Flagstaff City Manager's CEC Advisory Panel Preliminary Data Report September 14, 2015

The last update made by City staff on the Compounds of Emerging Concern (CEC) Advisory Panel was provided May 2014. That update provided the findings issued in the Panel's Interim Report, a status update from the Research Subcommittee, and the "Next Steps" for the Full Advisory Panel. This update is intended to provide the status of staff's action items while sampling and research is ongoing.

CEC Advisory Panel Overview

The role of the Advisory Panel is to provide the City with an assessment to help the City understand what CECs mean locally. The Panel was asked to recommend actions the City should take to better understand the effects, if any, these constituents have in our source water, drinking water, reclaimed water and respective distribution systems.

Flagstaff's source groundwater supplies are very clean in terms of natural or chemical compounds, relative to supplies in other parts of the state or nation where intense industry or land-application of substances is more concentrated. The quality of Flagstaff's water from the C aquifer some 1,200 feet deep is of such a high quality that groundwater only requires disinfection with a small dose of chlorine before entering the distribution system. Compounds in our water supplies are found in the part per billion level (microgram per liter) and part per trillion level (nanogram per liter). Whereas regulatory standards require water supplies to be extensively tested for metals and inorganic compounds, among others, mostly at the part per million level (milligram per liter).

For perspective, one part per billion is the equivalent of one-half teaspoon in an Olympic-sized pool, or one penny in $10 million. A part per trillion is equivalent to one grain of salt in an Olympic-sized pool, or one penny in $10 billion (WRF, 2015).

The Advisory Panel advises staff to continue sampling for trace substances in our various water supplies and systems as background information in the case that regulations are established. The Panel advises no data suggest that the continued use of reclaimed water provides undue risk to human health. The Panel recommends testing for Antibiotic Resistance Genes (ARGs) or bacteria in reclaimed water in Flagstaff. The Panel thinks that it is possible that a variety of bacteria may be found in natural water sources and in reclaimed water as the scientific tools in use now allow for a better understanding of the microbes that exist in nearly every

environmental, man-made and living system. The challenge will be to generate a sufficient microbiological and epidemiological knowledge base to interpret these findings. The Panel has applied for and received funding for a number of projects that are allowing for these types of analyses.

Collectively, CECs include chemicals found in various water supplies in trace or very low concentrations that are not regulated by the U.S. EPA, such as pharmaceuticals, personal care products (PPCPs), endocrine disruptors, antibiotic resistance bacteria (ARBs) and (ARGs). Previous City Manager, Kevin Burke, organized an advisory panel composed of 12 local, state and nationally recognized scientific professionals. Their role is to provide the City with an assessment of the risk CECs may pose to human health in general and in Flagstaff specifically, and also to recommend actions the City should take to better understand the effects, if any, CECs have in our source water, drinking water and reclaimed water. The CEC Advisory Panel first met in January 2013 and issued their Interim Report in July 2013.

CECs are substances that have been released to, found in, or have the potential to enter our water supplies. "New" compounds found in water supplies are termed "emerging" not because they have only recently appeared in water, but because technologies for detection have improved in recent years, facilitating our ability to identify CECs at lower levels than ever before. Many of these substances have likely been in our water supplies for as long as humans have been using chemicals, personal care products and pharmaceuticals. CECs include pharmaceutical and personal care products ingredients and endocrine disrupting compounds. The same CECs detected in the Flagstaff potable and reclaimed water systems are so widespread in the environment that they are found in foods and beverages including bottled water (WRF, 2015).

Antibiotic resistance is a natural phenomenon, continually developing as bacteria that can resist an antibiotic survive. Bacteria are everywhere in our environment. Current treatment systems eliminate potentially harmful bacteria, but not all bacteria are not completely eliminated from water or reclaimed water. The Panel's research will help address the relative abundance and diversity of ARGs and pathogens in reclaimed versus potable water distribution systems.

The Advisory Panel Interim Report issued the following recommendation on Drinking Water:

> *Monitoring of any CECs on the* Contaminant Candidate List (*CCL3*)*, beyond the required U.S. EPS Unregulated Contaminant Monitoring Rule (UCMR) sampling of Flagstaff drinking water, at this time is unnecessary.*
>
> *However, City of Flagstaff Utilities Division staff may want to consider evaluating which contaminants within the CCL3 that are likely being utilized or prescribed for use in the Flagstaff community as background information in preparation for the potential of future regulation.*

The Advisory Panel Interim Report issued the following recommendation on Reclaimed Water:

> *There are no data at present time to suggest that the continued use of reclaimed water provides undue risk to human health. In fact, other national panels, such as the National Research Council which reports to the U.S. Congress, have concluded the same. The panel recommends applying the best science available and that the outlined studies (in the interim report) be pursued.*

Two efforts recommended by the Panel in their Interim Report have been implemented and are discussed in more detail below: 1) a sampling of the reclaimed and drinking water systems to study ARB and ARG; and 2) sampling of source water (untreated lake water or groundwater), potable water (after filtration or disinfection of source water) and reclaimed water for CECs only (not endocrine disruptors or ARG).

Status of Action Items

1) ARB and ARG Project Status – National Science Foundation Grant

Drs. Amy Pruden (Virginia Tech), Jeannie McLain (University of Arizona) and David Engelthaler (TGen) are the panel advisory members for this part of the study. This team was awarded a $330,000 National Science Foundation grant in July, 2014 to study the "relative abundance and diversity of ARGs and pathogens in reclaimed versus potable water distribution systems," with utilities participating from Florida, California and Arizona. Specific research questions include:

1. Are the kinds and levels of ARGs found in Flagstaff reclaimed water different from other reclaimed waters in other parts of the country?
2. Are the kinds and levels of ARGs present in reclaimed water greater, equal, or less than those found in comparable background samples?
3. Are live ARBs detectable in the reclaimed water (*E. coli* or *Enterococcus*) and, if so, are the numbers of live bacteria comparable to potable or source waters?
4. What operational modifications to the reclaimed water distribution systems might be effective to maintain the system free of pathogens and ARGs equal to background (background defined as potable water system levels)?

Additionally, Dr. Engelthaler has allocated $25,000 in current grant funds from the Flinn Foundation to provide additional genomic and epidemiologic analysis of these samples. Lastly, Dr. Engelthaler is also providing $25,000 in in-kind resources from an ongoing FDA-funded program to monitor and sequence select microbes collected in the environment. City staff assisted scientists from the University of Arizona and Virginia Tech by identifying areas of the system for sampling that meet the study criteria and collecting samples of water at those locations shown on the system map below. A table is provided as an attachment to this report that summarizes specifically where samples were collected. One final round of sampling will occur in 2015. The team estimates that it will require about 6-8 months of effort to analyze all

of the samples that were collected from Flagstaff and other communities for ARGs and an additional 4-5 months to analyze the data and prepare a report of the findings.
This research is expected to be complete in 2017.

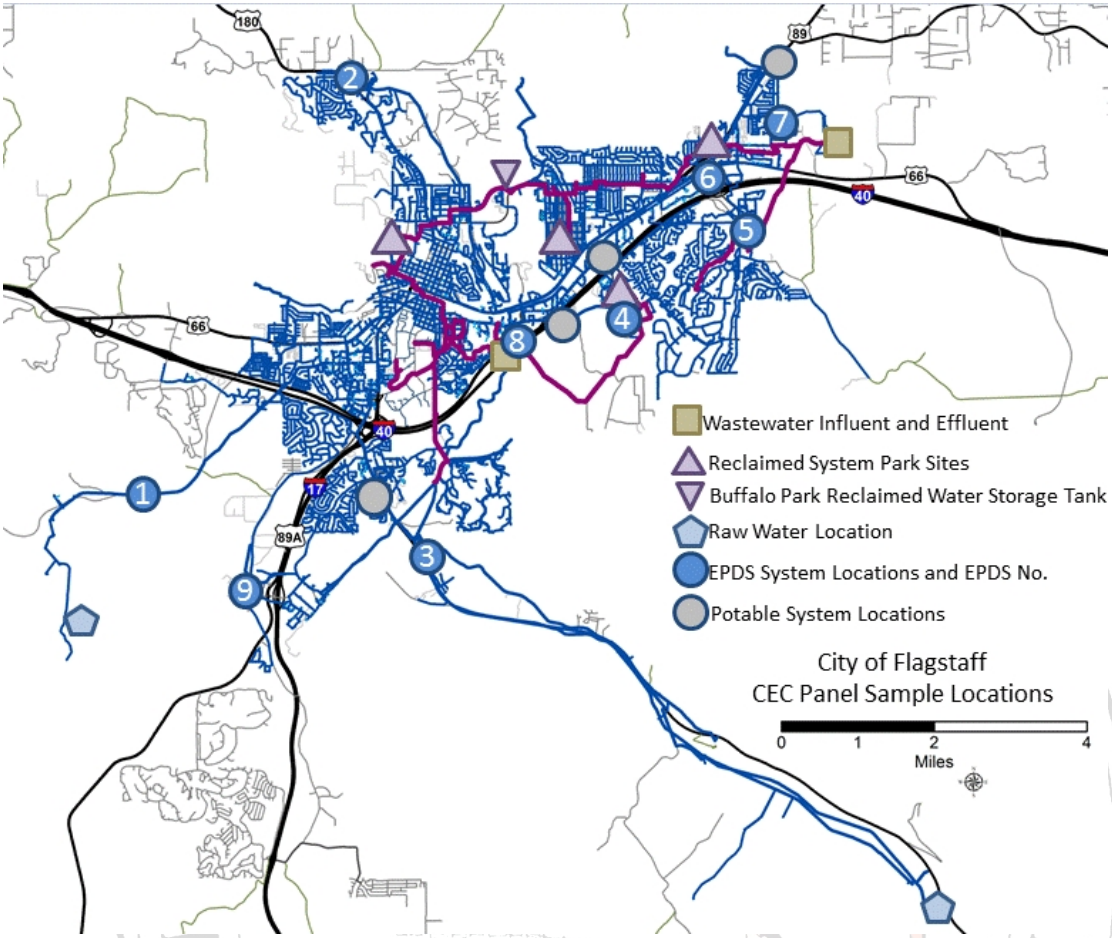
2) CEC System Sampling Project Status

City staff has collected water samples from reclaimed water sources, potable water sources (filtered or chlorinated source water), and from raw water (untreated source water) in Upper Lake Mary and several groundwater wells, and analyzed for CECs. The detected CECs in trace concentrations are similar to what has been detected in previous sampling efforts. *It is significant to note that these compounds are also detected in trace concentrations in communities nationwide.*

Based on recommendations from the Panel, City staff collected water samples from our raw (or untreated source water) water in Upper Lake Mary and untreated groundwater, potable water sources (filtered or chlorinated source water), and reclaimed water and analyzed for CECs. The Panel recommended sampling for caffeine, 17-beta estradiol and triclosan, which are analytes included in the U.S. EPA Unregulated Contaminant Monitoring Rule program list, and N-Nitroso-dimethylamine, or "NDMA". All samples were sent to the national laboratory, Eurofins Eaton Analytical, and analyzed for the following:

- 95 analytes including caffeine, 17-beta estradiol, and triclosan (as recommended by the Panel) at 7 sites in the reclaimed system and 8 sites on the drinking water system. Though the Panel did not recommend CECs beyond the U.S. EPA Unregulated Contaminant Monitoring Rule program list be monitored, it was cost effective to sample for the 95 analytes.
- U.S. EPA UCMR3 list of 30 contaminants. The U.S. EPA requires public water systems sample for this list of contaminants, used by EPA (and other interested parties) in the development of regulatory decisions. The samples are collected after disinfection or treatment of source water at the City's 9 Entry Points to the Distribution System (EPDS). Since July 2013, six samples were collected at the Lake Mary Water Treatment Plant (EPDS 3), five samples from the Inner Basin at the Reservoir Treatment Plant, and 19 samples at the 7 EPDS well sites. This sampling is ongoing as it is required by the EPA.
- NDMA (N-Nitroso-dimethylamine) is an unintended byproduct of chlorination of wastewater. Six locations were sampled for NDMA from the reclaimed water distribution system.

System sample collection locations are shown on the map below. For specific locations for the ARB/ARG sampling, CEC sampling, and sample dates, refer to the tables included as attachments to this document.



Preliminary Results

Mayor Nabours made opening remarks to more than 100 water professionals who attended the Arizona WateReuse Symposium in Flagstaff July 27-28, 2015. Mayor Nabours pointed out the various challenges of delivering reclaimed water to customers in Flagstaff. At a technical session of this conference, Utilities Director Brad Hill presented an overview of reclaimed water use in Flagstaff, including the creation of the City's CEC Panel and the status of the research. He provided preliminary results from the CEC laboratory analyses (not the ARB and ARG research as the data collected for this NSF study is still under preliminary analysis).

Results from sampling source water, potable water and reclaimed water for CECs since 2013 are similar to what has been detected in the City's water supplies in previous years. It is significant to note that these compounds are also detected in communities nationwide. A summary of what has been detected in the water supplies is provided in the table below.

Reclaimed and potable water sampling locations are provided in Table 1 and Table 2 in the Appendix.

Detected compounds of emerging concern in Flagstaff water systems since 2013			
	CECs (95 analytes)	**NDMA**	**UCMR**
Drinking Water EPDS (8 sites)	Not tested in 2014 (see UCMR)	Not tested	Chromium, Strontium, Vanadium, Hexavalent Chromium common, others include Dioxane and Chlorate
Drinking Water Distribution System (3 sites)	9 total detections in 2014; max of 5 detected CECs at one location	Not tested	Not required*
Drinking Water LM WTP EPDS	1 detection in 2014	Not tested	Not required
LM WTP Upper Lake Mary Source Water	1 detection in 2014	Not tested	Not required
Source Groundwater (3 sites)	1 detection @ 2 locations in 2014	Not tested	Not required
Reclaimed Water Sprinklers (4 sites)	112 total detections in 2014; From 23 to 31 detected at any one site	Detected at both sites tested	Not required
Buffalo Park Tank Reclaimed Water	31 in 2014	Detected	Not required
Wildcat Reclaimed Water	26 in 2014	Detected	Not required
Rio Reclaimed Water	47 in 2014	Not Tested	Not required

- UCMR requires duplicate samples be collected adjacent to the EPDS
- EPDS – Entry Point into the drinking water distribution system

Conclusions

The City has additional laboratory results that add more CEC data to our water quality database. The City of Flagstaff continues to take water quality seriously and is taking a proactive approach by voluntarily establishing baseline water quality information beyond what is required under current State or Federal regulation. The data will be provided to the CEC Advisory Panel for comment. The identified substances are similar to what has been detected in Flagstaff water supplies since 2002 and found in many cities nationwide (WRF, 2015).

As mentioned above, Flagstaff's source groundwater supplies are very clean in terms of natural or chemical compounds, relative to supplies in other parts of the state or nation where intense industrial or land-application of substances is more concentrated. The quality of Flagstaff's water from the C aquifer some 1,200 feet deep is of such a high quality that groundwater only requires disinfection with a small dose of chlorine before entering the distribution system. Compounds in our water supplies are found in the part per billion level (microgram per liter) and part per trillion level (nanogram per liter). Whereas regulatory standards require that water supplies are required to be extensively tested for metals and inorganic contaminants, among others, mostly at the part per million level (milligram per liter).

Ongoing research worldwide is focused on determining whether there is any toxicological significance to detecting CECs in a water supply. Though some CECs have been shown to be a concern in past studies in the environment, those levels of concern are many orders of magnitude higher than those found in Flagstaff source waters. This highlights the "issue" of modern detection methods. CECs that were not detected in the past are now found in some source waters, which is more often a result of more sensitive detection methods, and not the result of increased contamination of source water. The Arizona Department of Environmental Quality's Advisory Panel on Compounds of Emerging Concern will be releasing their report shortly. The City of Flagstaff participated on this state-wide Panel. The report should help to put into context the results of the Flagstaff analysis presented in this Preliminary Data Report and CCR in comparison to other Utilities within Arizona.

Lastly, a comprehensive report was issued by the Water Research Foundation in 2015, with the objective to distil and synthesize current information on PPCPs and EDCs in source and drinking water (WRF, 2015). This report provides technical summaries of CEC data, such as how often various substances have been detected in drinking water, the maximum detected concentrations of those substances, and the identification of a tolerable substance level in drinking water (estimated amount of water to drink per day as an acceptable daily intake.)

One example from the report is for caffeine, one of the most common substances found in drinking water supplies. Caffeine was detected in 33% percent of municipal drinking water samples nationwide with a maximum concentration of 0.22 parts per billion. The report puts into context how much water a person would have to drink per day to equal the dose in one 8-oz cup of coffee. This would be 1,530,000 8-oz glasses of water per day to get the same amount of caffeine as one 8-oz cup of brewed coffee. The highest detected concentration of caffeine in Flagstaff's drinking water (in samples collected since 2010) was 0.082 parts per billion (see table in Appendix). Utilizing the same method, one would have to drink 4,120,000 8-oz glasses of Flagstaff water in a day to get the same amount of caffeine from the water as one would get from drinking the equivalent sized cup of brewed coffee.

Another example is the insect repellant, DEET, which was detected in 29% of the samples nationwide at a maximum concentration of 0.097 parts per billion (WRF, 2015). To get an

average dermal absorbed dose after a single application of DEET insect repellants, one would have to drink 23,800,800 8-oz glasses of water per day (WRF, 2015). In Flagstaff's drinking water sampled since 2010, DEET was found at a maximum concentration of 0.0024 parts per billion or over 40x less in concentration.

References

City of Flagstaff, May 2014, CEC Advisory Panel Update, 4 p., last accessed August 27, 2015 www.flagstaff.az.gov/DocumentCenter/Home/View/44360

City of Flagstaff, July 16, 2013, CEC Panel Interim Report, 5 p., last accessed August 27, 2015 www.flagstaff.az.gov/DocumentCenter/View/42688

Water Research Foundation (WRF), 2015, Pharmaceuticals and Endocrine Disrupting Compounds in Water: A Primer for Public Outreach, 4387a, 85p.

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APPENDIX: ADDITIONAL TABLES

Table 1. Panel recommended reclaimed water sample collection dates and locations since July, 2014.

CEC ARB & ARG Sample Locations and Sample Plan
Compounds of Emerging Concern Advisory Panel Recommendations
City of Flagstaff

Sample Location	Significance of Sample Location	Panel Recommendations & Sample Collection Dates		
RECLAIMED WATER		**NDMA**	**CEC [2]**	**ARB/ARG**
Rio WRF Reclaimed Water Influent	Measures ARBs & ARGs in untreated sewage	NR	NR	2 in 2014 2 in 2015
Rio WRF Class A+ Reclaimed Water	Measures CECs, ARBs & ARGs in reclaimed water at the treatment plant with UV disinfection	NR	23-Oct-14	2 in 2014 2 in 2015
Wildcat WRF Reclaimed Water Influent	Measures ARBs & ARGs in untreated sewage	NR	NR	2 in 2014 2 in 2015
Wildcat WRF Class A+ Reclaimed Water	Measures CECs, ARBs & ARGs in reclaimed water at the treatment plant with chlorine disinfection	30-Oct-14	23-Oct-14	2 in 2014 2 in 2015
Class A+ Reclaimed Water Distribution System Buffalo Park Storage Tank	Measures CECs, ARBs & ARGs in reclaimed water from both treatment plants stored in a tank	30-Oct-14	23-Oct-14	2 in 2014 2 in 2015
Class A+ Reclaimed Water at Irrigation Sites (4 sites) [1]	Measures CECs, ARBs & ARGs in reclaimed water from both treatment plants at the sprinkler heads	October 2014 (Foxglenn and Thorpe only)	23-Oct-14	2 in 2014 2 in 2015

NR = Not recommended for sampling

1 - Christensen Elementary School, Joel Montalvo Park, Thorpe Park, Foxglenn Park

2 - Panel recommended sampling for caffeine, 17-beta estradiol, triclosan and NDMA. City samples were run for 95 analytes on Eaton Eurofins CEC list. NDMA collected seperately.

Table 2. Panel recommended drinking water sample collection dates and locations since July, 2014.

Sample Location	Significance of Sample Location	Panel Recommendations & Sample Collection Dates		
POTABLE WATER		**UCMR 3** [3]	**CEC** [4]	**ARB/ARG**
Upper Lake Mary Raw Surface Water	Measures CECs, ARBs & ARGs in untreated surface water	NR	6-Aug-14	2 in 2014 2 in 2015
Treated Surface Water at Lake Mary Water Treatment Plant	Measures ARBs & ARGs in treated surface water	NR	NR	2 in 2014 2 in 2015
EPDS 3 Surface & Groundwater at Lake Mary Water Treatment Plant	Measures CECs, UCMRs, ARBs & ARGs in treated surface water & groundwater prior to chlorination	24-Oct-13 14-Nov-13 29-Jan-14 1-May-14 17-Jul-14 24-Jul-14	6-Aug-14	2 in 2014 2 in 2015
Raw Groundwater at Woody Mountain Well #11	Measures CECs in untreated groundwater upgradient of City in C aquifer	NR	23-Oct-14	NR
EPDS Groundwater (8 sites) EPDS 1 Woody Mountain EPDS 2 Inner Basin Res Plant EPDS 4 Foxglenn & Sinagua EPDS 5 Continental EPDS 6 Interchange EPDS 7 Shop EPDS 8 Rio EPDS 9 Ft. Tuthill	Measures CECs and UCMR3 in chlorinated groundwater downgradient of City Wastewater WRFs in C aquifer	Oct-13 (EPDS 1, 2, 4, 5, 6, 7, 8, 9) Nov-13 (EPDS 1, 2, 5, 6, 8, 9) Jan-14 (EPDS 2) May-14 (EPDS 1, 2, 4, 5, 6, 8, 9) Jun-14 (EPDS 7) Jul-14 (EPDS 2)	12-Jun-14	NR
Distribution System (3 sites) [1]	Measures CECs in the potable water distribution system	NR	6-Aug-14	NR
Distribution System (5 sites) [2]	Measures ARBs & ARGs in the potable water distribution system	NR	NR	2 in 2014 2 in 2015

1 - Fire Station #6, Montoya Center, NPS Office

2 - Fire Station #6, NPS Office, Luke Air Force Base at Fort Tuthill, Little America, Aquaplex

3 - UCMR3 EPA list includes 30 contaminants

4 - Panel recommended sampling for caffeine, 17-beta estradiol and triclosan. City samples were run for 95 analytes on Eaton Eurofins CEC list. NDMA collected seperately.