2003 Annual Microbiological Monitoring Report

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Welcome to the 5th Edition of the Annual Microbiological Monitoring Report.

The purpose of this report is to focus on:

- Coliform monitoring results and
- Distribution system information such as:
  - Chlorine, pH, electrical conductivity, and temperature during the past year.

This year we are pleased to announce that out of 2,953 microbiological samples collected within the main system in 2003[1], only one tested positive for coliform[2]. This is the lowest number of positive samples collected in either the main or small systems since installing the new dedicated sampling stations in 1997.

In addition to this, two new small systems and two new sample points[3] were added to those already serving the existing isolated systems, and none of these 10 isolated systems tested positive for either total coliforms or E. *coli*.

[1] In all, a total of 3,117 samples were collected from the main system and all isolated systems.
[2] This sample tested negative for E. coli.
[3] Serrita Foothills, SP-270 [10-270] and Sunset Ranch, SR-239 [10-325]

INTRODUCTION

Tucson Water operates eleven separate drinking water systems that provide water to Tucson and its surrounding areas. Most Tucson Water customers (approximately 98% or 675,000 people) receive their drinking water from the main system. The remaining 2% are served by ten smaller isolated systems that are located outside of the city limits on the outskirts of the Tucson metropolitan area.

To ensure a safe and sanitary water supply, extensive water quality monitoring is done throughout the year at 260 dedicated sampling stations that are located within each water quality zone and isolated system.

Additional system information is also routinely collected in order to provide more information to our customers. Information on the chlorine residual, temperature, pH, and electrical conductivity is collected in the field along with each coliform sample. In addition to this , a complete mineral analysis is also done for each sample point once a quarter (see Additional Measurements section for more information).

In addition to distribution system monitoring, source water monitoring is also performed regularly at approximately 200 wells, or POEs[4], to ensure that it is free of harmful contaminants that could enter the distribution system from the source[5]. (This report only covers samples collected from the distribution system.)

DRINKING WATER REGULATIONS

The Arizona Department of Environmental Quality (ADEQ) is responsible for enforcing drinking water standards in the state of Arizona and has set the minimum number of samples collected per month at 240 for a population size between 600,001 and 780,000. Tucson Water regularly exceeds the minimum state regulatory standard for coliform monitoring by collecting more than the minimum

[4] A **Point of Entry** (**POE**) in a water system is a location where the source water enters the distribution system for delivery to customers.

number of samples required by ADEQ. Currently, Tucson Water collects 246 samples per month from the main system and a total of 14 samples from the isolated systems.

Standards for drinking water have come a long way from the original 18 that were adopted in 1975 in response to the federal Safe Drinking Water Act. Today, there are more than 90 regulated compounds and 12 unregulated compounds that water systems are required to monitor for. Most of the regulated contaminants are chemicals such as toxic metals or synthetic organic compounds (SOCs), which are seldom detected in our drinking water. Detection of any contamination from these types of chemicals, in the few cases where found, is usually due to contamination of source water rather than from problems in the distribution system. In contrast, bacterial contamination can potentially enter the distribution system whenever any failure of sanitary mechanism occurs. Therefore, unlike sampling for chemicals that most often occurs at points where water first enters the system, bacterial monitoring is done throughout the distribution system. Monitoring for coliform bacteria has been of key importance for evaluating drinking water quality from a microbiological standpoint for over a century.

MONITORING RESULTS

Coliform Bacteria

Coliform bacteria are common in the environment and are generally not harmful. However, the presence of these bacteria in drinking water is usually the result of a problem with the treatment system or the pipes that distribute the water. The presence of coliform bacteria indicates that the water may be contaminated with germs that can cause disease.

When a water sample is tested for coliform, the results are reported as either positive or negative. A positive result means that at least one coliform bacterium is present in a 100-milliliter sample. When this situation occurs, the sample must be tested for the presence of E. coli[6], and a set of three more samples, known as "repeats," must be collected in response to each positive sample within the next 24 hours. This sample set includes the original point, plus an upstream and a downstream sample collected within five water services. This sampling must continue until all repeat samples are negative. Samples testing positive for coliform, including the additional repeats, must not exceed 5% of the total number of samples collected for the month. Small water systems, which collect fewer than 40 samples per month, violate the standard if more than one sample is positive. When the coliform standard is exceeded, Tucson Water is required to notify the public.

During 2003, a total of 3,117 coliform samples were collected from the main system and all isolated systems combined, and Tucson Water was in full compliance with the coliform standard for all systems.

Table 1 represents the number of positive coliform samples observed from 1997 to 2003. In 2003, only one sample from the main system tested positive for total coliform. This sample was also analyzed for the presence of E. *coli* and found to be negative.

Table 1

Year	Total # of samples collected	Total # of positive samples from main system	Total # of positive samples from Isolated systems
1997	3075	5	0
1998	3114	17	0

[5] These results are summarized in "The Annual Water Quality Report" which provides information on all contaminants detected throughout the year.

[6] **E coli** are bacteria whose presence indicate that the water may be contaminated with human or animal wastes. Water contaminated with such waste can cause illnesses that can range from a minor bout of diarrhea, cramps, nausea, or other symptoms to a much more serious illness, which can seriously threaten vulnerable individuals, i.e. the very young, the aged, and immunocompromised.

1999	3114	4	0
2000	3114	2	1
2001	3130	5	3
2002	3140	8	1
2003	3117	1	0

Figure 1 represents the number of positive coliform samples observed from 1997 to 2003. As you can see from this chart, 2003 was a good year for coliform sampling.

- Only one sample in the main system tested positive for total coliforms. This sample also tested negative for E. *coli*.

Chlorine

Tucson Water adds chlorine to the water supply in order to control microbiological growth within the distribution system and to eliminate any microbiological contamination that might enter the system through a main break or other potential sources. In addition to the monthly coliform monitoring, the level of chlorine residual[7] is tested each time a coliform sample is collected.

Tucson Water aims to maintain all water entering the system at a target chlorine residual range of 0.80 - 1.00 parts per million (ppm). Prior to 2002, the target range for residual chlorine at the wells and reservoirs was between 1.0 and 1.20 ppm. The range was lowered in order to improve the taste and odor of the water while continuing to maintain public health. In addition, Tucson Water aims to maintain a minimum of 0.40 ppm in the distribution system.

[7] **Chlorine residual** is the amount of chlorine remaining in the water that is available for disinfection

Figure 2 is a graph of the average monthly free chlorine residual for the year.

- The lowest average for the year (0.72 ppm) was found in June and was well above the minimum of 0.40 ppm.
- The highest chlorine residual average was in August and was 0.85 ppm which was also well within the target range.

Figure 3 represents the distribution of monthly free chlorine residual levels across the system for 2003. The various colors are used to represent the different ranges of chlorine residual throughout the year. During 2003, sixteen samples (0.5%) had a chlorine residual at or below 0.05 ppm, which is 0.2% higher than for last year, and 100 samples (3.2%) had chlorine values that were between 0.05 and 0.40 ppm.

- The months showing the highest number of chlorine residuals at or below 0.05 ppm were June, July, and August. Each of these months had 4 samples that were at or below this level.
- Chlorine residuals at or below 0.05 ppm also occurred in May (2), September (1), and December (1).
- 2 sample points had low chlorine values that were recurring[8] in consecutive months.
  - SR-259[9] and SP-233[10] were found to have less than 0.05 ppm of chlorine in July and again in August.
  - SP-233 also showed chlorine residuals below 0.40 ppm in January (0.34 ppm), March (0.22 ppm) and again in June (0.36ppm).
  - SR-259 also showed chlorine residuals below 0.40 ppm in the months remaining in 2003: September (0.08 ppm), October (0.07 ppm), November (0.17 ppm), and December (0.14 ppm).

[8] SP-180 (625 W. La Pasadita St, WQZ 3) also had recurring chlorine residual values at or below 0.05 but not in consecutive months. SP-180 showed chlorine residuals at or below 0.05 ppm first in June and again in September.
[9] SP-259 is located at 15710 W. Diamond Bell Rd in the Diamond Bell isolated system [10-159].
[10] SP-233 is located at 1660 N. Business Park Dr. which is in Water Quality Zone 1.

- Another sample point of concern is SR-239[11]. Samples collected from this point in February (0.37 ppm), March (0.39 ppm), May (0.24 ppm), June (0.32 ppm), July (0.18 ppm), August (0.37 ppm), September (0.13 ppm), and December (0.29 ppm) showed chlorine residuals below the 0.40 ppm minimum standard set by Tucson Water.
- Overall, 87.7% of all samples collected for free chlorine were between 0.40 and 1.00 ppm. This translates to a total of 2,734 samples.
- In March, a chlorine residual of 5.50 ppm was detected at SR-278[12].
- In October, a chlorine residual 4.0 ppm was detected at SR-258[13].

Temperature

The temperature of the water in the distribution system varies slightly from point to point and can change from one month to the next. This variability

in temperature is due in part to the time of year and the location where the measurement is taken. It is also partly due to the fact our water supply comes from more than 200 different wells. This is because groundwater temperature is a function of depth below the surface and the geology surrounding the well. In addition, the temperature of the water can also change as it flows through our distribution system, depending on outside temperatures.

Figure 4 illustrates the 2003 average monthly temperature of the water in the distribution system. From this chart, you can see that:

- The highest temperature seen in the system, almost 89 degrees Fahrenheit, was found during July, right at the height summer.
- The lowest temperature was almost 72 degrees F and was predictably in January, the coldest month of the year.

Figure 5 illustrates the average temperature of the water in each Water Quality Zone from 2001 to 2003. From this chart, you can see that:

- The average water temperature for each zone does not change much from year to year.

pH

The pH of water is a measure of the water's balance of acids and bases. A pH of 7 is considered neutral. Lower pH values represent water that is more acidic. Higher pH values represent water that is more basic or alkaline. Tucson's water supply is slightly alkaline and averages between 7.5 and 8.2 in the distribution and isolated systems.

Figure 6 shows the average pH for each of the water quality zones from 2001 to 2003. As you can see from this chart, there has been a slight decrease in pH over the years.

- The zone with the lowest pH value was Zone 8 with a pH of approximately 7.5 standard units;
- The highest average pH was seen in Zone 2 where the average was almost 7.9 standard units.
- The zone with the lowest consistent pH over the last three-year period is Zone 1. The 3-year pH average for this zone over the last three years was 7.56.
- The zone with the highest consistent pH from 2001 to 2003 was Zone 2. The 3-year pH average for this zone was 7.92.

Conductivity

The electrical conductivity, or EC, of water is a measure of its ability to carry an electric current. The

[11] SR-239 is located at 8364 N. Sunset Ranch Loop in the Sunset Ranch isolated system [10-325] near Continental Ranch.
[12] SR-278 is located at 6260 S. Mesquite Trail in the Thunderhead isolated system [10-179].
[13] SR-258 is located at 12655 W. Castle Dr. in the Valley View

more minerals (total dissolved solids or TDS) in solution, the greater the electrical conductivity. By measuring the conductivity of a water sample, we can estimate the amount of total dissolved solids in the sample by using a minor calculation[14].

Figure 7 shows the average EC for each water quality zone from 2001 to 2003. This chart vividly shows the difference between the zones as they relate to EC and TDS.

- Zone 1 has the highest EC and TDS.
- The three-year EC and TDS averages for Zone 1 were 621 and 397 mg/L.
- The lowest EC and TDS values seen over the three-year period was Zone 10.
- The three-year EC and TDS averages for Zone 10 were: 344 and 220 mg/L.

Figure 8 is a map of the Tucson area illustrating the locations for all dedicated taps within the Tucson Water distribution system. The green circles (●) represent dedicated sampling stations within the main system, and the green triangles (▲) represent dedicated sampling stations within the ten isolated systems. The red circles (▲) and red triangles (●) represent locations where total coliform samples tested positive during 2003. The purple circles (●) and purple triangles (▲) on this map represent locations where samples had a chlorine residual below 0.05 ppm.

Acres isolated system [10-158].

[14] EC x 0.64 = ~ TDS mg/L

ADDITIONAL MEASUREMENTS

Tucson Water's Water Quality Management Division staff collects additional water quality samples throughout the year that are not mandated by laws or regulations. Tucson Water performs this discretionary monitoring to provide our customers with current results on the most frequently requested water quality information.

Extended Parameters

The following tests, referred to as "extended parameters," are performed on a quarterly basis at each of the 259 dedicated sampling locations throughout the distribution systems: alkalinity, chloride, copper, fluoride, iron, sodium, calcium, total dissolved solids, hardness, total organic carbon, manganese, nitrate, nitrite, potassium, silicon, sulfate, and zinc. For more information with regard to these analytes, please see the "2003 Extended Parameter Report".

More details concerning the above parameters are available from:

1. The Tucson Water automated phone line at 791-4227
2. The Tucson Water website: http://www.ci.tucson.az.us/water/
3. The Tucson Water, Customer Satisfaction Advocate, Dave Shodroski, at 791–5945.

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