2015 SAME Joint Engineer Training Conference & Expo

Preventing Disease by Treating Drinking Water

Moderator: Cdr. Brian Breuer, USPHS

Speakers:

- Kip Duchon, P.E., National Fluoridation Engineer, Centers for Disease Control and Prevention
- Lt. Kelly Hoeksema, USPHS, Project Manager, Virgin Islands National Park
Water Fluoridation: A Public Health Success Story

Kip Duchon, MS, PE
National Fluoridation Engineer

This findings and conclusions in this presentation are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
Fluoride is Naturally Occurring

- **Surface water (rivers)** -- typically low concentrations, 0.2 mg/L (ppm) or less
- **Groundwater (wells)** -- higher concentrations, 0.1 mg/L to over 5.0 mg/L
- **Ocean water** is typically 0.8 to 1.4 mg/L
Definition of Fluoridation

- Fluoridation is the *controlled addition* of fluoride to a CWS to achieve a level that is beneficial for prevention of tooth decay.

Natural F amount in water + Added F = 0.7 ppm

Optimal Range
Risk Factors for Caries

- **Diet**
  - sugars and carbohydrates

- **Oral hygiene**

- **Saliva**
  - flow and composition

- **Bacteria Levels**
  - (e.g., mutans streptococci)
How Fluoride Works Topically

Demineralization

Enamel Crystal = Carbonated Apatite

Partly Dissolved Enamel Crystal

Acid

Calcium

Phosphate

Carbonate

Remineralization

Reformed Enamel Crystal

Calcium

Phosphate

Fluoride

Fluorapatite-like crystals

Source: Adapted from Featherstone, 1999
Fluoridation in Context

• At the time when CWF was initiated:
  – Everyone had tooth decay
  – No one knew how to prevent it
  – Not uncommon for 13-year-olds to have lost one or more permanent teeth to decay
  – About half of older Americans (age 65+) had lost all their natural teeth
  – Recruits into WWII rejected because of poor oral health – 6 opposing teeth -10% rejection rate – 40% needed immediate treatment for relief of pain
## Fluoridation Benefits for Adults

<table>
<thead>
<tr>
<th>Period of F Exposure</th>
<th>Number Adults</th>
<th>Average DFS</th>
<th>Percent Red.</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>226</td>
<td>27.9</td>
<td>-----</td>
</tr>
<tr>
<td>15 – 34</td>
<td>266</td>
<td>22.2</td>
<td>20.0</td>
</tr>
<tr>
<td>0 – 14</td>
<td>40</td>
<td>20.0</td>
<td>28.3</td>
</tr>
<tr>
<td>0 – 34</td>
<td>63</td>
<td>15.7</td>
<td>43.7</td>
</tr>
</tbody>
</table>

Grembowski et al., JADA, 123:49-54, 1992
Recent Scientific Reviews of Benefits

- Health Effects of Water Fluoridation, Royal Society of New Zealand and Prime Minister’s Chief Science Advisor (2014)
- J. Dental Research Papers, Adult benefits
  - Slade et.al. Australia (2013)
- Forum on Fluoridation, Ireland (2002)
- CDC Fluoride Recommendations (2001)
- University of York, UK (2000)
Community Water Fluoridation Recommendations

• Previous recommendation
  • U.S. Public Health Service (1962):
    • 0.7-1.2 mg/L water
      • Based on findings of increased water intake among children with increase in outdoor air temperature

• Current HHS recommendation (2015):
  • 0.7 mg/L water
    • Lowest concentration in current range
    • Federal Register Notice at https://federalregister.gov/a/2015-10201/
Reasons for Proposed Change

- Drinking water is now one of several sources of ingested fluoride
- Increase in prevalence of dental fluorosis
- Likely that caries prevention can be maintained while reducing risk of fluorosis
- Lack of association between water intake by children and outdoor temperature supports single target concentration for all temperature zones in U.S.
Reasons for Change to 0.7 mg/L

• Drinking water is now one of several sources of ingested fluoride
  - Fluoride toothpaste (if ingested)
  - Fluoride supplements
  - Commercial foods and beverages

• Increase in prevalence of dental fluorosis in younger age cohorts in the U.S.

http://www.cdc.gov/nchs/data/databriefs/db53.htm
Standards History

**Recommended**

- **1945 - 1.0 mg/L**
  Dental research consensus

- **1962 - 0.7 to 1.2 mg/L**
  US PHS Standards
  Annual temperature range
  Lower   Optimal   Upper
  0.9     1.2       1.7
  0.8     1.1       1.5
  0.8     1.0       1.3
  0.7     0.9       1.2
  0.7     0.8       1.0
  0.6     0.7       0.8

- **2015 - 0.7 mg/L**

**Regulatory Level**

- **1977 - 1.4 to 2.4 mg/L**
  EPA Interim Standards
  Annual temperature range
  Lower   Optimal   Upper   Limit
  1.1     1.2       1.3     2.4
  1.0     1.1       1.2     2.2
  0.9     1.0       1.1     2.0
  0.8     0.9       1.0     1.8
  0.7     0.8       0.9     1.6
  0.6     0.7       0.8     1.4

- **1986 – 4 mg/L MCL**
  EPA Primary Standards
  2 mg/L SMCL
  4 mg/L MCLG

- **2011 – EPA Draft – in review**
  Risk Assessment
  Relative Exposure
Water fluoride levels

- **Excessive Fluoride** (16 states)
  - MCL 4 mg/L

- **High Fluoride** (34 states)
  - SMCL 2 mg/L

- **Recommended**
  - 0.7 mg/L

- **Inadequate fluoride**
  - 0.4 mg/L

USGS Estimate: private wells 14% of population

- 4% exceeds 2 mg/L
- 1.2% exceeds 4 mg/L
National Primary Drinking Water Regulations

**MCLG > MCL > SMCL**

- **MCLG** - Maximum Contaminant Level Goal
  - Level at which anticipated adverse health effects would not be expected
  - Non-enforceable health-based goal
  - For Fluoride - 4.0 mg/L
National Primary Drinking Water Regulations

\[ \text{MCLG} > \text{MCL} > \text{SMCL} \]

- **MCL** - Maximum Contaminant Level
  - The maximum permissible level of a contaminant
  - Economically and technologically feasible
  - For Fluoride - MCL - 4.0 mg/L
  - States can set stricter standards: CA, FL, NY
National Secondary Drinking Water Regulations

MCLG > MCL > SMCL

- SMCL – Secondary Maximum Contaminant Level

Aesthetic or cosmetic qualities of water

- Not enforceable: exceedance prompts public notification; intended as guidance
- For Fluoride - 2.0 mg/L
- EPA website indicates that this was promulgated for naturally high fluoride waters
Dental Fluorosis

Unaffected to Questionable

Very Mild to Mild

Moderate and Severe
Key Messages: General Public

• CWF – 70 years experience: dramatic decline in tooth decay for people of all ages.
• Effective, inexpensive, and does not depend on personal financial resources or access to dental care.
  – Reduced inequalities in dental health across socioeconomic status and race/ethnicity.
• Three quarters of older adults are keeping their natural teeth
Key Messages: Drinking Water Professionals

• Water fluoridation is the most effective public health intervention, preventing at least 25% of tooth decay across the lifespan
• Each dollar spent on CWF saves over $43.
• Recommended level is safe and is below maximum regulatory levels allowed under SDWA.
• NSF/ANSI Standard 60 and AWWA Standards ensure quality products and protect the public.
## Intervention Costs

<table>
<thead>
<tr>
<th>Study*</th>
<th>Location</th>
<th>Community Population Size</th>
<th>Actual Cost?</th>
<th>Time Horizon (Years)</th>
<th>Per Capita Annual Cost (including fixed and recurrent cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tchouaket 2013</td>
<td>Quebec, Canada</td>
<td>10,000</td>
<td>No</td>
<td>20</td>
<td>$1.69</td>
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<tr>
<td>O’Connell 2005</td>
<td>Colorado, U.S.</td>
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<td>No</td>
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<td>$3.36</td>
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<td></td>
<td>≥20,000</td>
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<td>15</td>
<td>$0.54</td>
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<tr>
<td>Wright 2001**</td>
<td>New Zealand</td>
<td>1,000</td>
<td>Yes</td>
<td>30</td>
<td>$4.89</td>
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<td>&gt;300,000</td>
<td>Yes</td>
<td>30</td>
<td>$0.11</td>
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<tr>
<td>Griffin 2001***</td>
<td>U.S.</td>
<td>&lt;5,000</td>
<td>No</td>
<td>15</td>
<td>$5.26</td>
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<tr>
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<td>&gt;20,000</td>
<td>No</td>
<td>15</td>
<td>$0.70</td>
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<tr>
<td>Cobicac 2012</td>
<td>Australia</td>
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<td>15</td>
<td>$24.00</td>
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<tr>
<td></td>
<td></td>
<td>≥1,000</td>
<td>No</td>
<td>15</td>
<td>$0.24</td>
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<tr>
<td>Ciketic 2010</td>
<td>Australia</td>
<td>--</td>
<td>No</td>
<td>15</td>
<td>$0.81</td>
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</tbody>
</table>

**NOTES:** *All studies are based on cost-benefit or cost-effectiveness studies; **5% discount rate; ***4% discount rate

*Slide courtesy Community Preventive Services Task Force www.thecommunityguide.org, 2014
Get the training you need!

CDC Water Fluoridation Principles and Practices

- Murfreesboro, TN
  September 14-17, 2015
- Sacramento, CA
  February 8-11, 2016 (tentative)
Thank you for your efforts in health promotion through water fluoridation

Questions?

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The Challenges of Treating Drinking Water in Remote Locations and Seasonally Operated Systems

LCDR Kurt Kesteloot, PE, BCEE

Field Services Branch
Outline

- NPS/USPHS History
- National Park Service Office of Public Health
- Water and Wastewater System Challenges
- Moving Forward
- Comments, Questions, and Answers
The US Public Health Service has provided a Public Health Program for the National Park Service since 1921/1922 operating under a Memorandum of Understanding since 1955.

It all started when a US Public Health Service Sanitary Engineer Officer was asked to evaluate the condition of water and waste water systems in Yellowstone National Park in 1917.

MOSQUITO CONTROL

At the request of the director, J. C. Geiger and Asst. Sanitary Engineer, mosquito control measures were instituted. In April, prolific breeding was noted and efforts to control the population were begun.

In previous years, visitors to stay in the valley during July without much discomfort. In July without much discomfort. It is estimated that its loss would have been 60 per cent. Now, this is being done under the direction of the Asst. Sanitary Engineer, who has been working on this problem for many years.

The Yellowstone National Park is situated in northwestern Wyoming, with an extension of about 2 miles into Montana on the north and the same distance into Montana and Idaho on the west. It has a total area of about 2,348 square miles. The open season is approximately three months, and during this time in 1917 a total of 35,400 persons visited the park, the average length of stay being three or four days. In addition to the tourist travel there is a fixed population of about 1,500 persons in a normal season.

For convenience the tourists may be classified, according to the method used in seeing the park, as follows:

1. The tourist secures his meals and lodgings at one of the hotels located at the principal points of interest and is transported from one place to the other by the Yellowstone Park Transportation Co.

2. The tourist secures his meals and lodgings at one of the camps maintained by the Yellowstone Park Camping Co., and is transported from one place to another by the Yellowstone Park Transportation Co.

3. The tourist secures his own equipment and travels through the park.

In the third case, individuals wishing to go through the park provide their own means of conveyance and carry with them their camping and cooking facilities, together with their subsistence. A few of this class secure part of their meals and lodgings at the hotels or camps.

During the season of 1917 about 25 per cent of the tourists stayed at the hotels and 15 per cent had permanent camps; the remaining 60 per cent used private automobiles. It is estimated that approximately one-fifth of this latter class stopped at hotels or camps part of the time. The remainder used their own equipment during the entire trip.

The season at the close of the fiscal year is abnormal for the reasons that the hotels are not open, and the camping company must provide facilities for caring for the first two classes of tourists. In addition the greater number of tourists are traveling in their own automobiles due to the higher rates and inability to secure accommodations on the railroads.

SEWAGE DISPOSAL IN REFERENCE TO THE WATER SUPPLY.

When a stream is used to carry away sewage the water supplied along the lower course is more or less contaminated, being entirely due to the extent to which self-purification has advanced. The sewage at Mammoth Hot Springs reaches the Gardiner River through
NPS OPH Programs and Focus Areas

- Disease Surveillance
- Drinking Water
- Emergency Preparedness and Response
- Food Safety
- Health Promotions (HPHP)
- One Health
- Recreational Waters
- Vector Borne/Zoonotic Diseases
- Waste Water
The Importance of Skilled and Trained Operators
Problems Encountered in The Field

- Limited budgets (operational and improvements)
- Availability of proper disinfectants and materials
- Limited contractors (especially in oil country, remote areas, and/or islands)
- Thousands of aging utility systems
- Aging utility workforce (retirements/turnover), Limited personnel resulting in no backup operators, Limited number of applicants
- Increasing regulations and environmental concerns
The Field
Moving Forward

- Training is a must
- Simplify equipment
- Standardize systems and equipment as much as possible
- Meet with all of the operators and provide encouragement
- Talk with Managers and Superintendents to help highlight the importance of proper sanitation to ensure public health and help meet the mission of the NPS (Organic Act)
- Provide protocols for seasonal systems
- Partner with others to operate systems?
- Reduce requirements? (i.e. disinfection in Non-Public Sys.)
Questions or Comments?

LCDR Kurt Kesteloot
Phone: 402-661-1718
Fax: 402-661-1719
Email: Kurt_Kesteloot@nps.gov

PHP Website:
http://www.nps.gov/public_health/

National Park Service
U.S. Department of the Interior
The Christmas Debacle of 2013

Why regular maintenance shouldn’t be disregarded.

LT Kelly Hoeksema, PE
Facility Support Division
Trunk Bay

- St. John, US Virgin Islands
- Virgin Islands National Park
- Reverse osmosis plant
- Groundwater well
- Public water system
- Restaurant, restrooms, and showers
- Snorkel rinse station
- Water Use: 5,000 to 8,000 gpd
Raw water and Media filter tanks
Inside the RO plant

- Boost Pump
- RO Filters
- Cartridge Filters
Reverse osmosis plant
Plant failure timeframe

- Regional Public Health Consultant recommended membrane replacement on November 8, 2013.
- Regional Project Manager noted jump in conductivity on November 23, 2013.

<table>
<thead>
<tr>
<th>Date</th>
<th>Production Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 9</td>
<td>9 gpm (typical)</td>
</tr>
<tr>
<td>December 10</td>
<td>8 gpm</td>
</tr>
<tr>
<td>December 11</td>
<td>6 gpm</td>
</tr>
<tr>
<td>December 12</td>
<td>3 gpm</td>
</tr>
<tr>
<td>December 13</td>
<td>0 gpm</td>
</tr>
</tbody>
</table>
Failure Timeframe, cont.

- Initial reduced production rate noted on: December 10, 2013
- Reduced Production reported on: December 12, 2013
- Plant stopped producing on: December 13, 2013
- Initiated daily updates: December 12, 2013
- Public notification: December 12, 2013
- Failed bacteriological test: December 3, retested December 10
Why it Failed

- RO membranes clogged
- Last replaced: 2006 (7 years prior)
- Manufacturer’s recommended membrane life: 5 years

Recommend:
- Replace membranes at Trunk RO plant
- Replace membranes at Cinnamon Bay RO
- Replace media filter (status unknown)
Daily updates via conference call

- December 12, 2013 through April 18, 2014
- Report:
  - Chlorine residual
  - Height of water in storage tank
  - Replacement membrane status
  - Media filter tank status
  - Cartridge filter appearance

- Regional participants: Chief of Maintenance, Public Health Consultant, Project Management Branch Chief, Contracting Officer

- Park Participants: Superintendent, Concessions Specialist, Chief of Maintenance, Water Operator
Repairs

- Ordered replacement membranes
- Quotes for installing new membranes, removing media
- Ordered replacement media filter tank and media
- Quote for full removal and replacement of media filter tank
- Hauling water onto site

$45,760
7 yr. old membrane
Getting replacement parts

- Replacement membranes supposed to be ordered on December 18
- Purchase request signed on January 3 for membranes.
- Media filter tank, with media, lead time 30 days.
- Media filter tank ordered last week in January.
Repairs completed

- Membranes Replaced: January 10, 2014
- Media filter tank on island: March 10, 2014
  - Expect to install on March 18...
  - Actually installed on April 18, 2014
- Return to Normal Operation: April 18

Four months after crisis began the plant resumed normal operation.
When it rains, it pours...

- In other news:
  - Cinnamon Bay RO plant: pipe burst the last week in December; pumps will not run for more than 25 minutes before shutting themselves off.
  - Pressure gauge broke for membrane feed and concentrate broke the last week of February.
  - Cistern on housing unit (Lind Point 129) ran dry.
  - Water leak at park house, Island Fancy.
  - Lameshur house: no water pressure.
  - Biosphere chlorine residual below acceptable range.
Lessons learned

- Keep up with regular maintenance
- Keep a log on site (when parts were replaced, their typical useful life, and projected replacement date)—Don’t ignore this log!
- Stock replacement parts
  - If they have a short shelf life, then order within a reasonable timeframe for manufacturer’s recommended life of part.
- Out of sight, out of mind, leads to major failures.
- Don’t maintain systems by the motto, ‘If it’s not broke, don’t fix it.”
Questions?
Gearing up for round two
Thank you!
Contact Information

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- 340-690-2496