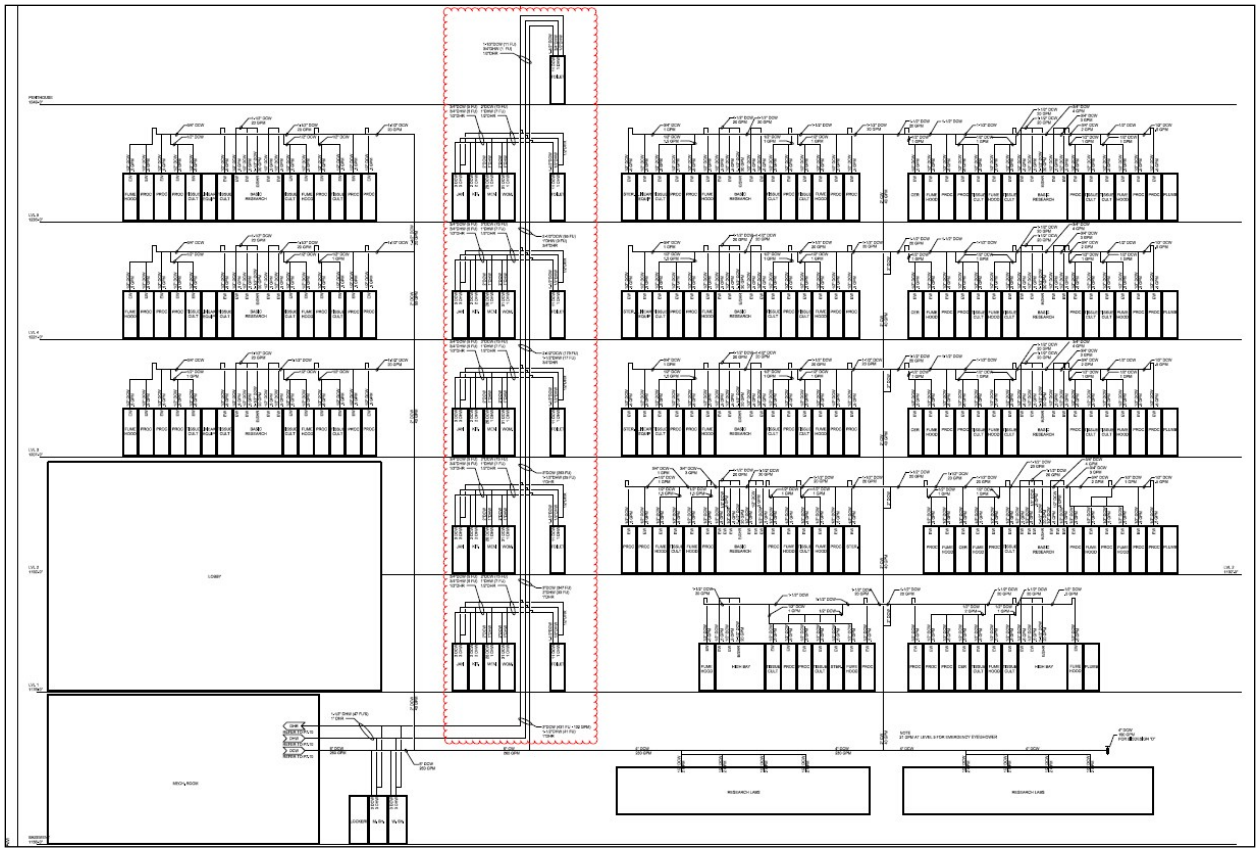

Figure S3: Domestic waterflow diagram of Biodesign C shows the restrooms stacked on top of each other from one riser. The other risers feed the laboratories. Two drinking fountains are in an alcove between the men's and women's restroom. The single restroom labeled "toilet" is about 35 feet away from the men's, women's restroom and drinking fountain alcove.

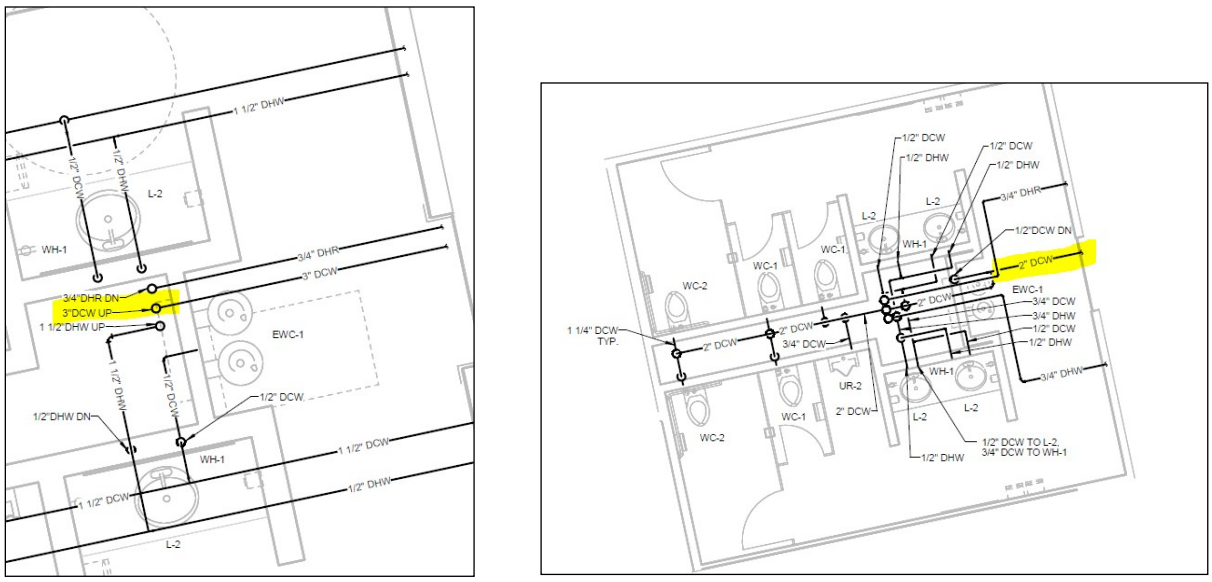


Figure S4a and b: The restroom riser is in figure on the left (Figure S4a). The riser starts in the basement and stays tucked behind the water fountains. The figure on the right (Figure S4b) is plumbing for floors 1-5 shows the alcove for the drinking fountains and a 2" domestic cold water (DCW) line that runs down the hall to the breakroom sink.

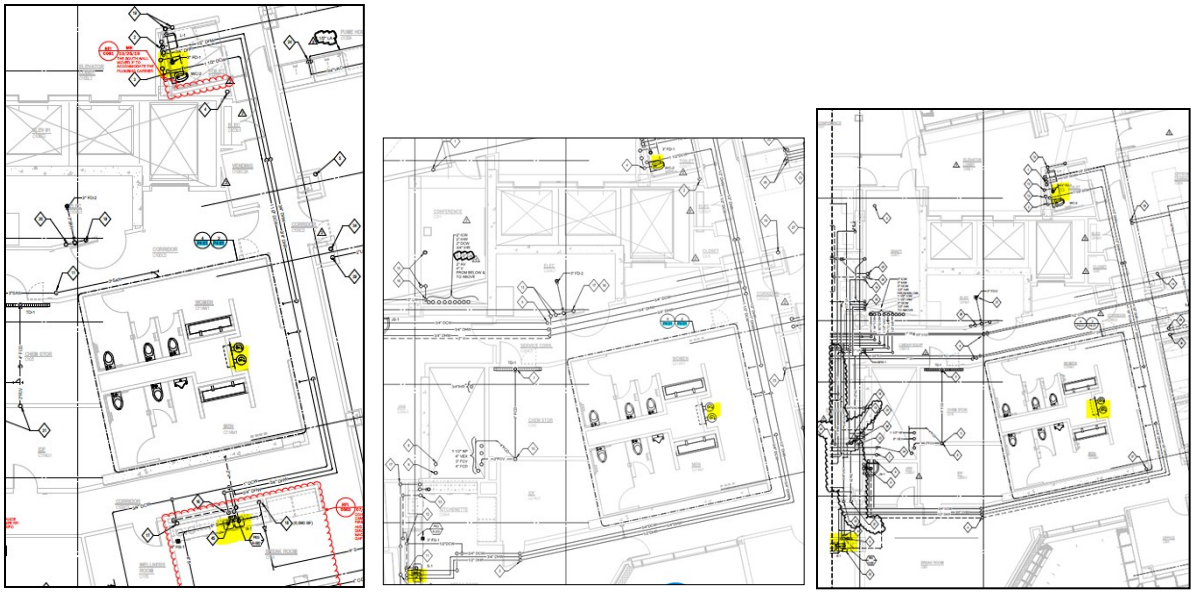

Figure S5a,b,c: Highlighted areas show the single restroom, the water fountain alcoves between the women and men's restroom as well as the breakroom sink. The domestic water line leaves the water fountain alcove and splits in two directions, one to feed the single restroom and the other direction is to feed the single breakroom sink. The most left figure (Figure S5a) is the 1st floor. The approximate distance from the single restroom to the water fountains is 35 feet. This holds true for all five floors. The approximate distance from the breakroom sink to the water fountains is 30 feet. The middle figure (Figure S5b) is the 2nd floor. The approximate distance from the single restroom to the breakroom sink is approximately 70 feet. The figure on the right (Figure S5c) represents floors 3 -5. The approximate distance from the breakroom sink to the water fountain is approximately 65 feet. Breakrooms and restrooms are stacked on top of each other for all floors barring the slight change in breakroom sink location on the 1$^{st}$ and 2$^{nd}$ floor in relation to floors 3-5.

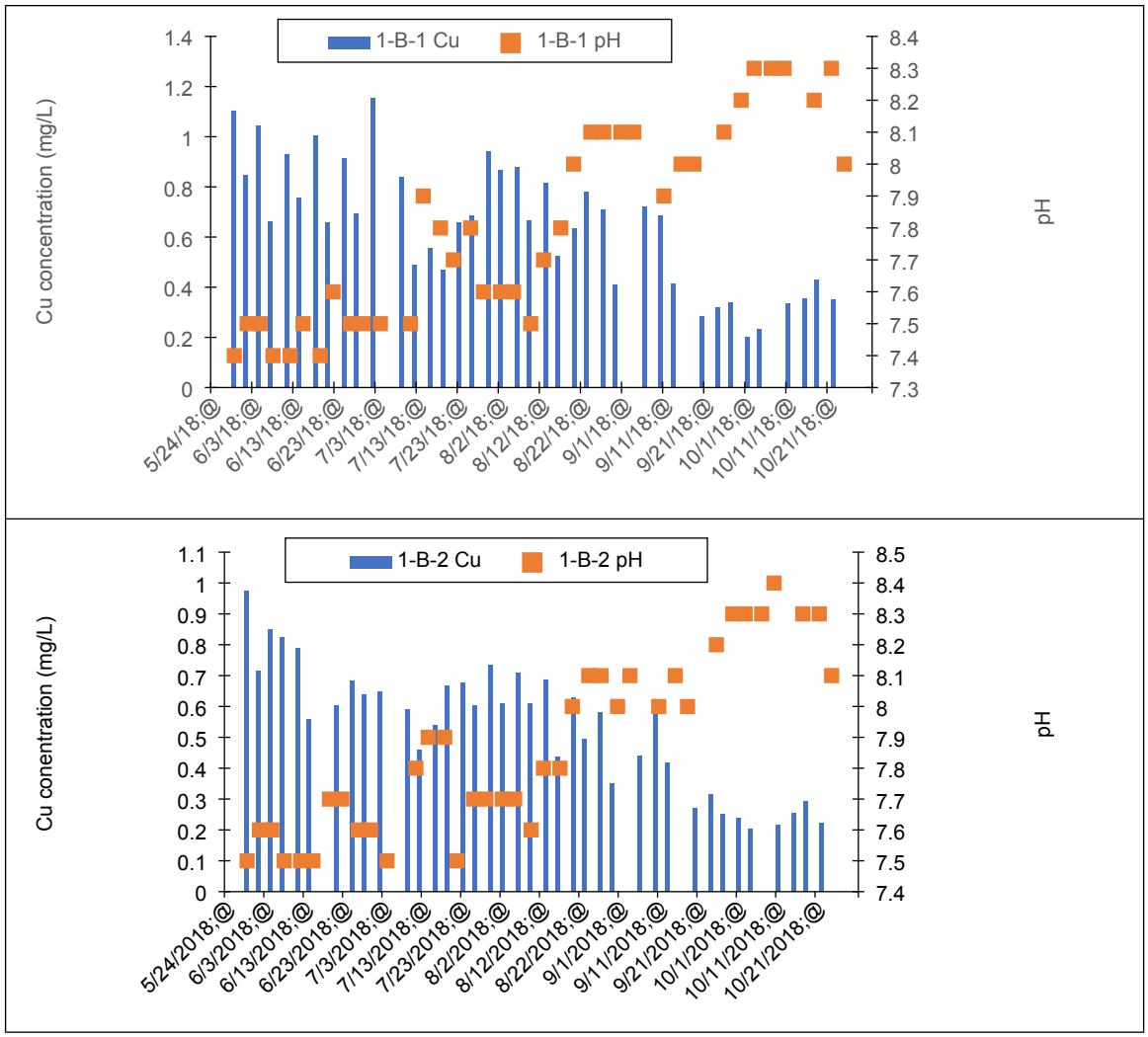


Figure S6: Linear regression of first and second draw Cu concentration vs pH. Only 1st floor is shown because all five floors behaved similarly.