A Utility Specific Taste-and-Odor Checklist that Facilitates Effective Response to Consumer Complaints

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Some Key Points:

- Utilities can improve communication about T&O with their consumers/customers
- Some tastes-and-odors can be more prevalent in local drinking waters helping utilities to focus efforts
- Descriptors for the 5 tastes are more universal
- Descriptors for odors are diverse based on local vocabulary, experiences, culture, and language

Example of diverse and local vocabulary

OUTLINE

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- Describing tastes and odors
- Developing a T&O Checklist
- Next steps

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Taste, a "Chemical" Sense

5 tastes are fairly straight forward to recognize and describe

Different receptors in mouth for each taste:

- Sweet, Salty, Sour, Bitter, Umami (savory, meaty; associated with glutamate and MSG)

Literature demonstrates consensus in descriptors

- **Sodium Chloride**

Salty

- **Ethylene Glycol**

Sweet

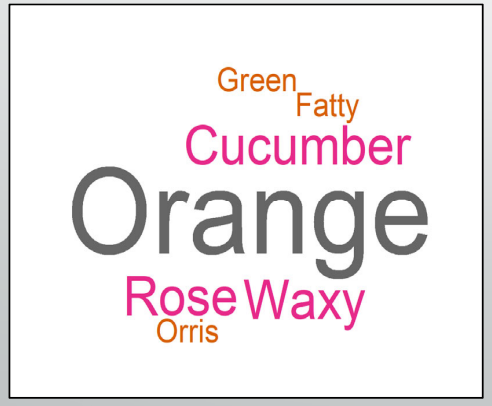
Syrupy

Odor, a "challenging" Sense

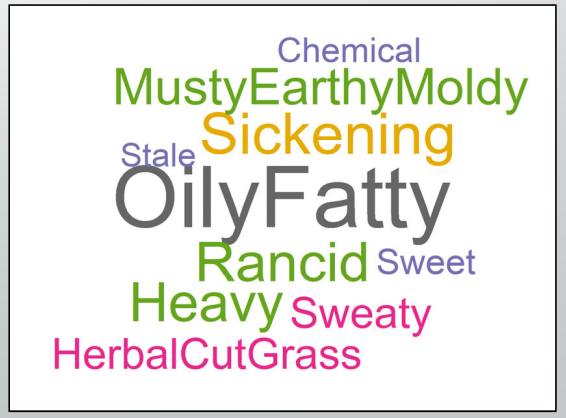
CONSENSUS exists for Hydrogen Sulfide

Sometimes, little or no consensus can be found

Nonanal



N-Heptanal



Odor, a "Chemical" Sense

- Million+ odors – too many to smell and name!
- Challenging for humans to recognize and describe because it highly depends on memory, vocabulary, language
- Literature demonstrates diversity for descriptors, sometimes without consensus
- Complicated chemically, psychologically, and physiologically/genetically

Check-If-Apply Approach from food and beverage industry

Orange Juice

- ☐ Apple
- ☑ Citrus
- ☐ Grape
- ☑ Sweet
- ☑ Sour
- ☐ Salty
- ☑ Bitter
- ☑ Watery
- ☐ Creamy

- Consumers select attributes that apply
- Approach is essentially a multiple- choice questionnaire - e.g., water T&O descriptors
- Used to obtain more consistent feedback

Developing a Utility Specific T&O Check-If-Apply List

- A common vocabulary to guide consumers and utility personnel
- Can incorporate descriptors with location, GIS, asset management system

- Approach
  - Identify typical T&O compounds for a water utility
  - Review sensory literature
  - Review T&O consumer comments/descriptors
  - Combine and refine to generate list of descriptors for use by utility staff and consumers

Case Study: General Pathway for Consumer Calls for "Bad Taste and Odor"

Consumer → Call Center → Field Inspector → **Water Quality Specialist** → Report to Consumer

Case Study: Limited Descriptors were used by utility to categorize Tastes and Odors

1. Chlorine/Swimming Pool/Bleachy
2. Earthy/Musty/Cucumber/Stale
3. Sulfurous/Rotten Eggs/Sewage
4. Metallic/Astringent/Aftertaste
5. Plastic
6. Chemical/Solvent
7. Other

This was done to try and make data entry easier for the call center

Historical data and literature identified 21 chemicals with T&O that could potentially affect the local water supply

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ID	Tastant/Odorant	T&O Wheel Category (Standard Method 2170)
1	Geosmin	Earthy/Musty/Moldy
2	2-Methylisoborneol	Earthy/Musty/Moldy
3	2,4,6-Trichloroanisole	Earthy/Musty/Moldy
4	2,4,6-Tribromoanisole	Earthy/Musty/Moldy
5	d-Limonene	Fragrant, Vegetable, Fruity, Flowery
6	Heptanal	Fishy/Rancid
7	Nonanal	Grassy/Hay/Straw/Woody
8a	E-2-Nonenal	Grassy/Hay/Straw/Woody
8b	Z-2-Nonenal	Grassy/Hay/Straw/Woody
9	Free Chlorine, pH 7	Chlorinous/Ozonous
10	Monochloramine	Chlorinous/Ozonous
11	Dichloramine	Chlorinous/Ozonous
12	Naphthalene	Chemical/Hydrocarbon
13	Toluene	Chemical/Hydrocarbon
14	1,2,4-Trimethylbenzene	Chemical/Hydrocarbon
15	Methyl-t-butyl ether	Chemical/Hydrocarbon
16	Ethyl-t-butyl ether	Chemical/Hydrocarbon
17	Hydrogen sulfide	Swampy, Septic, Sulfurous
18	Ethylene glycol)	Sweet taste
19	Sodium (as NaCl)	Salty taste
20	Copper (cupric)- flavor	Bitter taste
21	Iron (Ferrous) - flavor	Bitter taste

All 21 Chemicals were matched to Literature Descriptors

DESCRIPTOR	Example Chemical
Astringent/Aftertaste	Copper, Iron
Bitter	Copper, Iron
Cardboard	2-Nonenal
Chemical	Heptanal, ETBE, Naphthalene, Toluene
Chlorine/Swimming Pool/Bleachy	Free chlorine ($HOCl/OCl^-$), Monochloramine, Dichloramine
Citrus/Orange/Lemon	Limonene, Nonanal
Cucumber	Nonanal, 2-Nonenal
Drying	Copper
Earthy/Dirt	Geosmin, 2-MIB
Flat/Stale	Heptanal
Fishy	2-Nonenal
Gasoline	Toluene, Naphthalene

DESCRIPTOR	Example Chemical
Grassy	Heptanal
Metallic	Copper, Iron
Mineral-like	Sodium
Muddy	Geosmin
Musty/Moldy/Damp Basement	2-MIB, 2,4,6-Trichloroanisole, 2,4,6-Tribromoanisole
Plastic	ETBE, Toluene
Pungent	2-Nonenal
Salty	Sodium chloride
Shoe-polish	1,2,4-Trimethylbenzene
Solvent	ETBE, MTBE, Toluene
Sulfurous/Rotten Egg/Sewage	Hydrogen sulfide
Sweet	Ethylene glycol, MTBE
Other	

Expanded Utility Taste-and-Odor List or Check-If-Apply List

Descriptors based on:

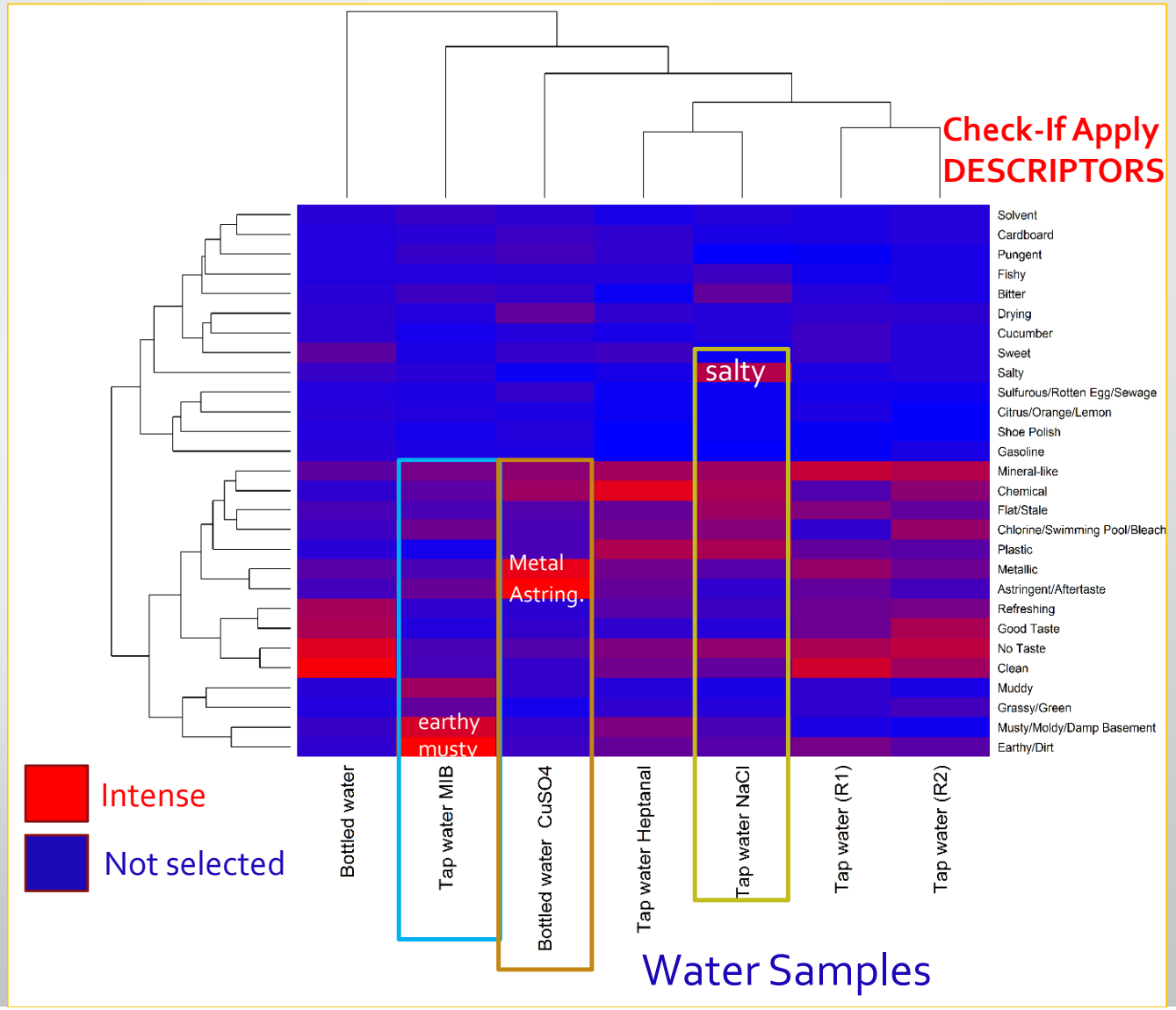
- Consumer comments
- **Blue are T&O descriptors previously used by utility staff**
- Sensory literature for the 21 common T&O issues at the utility

_____ 1. Astringent/Aftertaste
_____ 2. Bitter
_____ 3. Cardboard
_____ 4. Chemical
_____ 5. Chlorine/Swimming Pool/Bleachy
_____ 6. Citrus/Orange/Lemon
_____ 7. Cucumber
_____ 8. Drying
_____ 9. Earthy/Dirt
_____ 10. Flat/Stale
_____ 11. Fishy
_____ 12. Gasoline
_____ 13. Grassy
_____ 14. Metallic
_____ 15. Mineral-like
_____ 15. Muddy
_____ 16. Musty/Moldy/Damp Basement
_____ 18. Plastic
_____ 19. Pungent
_____ 20. Salty
_____ 21. Shoe-Polish
_____ 22. Solvent
_____ 23. Sulfurous/Rotten Egg/Sewage
_____ 24. Sweet
_____ 25. Other

Consumer Testing of Check-If-Apply

- 75 Untrained consumers
- 7 Water samples, random order
- Moderate odor/taste intensity
  - ~ 3 x OTC
- Sensory lab setting

Carneiro et al. STOTEN 2021



Next Steps

- Communications
- Tastes
- Odors
- Aesthetics
- Consumers
- Water Industry
- User Friendly Tool

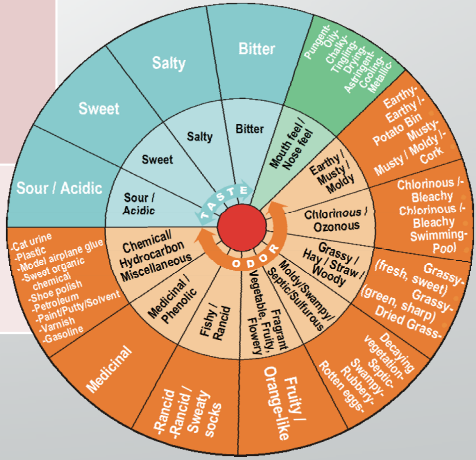
Implementing Check-If-Apply List

- Train utility personnel
- Implement into data management system
- Make available to consumers
- Cell-phone app?

Alternative Approach to Get Started

- If unable to develop a utility specific Check-If-Apply T&O List today, consider sharing the Taste-and Odor Wheel with consumers and utility staff
- T&O Wheel helped consumers (n=51) to correctly describe specific odorants

Consumer Questions: *Responding Helpful or Very Helpful*	**% of Consumers**
How helpful would the T&O wheel be for describing the *general category* of the odor?	94
How helpful was having a copy of the T&O Wheel in improving your ability to identify odors?	78



Phetxumphou, et al.2017. Implementing the drinking water taste-and-odor wheel to improve consumer lexicon. J. *American Water Works Association*, 109(11) E453 – E463, https://doi.org/10.5942/jawwa.2017.109.0122.

Finally, this approach can be applied to aesthetic quality in general

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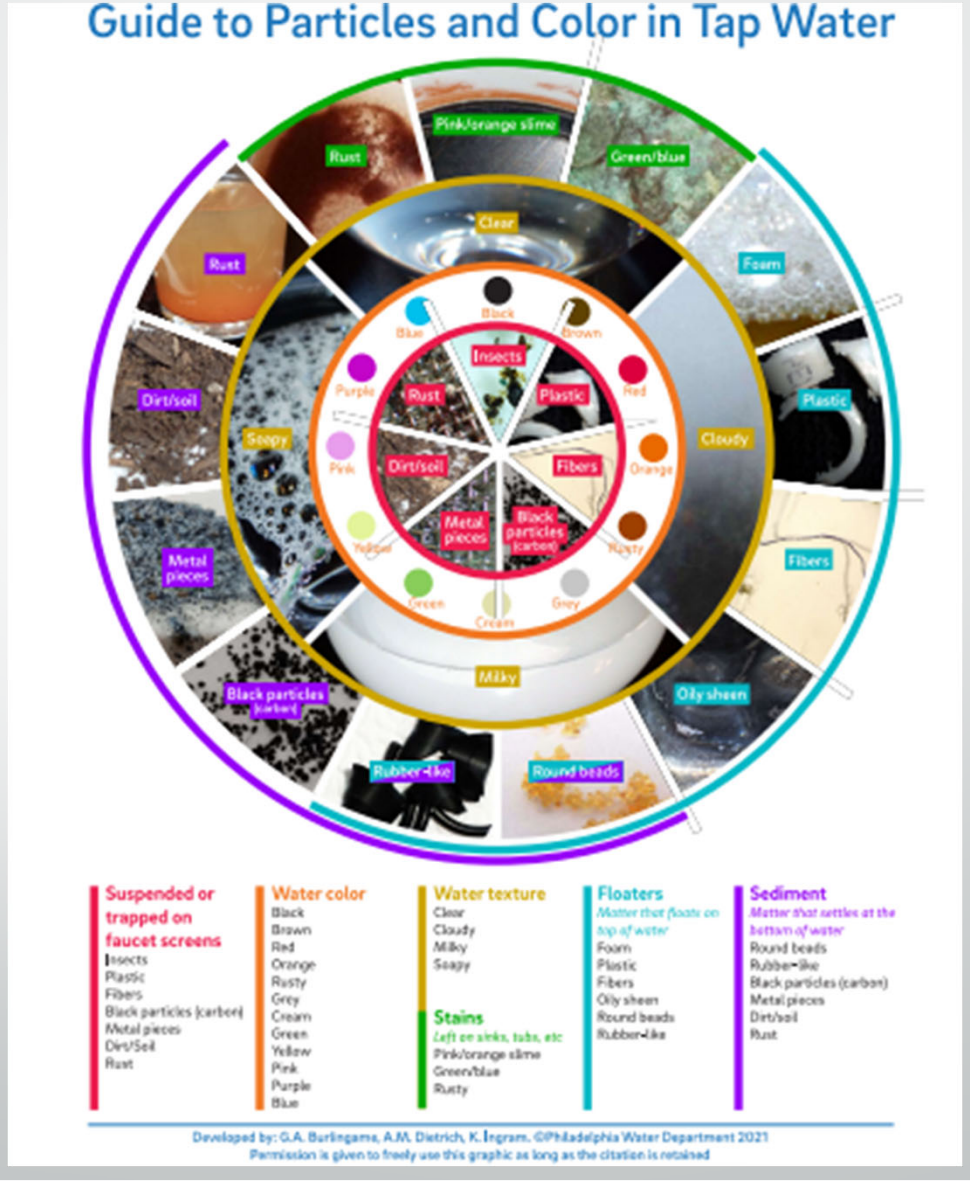

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CASE STUDY

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