City of Flagstaff

Compounds of Emerging Concern
A Case Study

by
Bradley M. Hill, R.G.
Utilities Director

2015 WateReuse Arizona Symposium
Flagstaff, Arizona
July 27-28, 2015

WATEREUSE ARIZONA

CITY OF FLAGSTAFF · ARIZONA · ESTABLISHED 1882

Objective

History of Flagstaff's use of reclaimed water
- (e.g., irrigation, snowmaking)

Compounds of Emerging Concerns
- Testing for Pharmaceuticals, Endocrine Disruptors, Antibiotic Resistance Genes/Bacteria

Creative Political & Technical solution
- City Manager's Advisory Panel
- City being proactive

University Research Activities
- City participation & sampling

HISTORY

1973 City started directly delivering reclaimed water to Continental Country Club Golf Course

1993 City expanded its direct delivery of reclaimed water with the construction of its 2nd wastewater treatment plant

2002 City signed an Agreement with the Arizona Snowbowl to directly deliver 552 AF/year of reclaimed water for snowmaking

Francis Short Pond reclaimed water

HISTORY

2002/2006 City contracted with USGS & Northern Az University Sampling groundwater & reclaimed water for Compounds of Emerging Concern (CECs) and early studies on endocrine disruption on local Mosquitofish & frogs

2009 City and Az Game & Fish sign Agreement for minimum deliveries for sustaining riparian habitat

Today reclaimed water 20% of all water delivered within Flagstaff

HISTORY

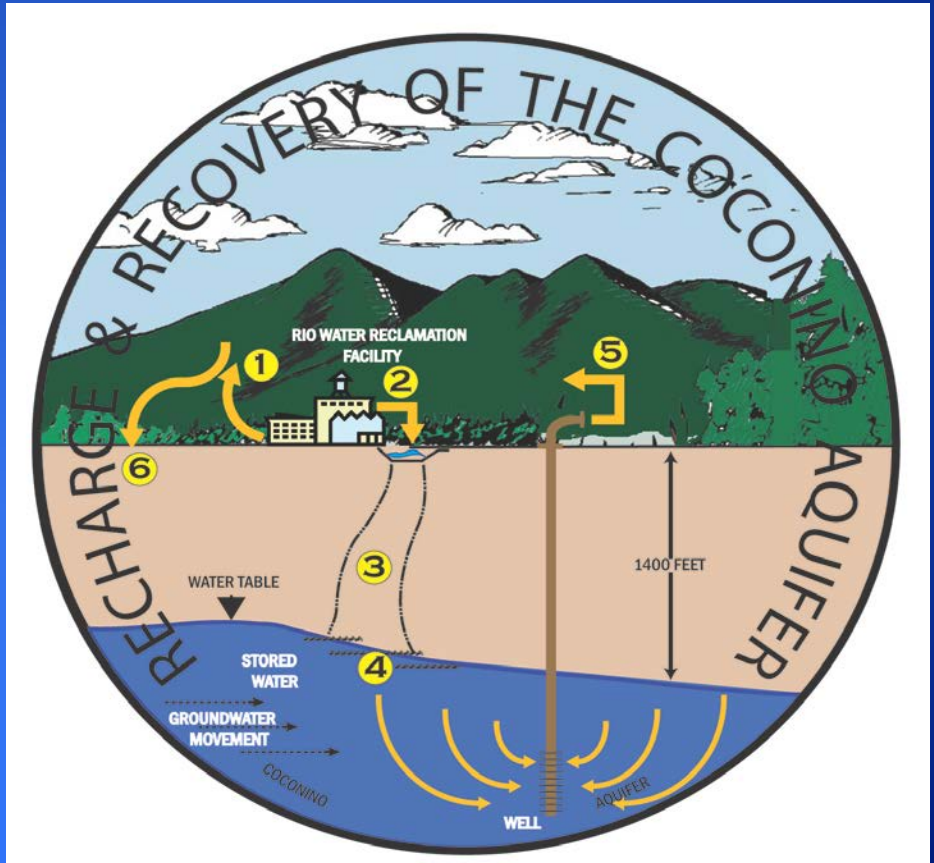
2010 Water Commission & City Council Meetings

Staff introduced "Recovered Reclaimed" to Council as a possible solution to Hopi / Navajo objection to snowmaking

~700 people attend each meeting

Good & Bad: drew attention to what City has been doing for 22+ years

water management v. water quality



HISTORY

2011 Hopi Tribe files Notice of Claim against City for the sale of reclaimed water to Snowbowl for snowmaking

2010/2011 City sampled drinking water distribution & reclaimed water system for CECs

2011 City hosted Reclaimed Water Forum (~400 attendance)

Present national & international issues; research findings; regulatory framework and Utilities industry best practices

Shane Synder, Ph.D. University of Arizona
Mike Fulton, ADEQ
Chuck Graf, R.G., ADEQ
Guy Carpenter, P.E., Carollo Engineers
Brad Hill, R.G., City of Flagstaff

HISTORY

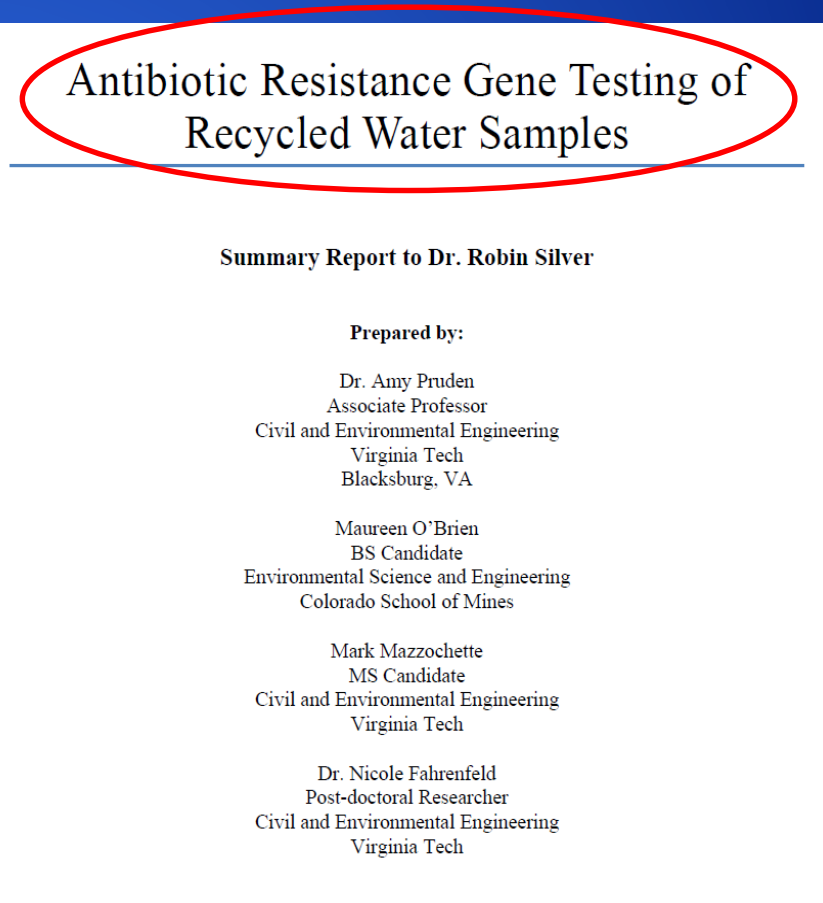
2012 In August a report was released by Virginia Tech University found Antibiotic Resistance Genes in the City's reclaimed system

NBC

Arizona Daily Sun

The Washington Post

The New York Times



Antibiotic Resistance Gene Testing of Recycled Water Samples

Summary Report to Dr. Robin Silver

Prepared by:

Dr. Amy Pruden
Associate Professor
Civil and Environmental Engineering
Virginia Tech
Blacksburg, VA

Maureen O'Brien
BS Candidate
Environmental Science and Engineering
Colorado School of Mines

Mark Mazzochette
MS Candidate
Civil and Environmental Engineering
Virginia Tech

Dr. Nicole Fahrenfeld
Post-doctoral Researcher
Civil and Environmental Engineering
Virginia Tech

HISTORY

2012 In December the Arizona Snowbowl started making snow

The New York Times

City Needed Expert Advice

The topic of reclaimed water use continued to be amplified in the community

City Council became bombarded with citizens questions regarding the safety of using reclaimed water for irrigation, recharge or snowmaking

September 2012, City Manager requested staff to develop a panel of experts - evaluation of the human health impacts from the local use of reclaimed water

January 2013 Same time ADEQ was creating their Panel of Emerging Contaminants

Community Advocacy Groups

Approached City to consider pilot testing a variety of new technologies, questioned why not use Advanced Treatment now?

Hosted 4 public forums with local experts on Water;

USGS, City Manager, Utilities Director, Water Resources Manager, Northern Arizona University professors, Advanced Analytical

Created a Video "Beyond Reclaimed"

friends of Flagstaff's Future

FRIENDS OF THE RIO DE FLAG

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Flagstaff City Manager's Advisory Panel

THE UNIVERSITY OF ARIZONA

TGen North

VirginiaTech

NORTHERN ARIZONA UNIVERSITY

Flagstaff Medical Center
Northern Arizona Healthcare

USGS
science for a changing world

City of Cottonwood, AZ
Heart Of The Verde Valley

PUBLIC HEALTH SERVICES DISTRICT
COCONINO COUNTY

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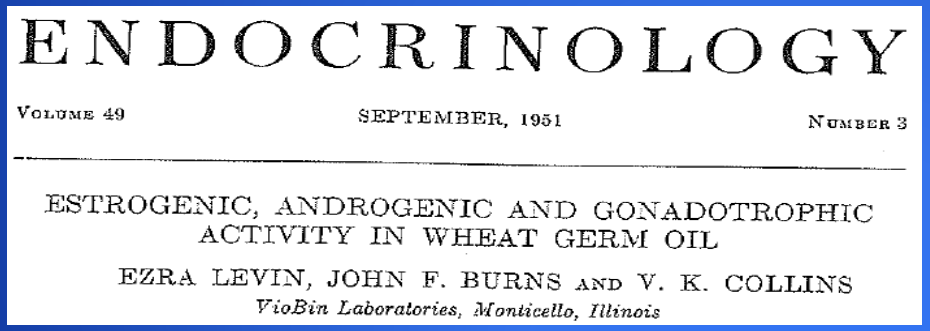
PURPOSE & OBJECTIVES

What does the detection of Compounds of Emerging Concern (CECs) in some parts of the City of Flagstaff's Drinking and Reclaimed Water Distribution Systems mean for possible human health effects beyond what already exists?



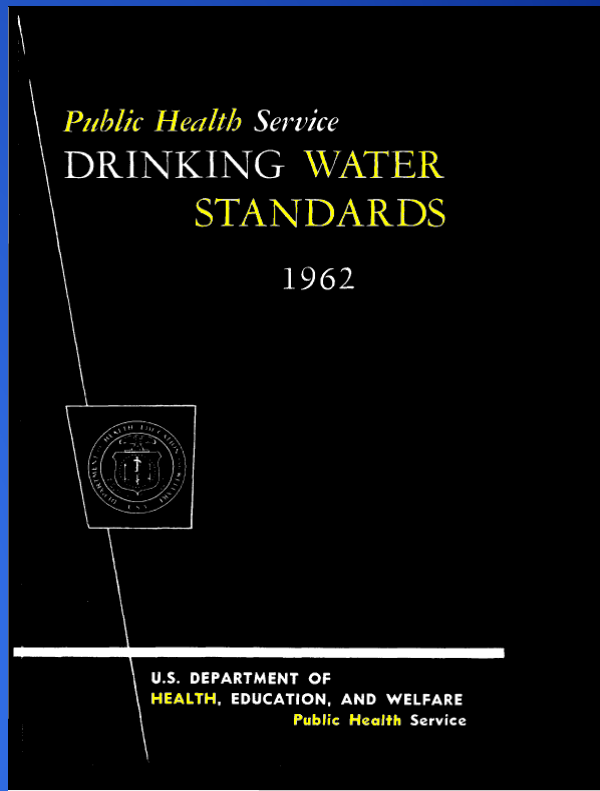
ENDOCRINOLOGY

VOLUME 49 SEPTEMBER, 1951 NUMBER 3

ESTROGENIC, ANDROGENIC AND GONADOTROPHIC ACTIVITY IN WHEAT GERM OIL

EZRA LEVIN, JOHN F. BURNS AND V. K. COLLINS

VioBin Laboratories, Monticello, Illinois



Public Health Service

DRINKING WATER STANDARDS

1962

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

PURPOSE & OBJECTIVES

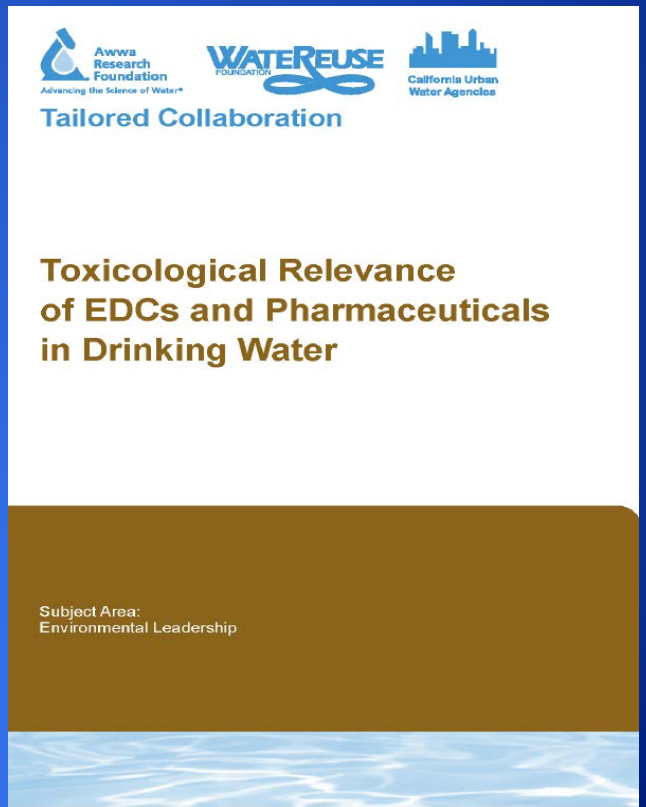
Identify what steps are necessary for understanding the human health effects of CECs in raw, drinking and reclaimed water

Political Dialogue

Detection ---(???)---> Human Health Impact

Determine what specifically to study?

Panel met 3 times 2013-2014



INTERIM REPORT

July 16, 2013

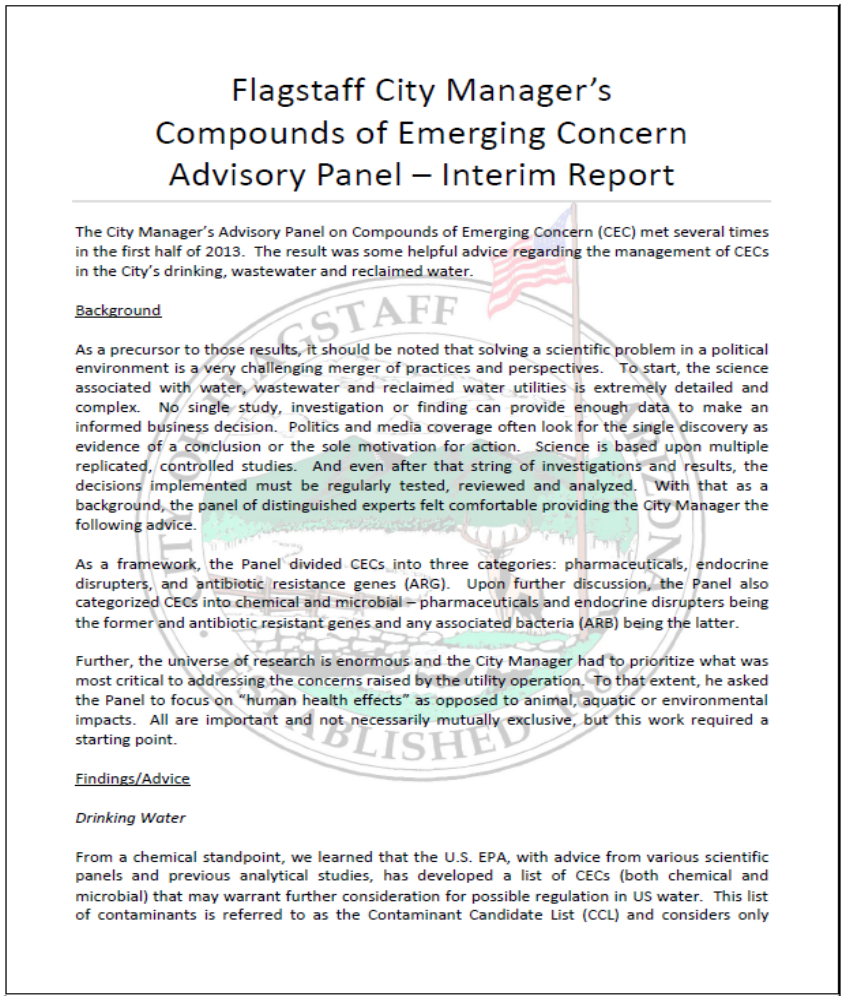
Framework: CECs into 3 categories:

1. Pharmaceuticals,
2. Endocrine Disrupters
3. Antibiotic Resistance Genes/Bacteria

Prioritize most critical issues addressing the concerns raised by the use of reclaimed water by the City:

human health impacts as opposed to animal, aquatic or environmental impacts

"we had to start somewhere"



Flagstaff City Manager's
Compounds of Emerging Concern
Advisory Panel – Interim Report

The City Manager's Advisory Panel on Compounds of Emerging Concern (CEC) met several times in the first half of 2013. The result was some helpful advice regarding the management of CECs in the City's drinking, wastewater and reclaimed water.

Background

As a precursor to those results, it should be noted that solving a scientific problem in a political environment is a very challenging merger of practices and perspectives. To start, the science associated with water, wastewater and reclaimed water utilities is extremely detailed and complex. No single study, investigation or finding can provide enough data to make an informed business decision. Politics and media coverage often look for the single discovery as evidence of a conclusion or the sole motivation for action. Science is based upon multiple replicated, controlled studies. And even after that string of investigations and results, the decisions implemented must be regularly tested, reviewed and analyzed. With that as a background, the panel of distinguished experts felt comfortable providing the City Manager the following advice.

As a framework, the Panel divided CECs into three categories: pharmaceuticals, endocrine disrupters, and antibiotic resistance genes (ARG). Upon further discussion, the Panel also categorized CECs into chemical and microbial – pharmaceuticals and endocrine disrupters being the former and antibiotic resistant genes and any associated bacteria (ARB) being the latter.

Further, the universe of research is enormous and the City Manager had to prioritize what was most critical to addressing the concerns raised by the utility operation. To that extent, he asked the Panel to focus on "human health effects" as opposed to animal, aquatic or environmental impacts. All are important and not necessarily mutually exclusive, but this work required a starting point.

Findings/Advice

Drinking Water

From a chemical standpoint, we learned that the U.S. EPA, with advice from various scientific panels and previous analytical studies, has developed a list of CECs (both chemical and microbial) that may warrant further consideration for possible regulation in US water. This list of contaminants is referred to as the Contaminant Candidate List (CCL) and considers only

INTERIM REPORT

July 16, 2013

Findings/Advice – Drinking water:

- USEPA on advice from various national scientific panels and analytical studies of currently unregulated CECs may warrant further consideration for regulation. Advisory panel recommended evaluating which contaminants on the list are being utilized or prescribed within Flagstaff as background information

- Antibiotic Resistance Genes are not on the USEPA's unregulated list (Contaminant Candidate List #3) but 9 hormones & 1 antibiotic are on the list.

- No documented study exists from around the world on human health impacts of the 10 CECs on list

INTERIM REPORT

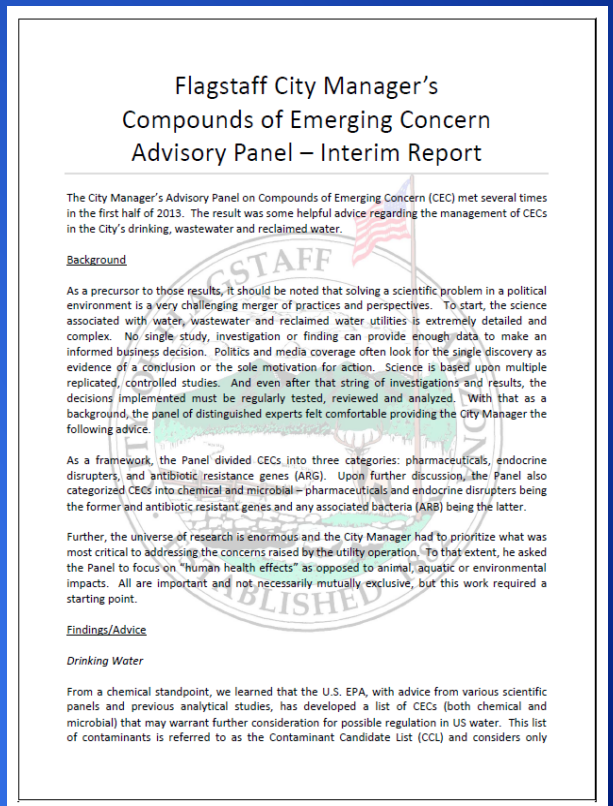
July 16, 2013

Findings/Advice – Reclaimed water:

No data at the present time to suggest that continued use of reclaimed water provides undue risk to human health

Advisory Panel recommended monitor four (4) chemicals on the CCL3 drinking water list in reclaimed water

Advisory Panel suggested parallel study to compare effects of various treatment technologies on removal of CECs including antibiotic resistance



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INTERIM REPORT

July 16, 2013

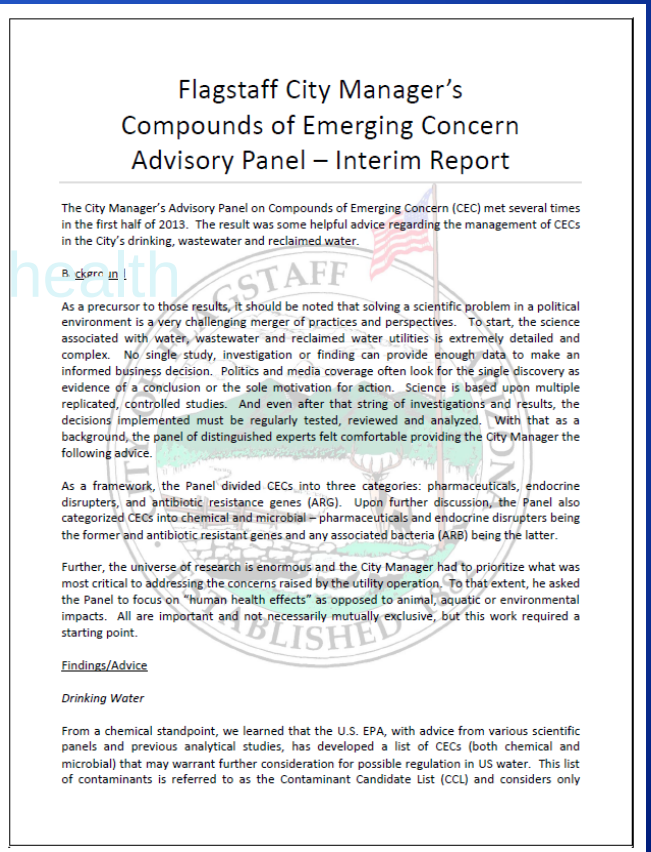
Findings/Advice – Overall:

Pharmaceuticals & Endocrine Disruptors being studied significantly

While documented environmental impacts of CECs – none to human health

Little to no data exists on Antibiotic Resistant Genes/Bacteria on public health in reclaimed water

Opportunity for research collaboration



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Research Subgroup of Advisory Panel

tasked with outlining a cutting edge epidemiological and microbial study focusing on antibiotic resistance

Identify what, if any Antibiotic Resistance Bacteria (ARBs) are found leaving the treatment plants

Identify what, if any ARBs are found at various end points in Flagstaff's distribution system

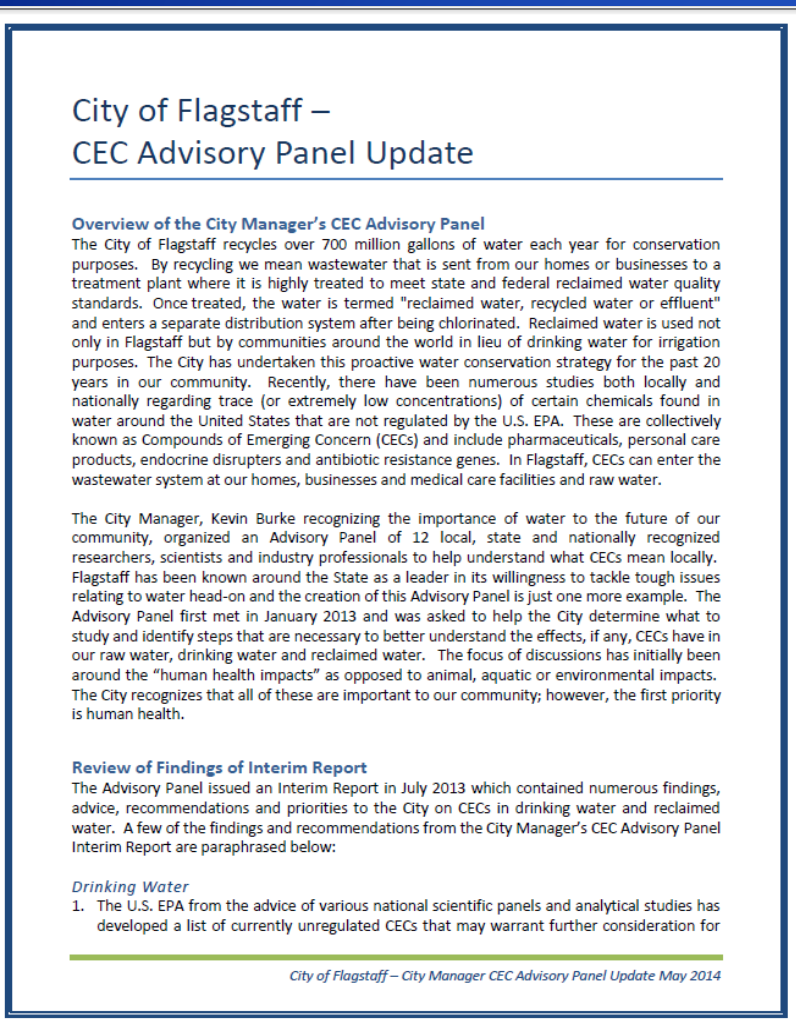
Identify if any ARBs can be found in raw and potable City water

Identify where any of the ARBs are most prevalent (soil, raw meat, \Flagstaff Medical Center, etc)

Identify what treatments kill or remove ARBs in water

UPDATE REPORT

May 2014



City of Flagstaff –
CEC Advisory Panel Update

Overview of the City Manager's CEC Advisory Panel

The City of Flagstaff recycles over 700 million gallons of water each year for conservation purposes. By recycling we mean wastewater that is sent from our homes or businesses to a treatment plant where it is highly treated to meet state and federal reclaimed water quality standards. Once treated, the water is termed "reclaimed water, recycled water or effluent" and enters a separate distribution system after being chlorinated. Reclaimed water is used not only in Flagstaff but by communities around the world in lieu of drinking water for irrigation purposes. The City has undertaken this proactive water conservation strategy for the past 20 years in our community. Recently, there have been numerous studies both locally and nationally regarding trace (or extremely low concentrations) of certain chemicals found in water around the United States that are not regulated by the U.S. EPA. These are collectively known as Compounds of Emerging Concern (CECs) and include pharmaceuticals, personal care products, endocrine disrupters and antibiotic resistance genes. In Flagstaff, CECs can enter the wastewater system at our homes, businesses and medical care facilities and raw water.

The City Manager, Kevin Burke recognizing the importance of water to the future of our community, organized an Advisory Panel of 12 local, state and nationally recognized researchers, scientists and industry professionals to help understand what CECs mean locally. Flagstaff has been known around the State as a leader in its willingness to tackle tough issues relating to water head-on and the creation of this Advisory Panel is just one more example. The Advisory Panel first met in January 2013 and was asked to help the City determine what to study and identify steps that are necessary to better understand the effects, if any, CECs have in our raw water, drinking water and reclaimed water. The focus of discussions has initially been around the "human health impacts" as opposed to animal, aquatic or environmental impacts. The City recognizes that all of these are important to our community; however, the first priority is human health.

Review of Findings of Interim Report

The Advisory Panel issued an Interim Report in July 2013 which contained numerous findings, advice, recommendations and priorities to the City on CECs in drinking water and reclaimed water. A few of the findings and recommendations from the City Manager's CEC Advisory Panel Interim Report are paraphrased below:

Drinking Water

1. The U.S. EPA from the advice of various national scientific panels and analytical studies has developed a list of currently unregulated CECs that may warrant further consideration for

City of Flagstaff – City Manager CEC Advisory Panel Update May 2014

Partnering with University of Arizona, Northern Az University and Virginia Tech

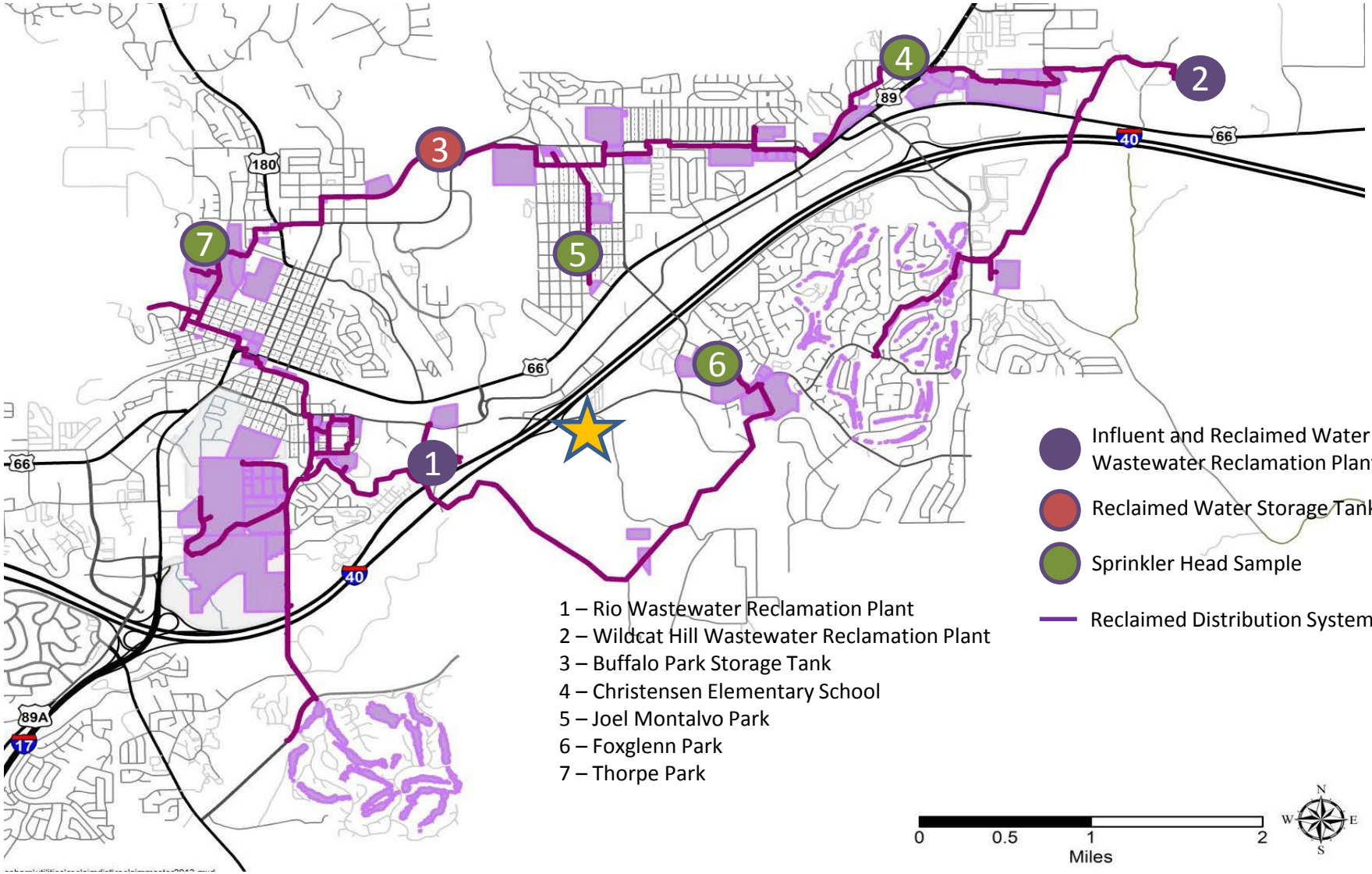
- Research Grant Proposals, Master Thesis
- ARG & CEC Sampling

CEC Panel Recommendations
Reclaimed Water

Sampling Strategy	Significance of Sample Location	Panel Recommendations		
RECLAIMED WATER		**NDMA**	**CEC**	**ARB/ARG**
Reclaimed Water Influent at Both Treatment Plants	ARBs & ARGs in untreated sewage			x
Reclaimed Water Leaving Both Treatment Plants Using Different Disinfection Techniques	CECs, ARBs & ARGs in reclaimed water at the treatment plant with UV and chlorine disinfection	x[1]	x	x
Class A+ Reclaimed Water System Storage Tank	CECs, ARBs & ARGs in reclaimed water from both treatment plants stored in a tank	x	x	x
Class A+ Reclaimed Water at Irrigation Sites	CECs, ARBs & ARGs in reclaimed water from both treatment plants at the sprinkler heads	x	x	x

1 - only sampled for at Wildcat Hill WRF

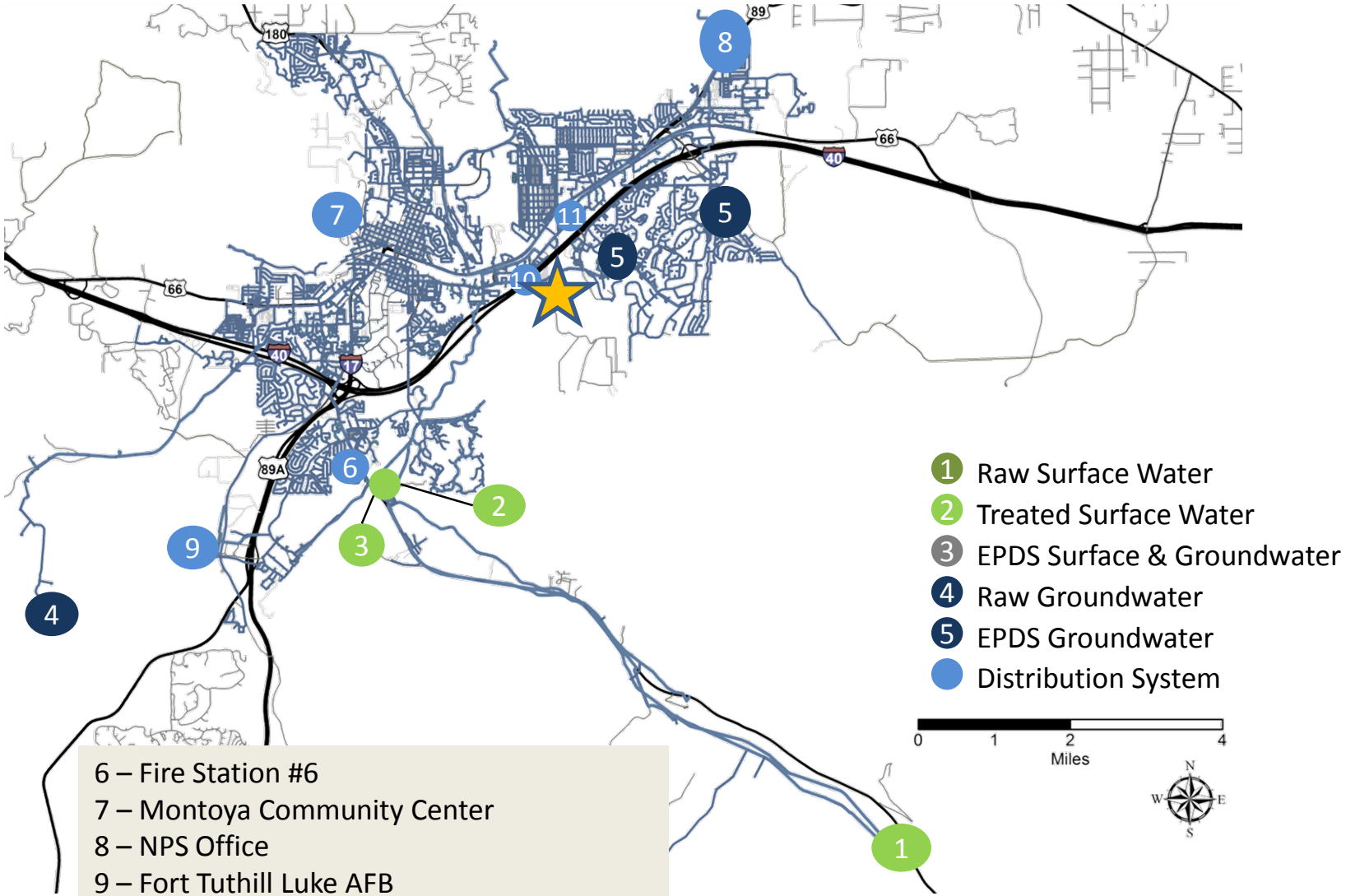
Reclaimed System Sampling 2014-2015



CEC Panel Recommendations Water

Sampling Strategy	Significance of Sample Location	Panel Recommendations		
POTABLE WATER		**UCMR 3**	**CEC**	**ARB/ARG**
Raw Surface Water	CECs, ARBs & ARGs in untreated surface water		x	x
Treated Surface Water	ARBs & ARGs in treated surface water			x
EPDS Surface & Groundwater	CECs, UCMRs, ARBs & ARGs in treated surface water & groundwater prior to chlorination	x	x	x
Raw Groundwater	CECs in untreated groundwater upgradient of City in C aquifer		x	
EPDS Groundwater	CECs and UCMR3 in chlorinated groundwater downgradient of City Wastewater WRFs in C aquifer	x	x	
Distribution System (4 sites)	CECs in the potable water distribution system		x[3]	
Distribution System (5 sites)	ARBs & ARGs in the potable water distribution system			x[4]

Water System Sampling 2014-2015



6 – Fire Station #6
7 – Montoya Community Center
8 – NPS Office
9 – Fort Tuthill Luke AFB
10 – Little America
11 – Aquaplex

National Science Foundation Project

Relative Abundance and Diversity of Antibiotic Resistance Genes and Pathogens in Reclaimed Versus Potable Water Distribution Systems

A. Pruden (Virginia Tech), M. Edwards (Virginia Tech), J. McLain (Univ Arizona), D. Engelthaler (TGen)

Award **$330,000**
August 1 2014-July 31, 2017

RESEARCH QUESTIONS

#1 – Are the Kinds & levels of ARGs found in Flagstaff reclaimed water different from in other reclaimed waters from other parts of the country?

#2 – Are the kinds & 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)

#4 – What is the best way to operate & maintain a reclaimed water distribution system free of pathogens & ARGs equal to background?

Virginia Tech

The University of Arizona

TGen North

CEC Sampling Update

96 CEC's sampled 2010 – 2014 (ng/L)

- Groundwater well
  - Fluoxetine
- Raw surface water – Lake Mary
  - Iohexal, Triclosan, Caffeine, DEET, Lopromide & Theobromine , Acesulfame-K
- Water Distribution System
  - Iopromide , Triclosan, Triclocarban, DEET, Azithromycin, Caffeine, Fluoxetine, Theobromine, Sulfachloropyridazine,
- Reclaimed Water System ~30 constituents

Summary

Reclaimed water is important to Flagstaff

- 20% of total water deliveries and recharge groundwater system

City has been proactive in understanding Compounds of Emerging Concerns and ARG/ARB within our community

City Manager's CEC Advisory Panel

- Creative political & technical solution
- Help the City & our community bring sound science into policy conversations

Research Results

- wait 1+ years for ARB/ARG