Board of Commissioners

Office: (541) 766-6800
Fax: (541) 766-6893

4500 SW Research Way
Corvallis, Oregon 97333

bentoncountyor.gov

AGENDA

BOARD OF COMMISSIONERS
INFORMATION SHARING MEETING
Tuesday, October 22, 2024, 9 AM

How to Participate in the Board of Commissioners Meeting	
Zoom Video Click for Zoom link	Click for YouTube LiveStream link
In-person: Kalapuya Building, 4500 SW Research Way, Corvallis, Oregon	

The meeting location is accessible to persons with disabilities. A request for an interpreter for the hearing impaired or for other accommodations for persons with disabilities should be made at least 48 hours before the meeting by contacting the Board of Commissioners Office at 541-766-6800 or 800-735-2900 TTY, by email bocinfo@bentoncountyor.gov, or on the County's website at https://boc.bentoncountyor.gov/contact/.

The Board of Commissioners may call an executive session when necessary pursuant to ORS 192.660. The Board is not required to provide advance notice of an executive session; however, every effort will be made to give notice of an executive session. If an executive session is the only item on the agenda for the Board meeting, notice shall be given as for all public meetings (ORS 192.640(2)), and the notice shall state the specific reason for the executive session as required by ORS 192.660.

1. **Call to Order and Introductions**

2. **Review and Approve Agenda**

   Chair may alter the agenda

3. **Announcements**

4. Work Session

4.1 30 minutes – 211 Services in Benton County – Shannon Rose, 211 Info Community Engagement Coordinator for Linn, Benton, and Lincoln Counties

4.2 20 minutes – Update on Continuum of Care for Linn, Benton, and Lincoln Counties – Pegge McGuire, Community Services Consortium

4.3 15 minutes – Update from Water District No. 22 of the Oregon Water Resources Department – Joel Plahn, Alyssa Mucken, Oregon Water Resources Department

4.4 30 minutes – Valley Neighbors for Environmental Quality and Safety Presentation – Debbie Palmer, Kate Harris, Catherine Stearns, Virginia Scott; Valley Neighbors for Environmental Quality and Safety

5. Approval of Meeting Minutes

5.1 Approval of the July 16, 2024 Board Meeting Minutes

6. Information Sharing

6.1 Xanthippe Augerot, Chair
6.2 Nancy Wyse, Vice Chair
6.3 Pat Malone, Commissioner
6.4 Rachel McEneny, County Administrator

7. Other

ORS 192.640(1) "…notice shall include a list of the principal subjects anticipated to be considered at the meeting, but this requirement shall not limit the ability of a governing body to consider additional subjects."

8. Executive Session ORS 192.660(2)(d)

The Board will convene into Executive Session under ORS 192.660[2][d] regarding labor negotiations.

WORK SESSION

Item 4.1 211 Services in Benton County

211info

2-1-1

Connect.
Inform.
Empower.

Shannon Rose

COMMUNITY ENGAGEMENT COORDINATOR

Linn/Benton/Lincoln Counties

she/her/hers
541.497.7424
Shannon.rose@211info.org

Who is 211info?

Mission

- Empower communities by helping people identify, navigate, and connect with the local resources they need

Oregon-based Private Nonprofit

- Managing the OR & SW WA 211 system

What is 211?

FCC-Authorized Hotline

- Easy-to-remember phone number connecting people to the help they need

Resource Hub

- Referring people to local health, human, and social service organizations

What is 211?

211	Information & Referral
311	Govt & Non-Emergency
411	Directory Assistance
511	Traffic & Weather
611	Phone Provider Support
711	TDD & Relay Support
811	Call Before You Dig
911	Emergency Service
988	Suicide & Crisis Lifeline

What is 211?

211
Information & Referral

- Food
- Housing & Shelter
- Utility Assistance
- Health Care
- Transportation
- Legal Services

988
Suicide & Crisis Lifeline

- Suicidal Thoughts
- Mental Health Crisis
- Substance Use Crisis
- Emotional Distress
- Veterans Crisis

911
Emergency Service

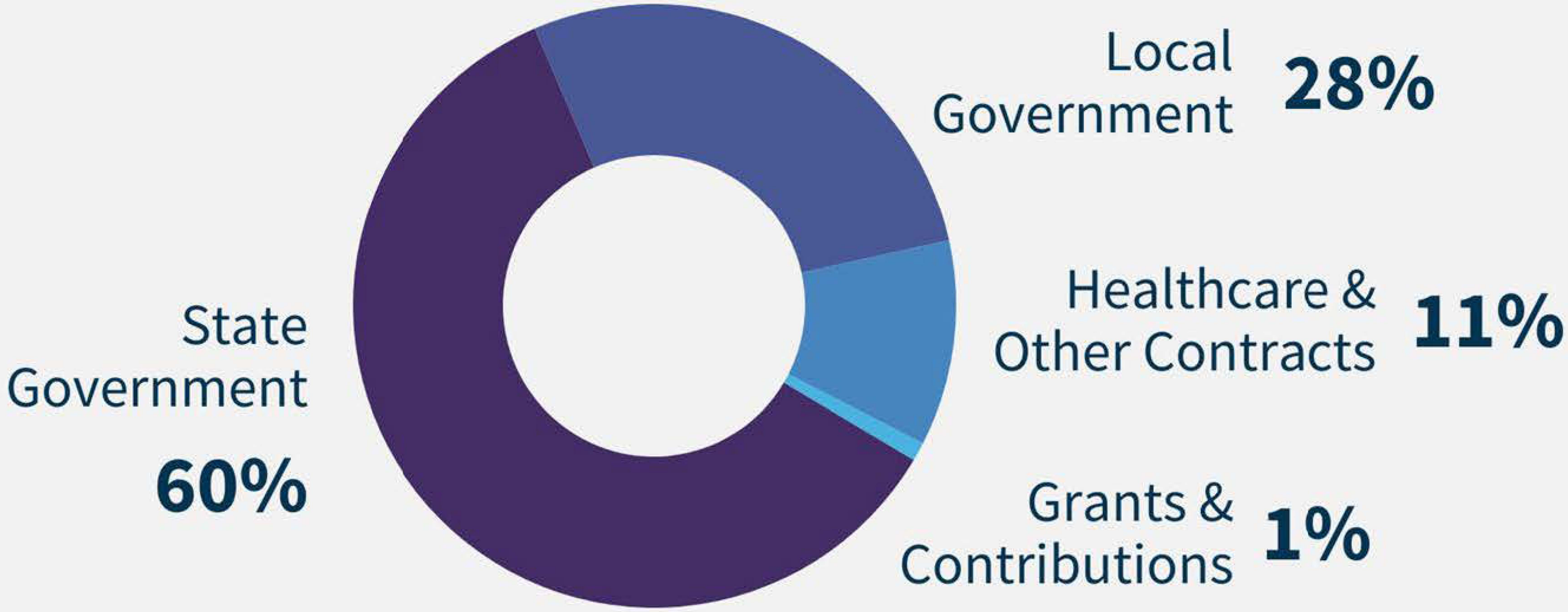
- Fire
- Medical Emergency
- Crime
- Abduction
- Domestic Violence
- Impaired Driving

Why use 211?

ACCESS | **PEOPLE** | **TRAINING**

- Open 24/7
- Multilingual staff
- Compassionate & empathetic
- Staff live throughout OR & WA
- 150 person workforce: no bots!
- Access to interpreter line
- Active listening & specialized training
- Equity-focused & trauma-informed

Funding


Local Government 28%
Healthcare & Other Contracts 11%
Grants & Contributions 1%
State Government 60%

How to contact 211?

Dial 211
866-698-6155

Text
zip code to 898211

Email
help@211info.org

Visit
211info.org

Download
211info App

Language interpreters available by phone. Text and email in English and Spanish. Hours vary by program.

What 211info offers

- Contact Center
- Resource Database
- Community Engagement
- Data & Reporting

Programs

Child Care Referrals

SNAP/Food Access Advocate

Maternal & Child Health

Foster/Resource Parent Support

Housing & Shelter

Disaster Services

Pesticide Reporting

Coordination Center

Child Care

CONFIDENTIAL REFERRALS, GUIDANCE, & INFO

- Partnership with
  - OR Department of Early Learning and Care
  - OR Department of Human Services
  - Child Care Resource & Referrals (CCR&Rs)
- Provider referrals based on location, care type, hours, ages served, language(s) spoken, special needs, & more

Maternal & Child Health

FAMILY CARE SUPPORT, REFERRALS, & INFO

- Partnership with OR Health Authority
- WIC assistance
- Children’s health & home visit programs
- Prenatal care & postpartum support
- Formula, diapers, clothing, cribs, car seats, etc.
- Reproductive & sexual health testing & counseling

SNAP Outreach

HELPING OVERCOME ACCESS ISSUES

- Partnership with OR Department of Human Services
- Screening for SNAP (food stamps) eligibility
- Dedicated in-house SNAP coordinator
- Answer FAQs, explain benefits & report issues to ODHS

SNAP USDA Supplemental Nutrition Assistance Program
Putting Healthy Food Within Reach

This institution is an equal opportunity provider.

Resource Parent Support

SPECIALIZED GUIDANCE & CRISIS ASSISTANCE

- Partnership with OR Department Human Services - Child Welfare
- Behavioral & developmental tools
- General parenting support & resources
- Help transitioning youth in & out foster care
- Strategies for working with caseworkers
- 24/7 phone, text, & email access

Seasonal Programs

SHORT TERM SPECIAL PROGRAMS

- Tax preparation
- Summer food for youth
- Back to school supplies
- Holiday assistance

Coordination Center

SYNCING HEALTHCARE & SOCIAL SERVICES

- Closed-loop referrals (CLR)
- Short-term care coordination
- Enhanced resource navigation
- Warm hand-offs
- Follow-up with clients

Disaster Services

CENTRAL HUB DURING RAPIDLY CHANGING CONDITIONS

- 24/7 access to the most up-to-date-information
- Ramp-up operations quickly
- Single point of contact during severe weather, wildfires, flooding, public health emergencies, etc.
- Share public safety information & emergency shelter updates

Resource Database

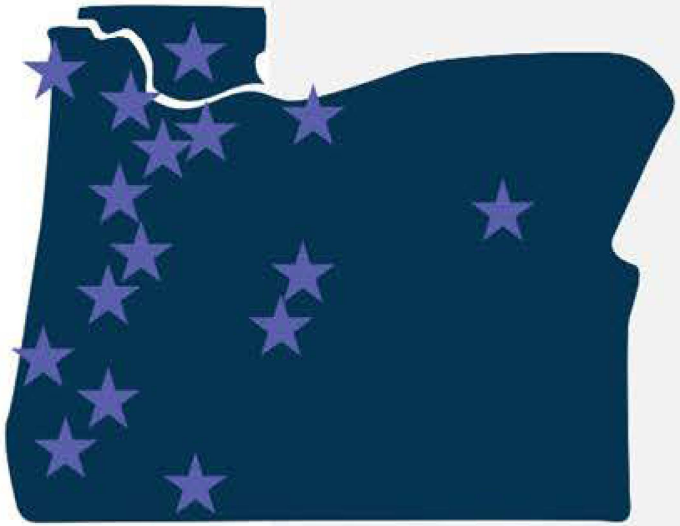
25,000+
Resources

2,500+
Agencies

95%
Annual Updates

Outreach & Engagement

BUILDING LOCAL RELATIONSHIPS

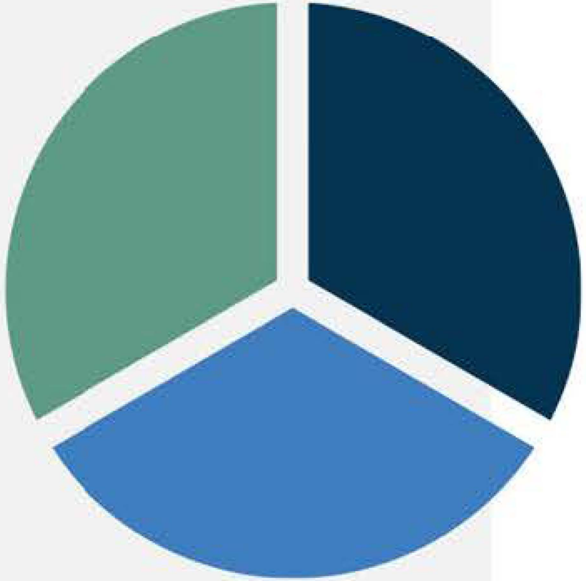


- **Locally based**: live and work in the community
- Community engagement coordinators (CECs) & specialty programs staff
- General & targeted community outreach
- Collaboration with providers to maintain accurate & up-to-date local resources

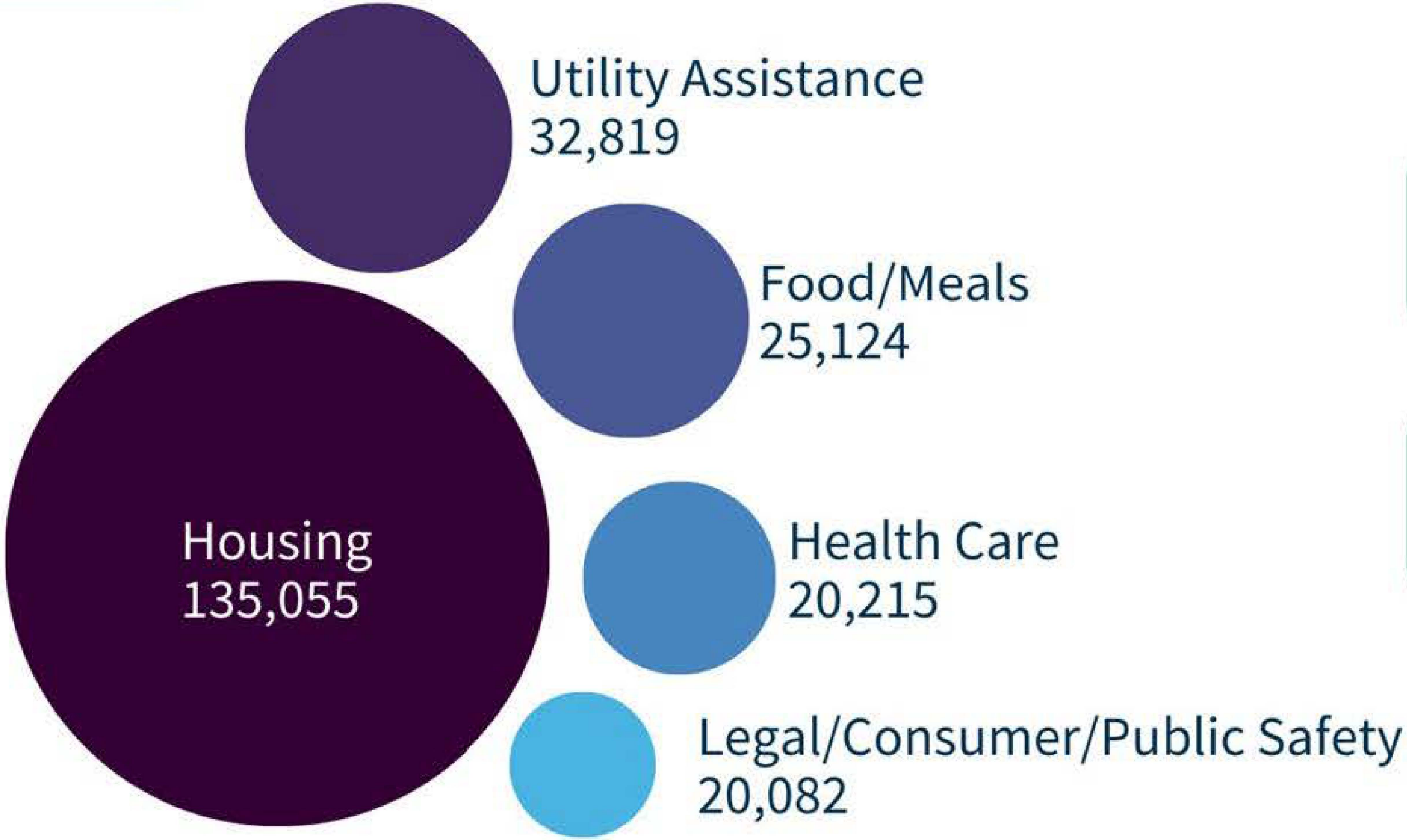
Data & Reporting

IDENTIFY SERVICE TRENDS & GAPS

- Public data dashboard
- Consumer needs & demographics data
- Aggregated custom reports
- Confidential & anonymous



Top 5 Needs 2023



391,154
Total Contacts

663,570
Total Identified Needs

Thank you!

211info.org

@211info on social

FEEDBACK

Item 4.2 Update on Continuum of Care for Linn, Benton, and Lincoln Counties

COMMUNITY SERVICES CONSORTIUM

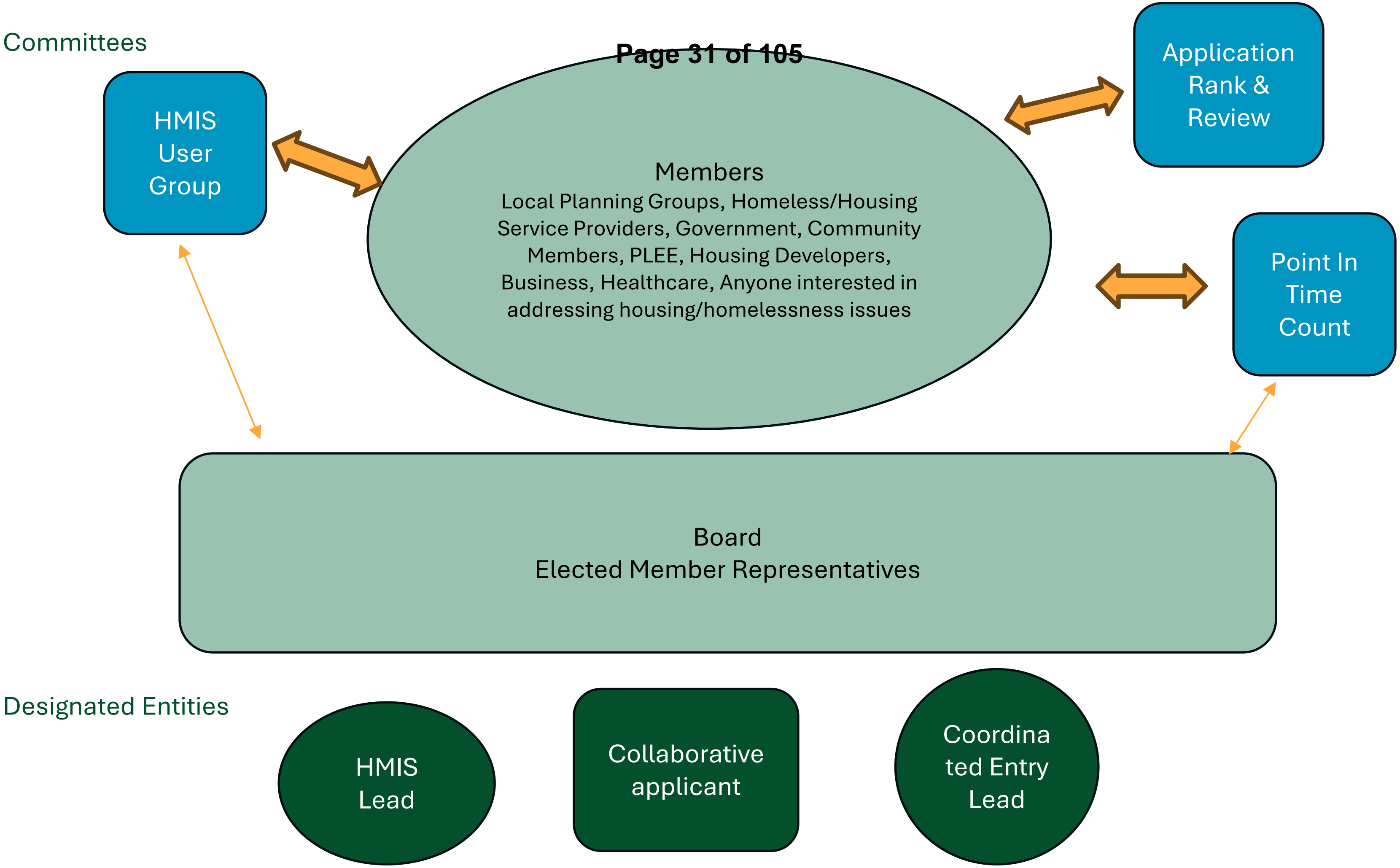
Liesl Eckert
Housing Services Manager
leckert@communityservices.us

Helping people. Changing Lives.

Linn, Benton, Lincoln Continuum of Care Timeline

June 2024				**Nov-24**		**25-Jan**		**25-Apr**		**June 2025**	July	Aug	Sept	Oct	Nov	Dec-25	26-Jan	Feb	March	April	May	**May/June 2026**	
Establishing COC										**HUD Approved COC**												**Established COC**	
Meet with HUD TA to develop 18 month timeline	GOVERNANCE CHARTER (Subcommittee Evidence in Charter) Coordinated Entry Process			Larger membership Mtg. Feedback on Gov Charter		HMIS documentation (MOU and ability to Run SPMs)		Submit formal packet of materials to HUD demonstrating ability to be independent COC		Approval process completed with HUD.	COC Board Elections		Written Standards & Protocols Subcomittees Formed			All COC protocols and board in place, ready to prep for application process	COC Board Meets	COC Board Meets Registration for 2026 HUD CoC application	COC Board Meets	COC Board Meets	COC Board Meets	NOFO Released--local prioritzation and ranking process	SubmittingAppication for tricounty funding

Community Services Consortium


Committees
HMIS User Group
Members
Local Planning Groups, Homeless/Housing Service Providers, Government, Community Members, PLEE, Housing Developers, Business, Healthcare, Anyone interested in addressing housing/homelessness issues
Application Rank & Review
Point In Time Count
Board
Elected Member Representatives
Designated Entities
HMIS Lead
Collaborative applicant
Coordinated Entry Lead

CSC Community Services CONSORTIUM

Sustainable Staffing

1 FTE CoC Coordinator

2 FTE Homeless Management Information System (HMIS)

2 FTE combination of administrative and supervisory support for the team

5 FTE total to sustainably do the work of the CoC for the tri-county region

*can apply for HUD planning, HMIS, and CE funds during competition but typically funds will not be available until the following year

Helping people. Changing Lives.

Next Steps

Community Services CONSORTIUM

- Steering Committee complete draft of Governance Charter
- First regional CoC membership meeting to review and approve the charter
- Submit materials documenting ability to meet HUD requirements to become a HUD approved CoC by June of 2025
- Identify sustainable funding to staff the work of the CoC
- Coordinate ongoing membership meetings, board election, committee formation and meetings, meet HUD application timelines, submit HUD collaborative application, and conduct community capacity building to be ready to apply

Thank You

Questions?

Helping people. Changing Lives.

Item 4.3 Update from Water District No. 22 of the Oregon Water Resources Department

No materials for this item; verbal report only

Item 4.4 Valley Neighbors for Environmental Quality and Safety Presentation

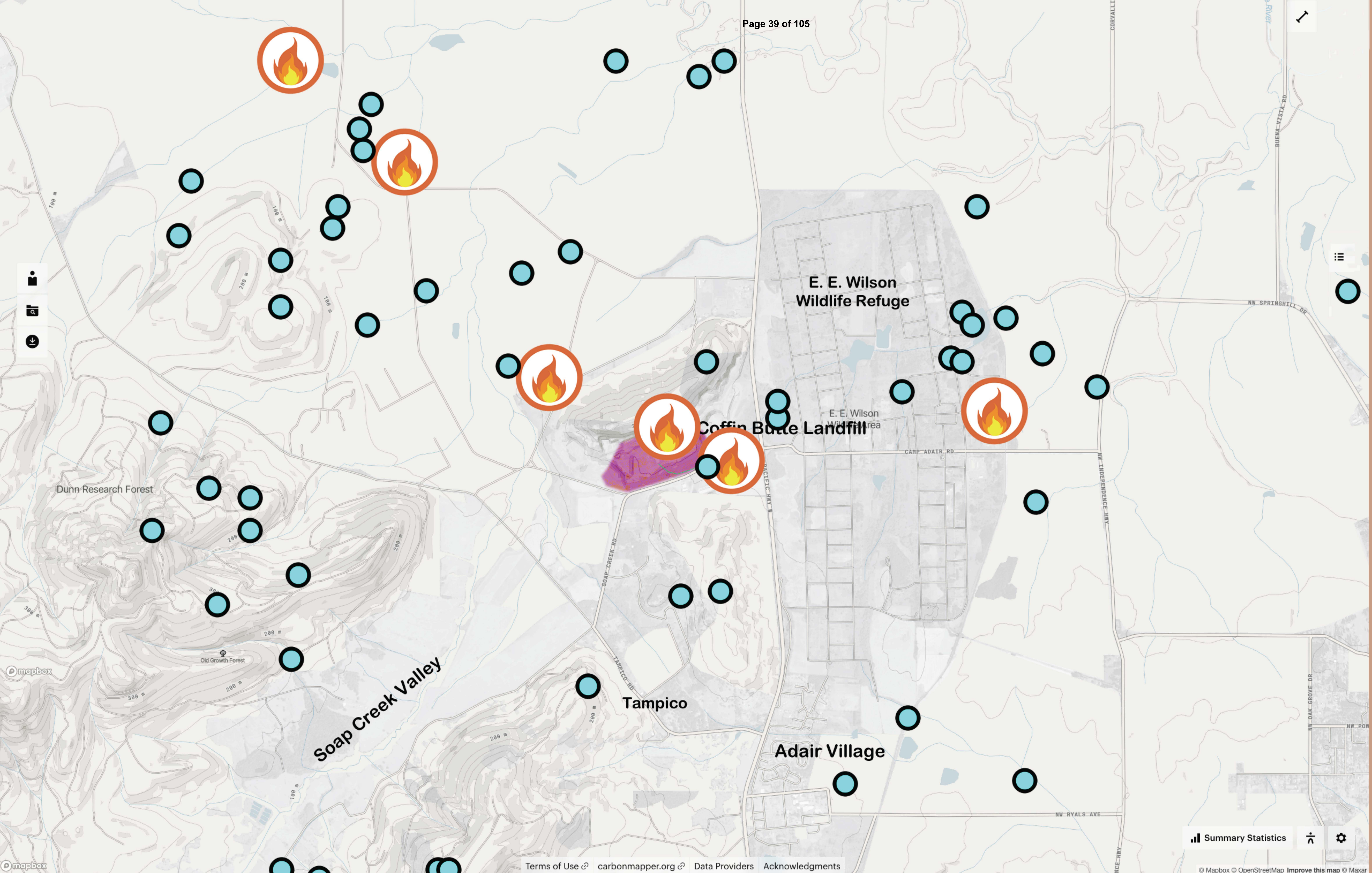
Valley Neighbors for Environmental Quality and Safety (VNEQS)

www.coffinbuttefacts.org

Working to prevent any expansion of the Coffin Butte Landfill in Benton County, Oregon

Coffin Butte Landfill and the Future of Benton County

- VNEQS, an Introduction: **Debbie Palmer**
- VNEQS People are Skeptical (and aware): **Kate Harris**
- VNEQS People are Undaunted: **Catherine Stearns**
- VNEQS People are Action-Focused: **Virginia Scott**
- VNEQS People are Future-Looking: **Debbie Palmer**



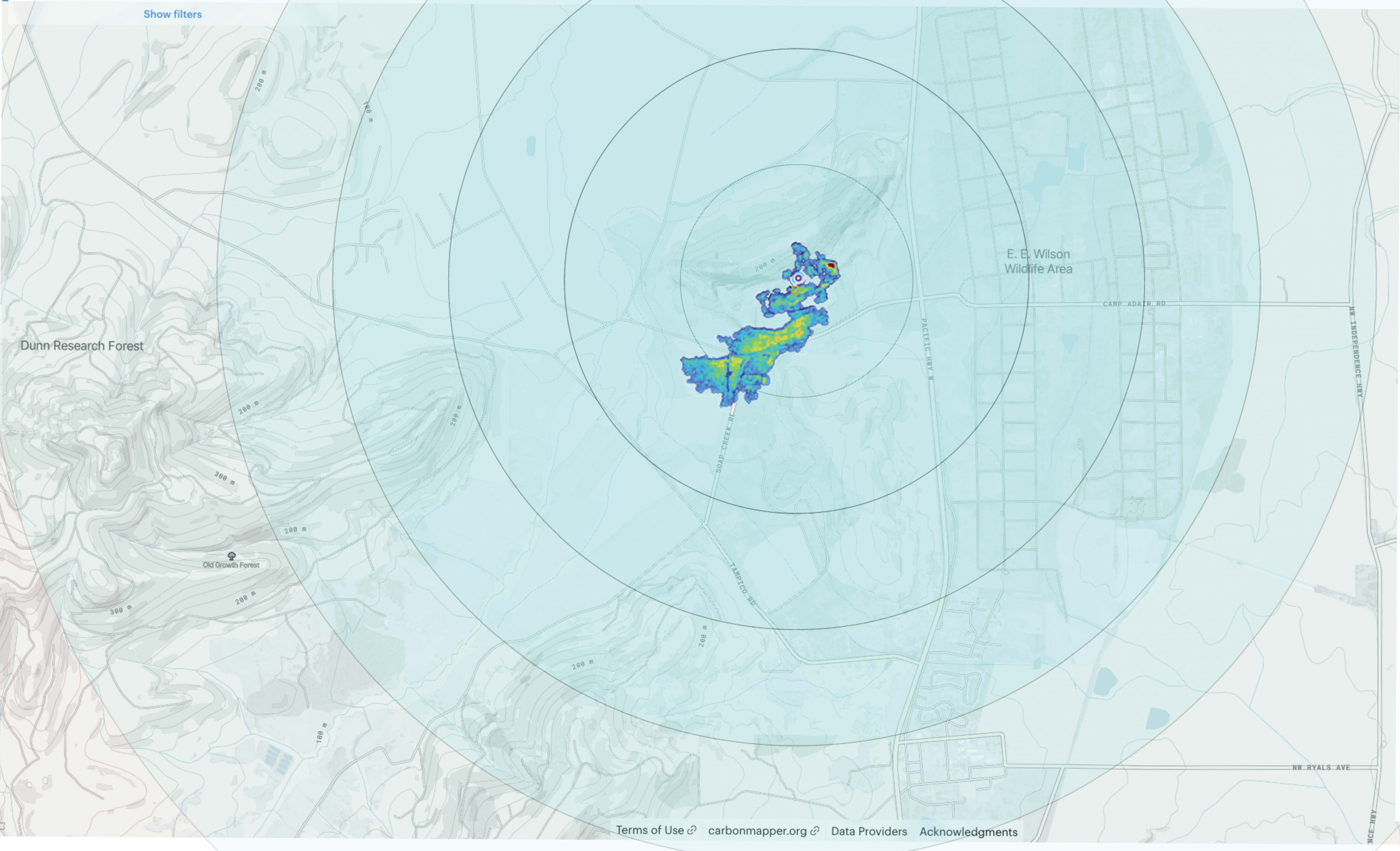
FIRE AND LIGHTNING EVENTS

7-23 to 10-24

(Partial List)

Fires with local fire response

Lightning Strikes



DUMP DAYS 2024

January 12

February 12

March 8

April 22

May 2

May 10

May 17

May 30

September 3

September 10

September 11

October 14

(541) 000-0000

The Disposal Site Advisory Committee (DSAC) welcomes comments, complaints, and other input from the public about Coffin Butte Landfill. You can file brief comments and complaints by calling 541-000-0000. DSAC also welcomes written comments; you may email these to dsac@bentoncountyor.gov, or deliver them to the Community Development Department. You may also comment verbally during the Public Comment portion of each DSAC meeting. DSAC will share your comments with the landfill owner, and with the Oregon Department of Environmental Quality, as per its duty by state law.

Jim Hutchinson, Republic Services:

…we were under the impression that the Tonnage Cap of 1.1m (if expansion isn't granted) was supposed to grow by 3% per year.

Vance Croney, Benton County Counsel:

That's not my recollection. We'd talked about a higher cap with an escalator after expansion is approved. But, we subsequently agreed to scrap that concept and instead eliminate the cap upon expansion approval…

What I can commit to you is this: If, in 2025 landfill expansion hasn't been approved, Benton County will work with Republic to address cap issues, if any have arisen. I don't plan to leave the county before that time, so I'll be around to help engage this conversation.

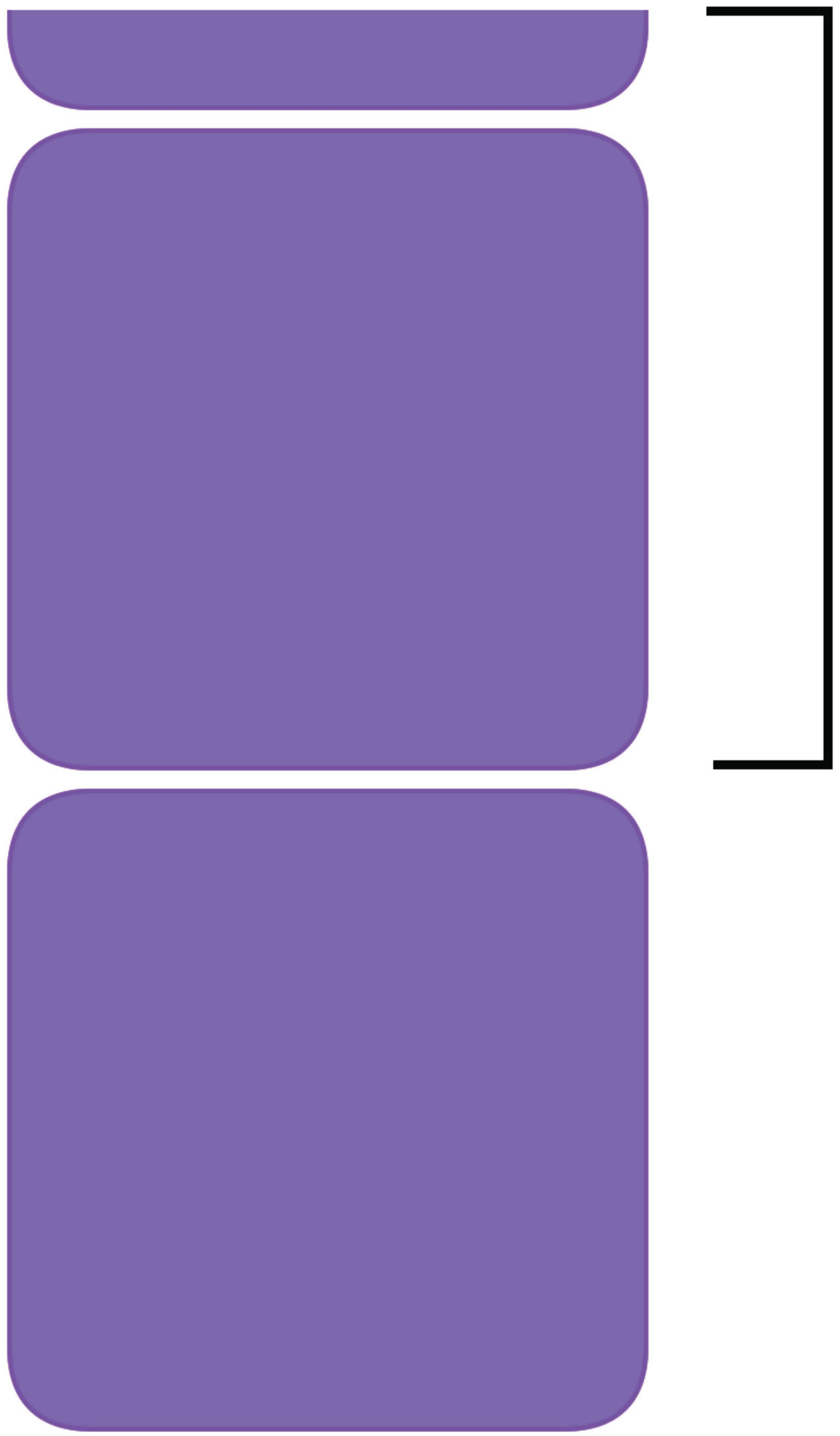
But, to be perfectly honest, I would be shocked if Republic hasn't obtained DEQ and county approval to expand by the end of 2024. The process is very straightforward and even with appeals (if any materialize) there isn't any reason to believe Republic won't be on track to expand Coffin Butte by 2025.

email exchange, December 17, 2020

CLIMATE DAMAGE in metric tons of carbon dioxide equivalent

July 13 – 22, 2023

1 block = 40 MTCO2e



Benton County Government's goal is to reduce its greenhouse gas emissions this much by the year 2030

Benton County Government

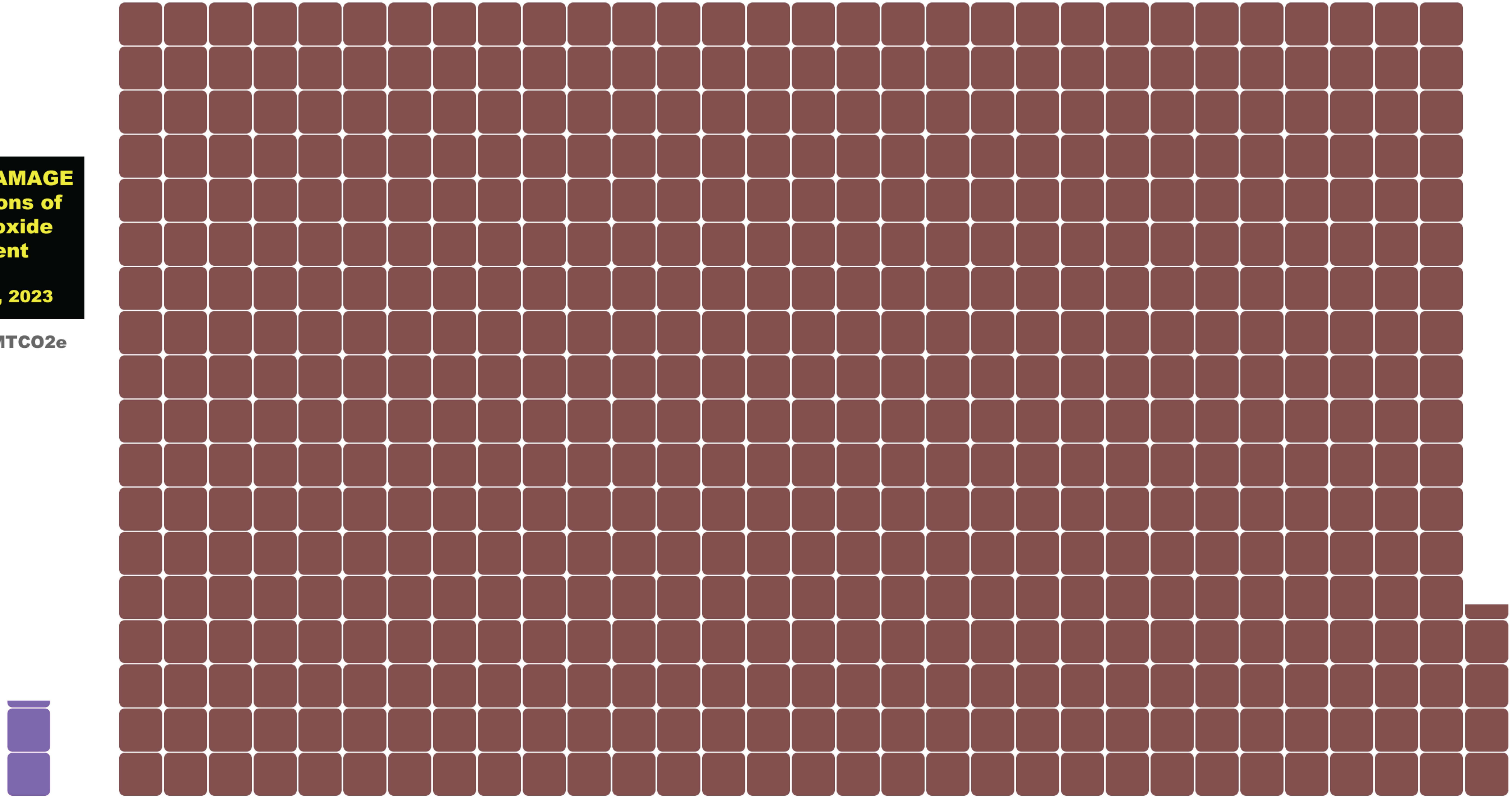
86 MTCO2e

Data source:
Benton County

CLIMATE DAMAGE in metric tons of carbon dioxide equivalent

July 13 – 22, 2023

1 block = 40 MTCO2e



Benton County Government

86 MTCO2e

Coffin Butte Landfill

21,773 MTCO2e

Data source: Benton County, Carbon Mapper coffinbuttefacts.org

valleyneighbors@coffinbuttefacts.org

To: Benton County Board of Commissioners

From: Kiko Denzer

Re: VNEQS presentation at Oct 22, 2024 BOC Information Sharing Meeting - “Coffin Butte Landfill and the Future of Benton County”

Greetings, Commissioners

My name is Kiko Denzer. I have lived, worked, and done business in Benton County for the last 30+ years. I moved from the east coast to the coast range in 1994. Ten years ago I moved to Philomath, where I share an acre of garden and orchard with family.

I know why I am here (and it's not just to complain about the landfill expansion), but I would like to ask you all, "Why are *you* here?” You don't have to answer, obviously, but I hope you'll keep the question in mind as you read.

If you will indulge me a moment, I would like to start with a story about compost. I grew up in town, and knew next to nothing about where food came from, or how nature worked. Most of my experience was concrete, brick, asphalt, glass, and steel. But mom was an artist; she never earned a lot of money, but was very good at "making something out of nothing." When she worked for the Boston Children's Museum, she'd cruise the industrial district for their "waste" -- leftover rubber matting with circular cutouts, discarded plastic lenses from a camera factory, scraps of leather -- all kinds of materials which she brought back to the museum so that kids could make things out of it. She hooked beautiful rugs out of castoff clothing that she cut into strips. When the NY Metropolitan Museum of Art saw her work, they hired her to conduct a tapestry workshop for kids. I got to help, and cut a lot of old clothes into strips.

So I learned to make do with what I had. Looking back now, I see it as compost: giving new life to dead "waste." I have since used that approach to make my own furniture and my own home. But when I got to Oregon, and moved into a tarpaper shack in a little valley, my understanding of home expanded. I didn’t live in the shack; I lived in a valley, next to a creek, among neighbors, trees, mushrooms, deer, bears, cougars, vultures, eagles, salmon. I planted seeds and grew some of my own food. Because there was nowhere to flush away the "waste" from my own body, I built a composting toilet that fed the soil and the garden, which eventually fed me and my family.

But one day, before I got married and had kids, while eating a meal of potatoes and beans that I had planted and harvested myself, from the ground just outside the door of my cabin, I suddenly got my answer to that BIG QUESTION that all of us face, at some point or another:

"Why are we here?"

I realized that I am here to make compost. That means so much more to me now than just improving soil fertility. To me, it means trying to live so that my life feeds what gives me life. And it is more than just a personal mission. It is also an undeniable truth, and perennial wisdom from so many spiritual traditions that teach us that the living eat the dead, and the dead feed the living. We are made of dust and will return to dust. But dust and rain make dirt; dirt feeds grass, and grass feeds flesh, flesh feeds grass...

Sadly, however, the little bit of compost coming out of the landfill doesn’t nearly balance the amount of trash that we turn into poison rather than compost.

So here's my question: Do you want to feed life and community? Or do you want to leave our children a toxic mess that will, in fact, poison their soil and water, and make their lives much worse than ours?

All the counties in Oregon that send their waste to Coffin Butte Landfill have a plan to manage their waste so as to minimize toxic consequences. All except for Benton County.

- In Yamhill County, people took their concerns about their regional landfill all the way to the Land Use Board of Appeals, who agreed with their concerns. And while it took a legal suit to close the landfill, the county adopted the goal of Zero Waste and is taking aggressive steps to reduce the trash they generate.

- Lane County recently announced plans to build and operate the most advanced integrated reuse and recycling facility in the nation.

- Polk County, to break their dependence on Coffin Butte Landfill, is considering a plan to build a waste transfer station.

- Metro Portland decided many years ago that sending trash to landfills in the Willamette Valley went against their stated values of protecting the environment. When they did their homework, they realized that the Valley, which is home to one of the most productive ag economies in the nation, was an irrevocably bad place to have a landfill, so they took a moral stand against dumping trash in the garden where farmers grow their food.

So what *is* Benton County doing? We do have some nice “eco-friendly” verbiage in our planning documents and 2040 Thriving Communities Initiative, but in fact and in practice, our plan looks like a plan to maximize profits for Republic Services and ignore any and all health and environmental impacts.

Those profits may provide the county a bit of money, but they won't feed anyone good food. Rather, garbage “is...an extraordinarily repeatable and inflation-resistant business.” (Investment manager Michael Hoffman, in Forbes Magazine, 8/22. Trash to cash investors include Bill Gates, whose personal holding company, Cascade Investments, has a 34% stake in Republic Services, to the tune of $200M/year.)

Clearly, for Republic and its investors, trash to cash is merely a hedge against inflation. It is impossible, however, to reduce real trash to mere numbers on a profit and loss statement. For those of us who live in Benton County, trash is a slowly exploding bomb.

VNEQS has documented evidence indicating the following:

- arsenic leaching into well water,
- toxic waste being illegally dumped and buried,
- dangerous methane leaks (methane, of course, being a potent greenhouse gas, highly flammable and clear and present fire risk in a heavily wooded area),
- continuing release of noxious and dangerous gases,
- massive dust clouds of unknown substance drifting beyond landfill boundary and over neighbors nearby (see separate document with video link),
- millions of gallons of toxic leachate (essentially untreated and full of heavy metals and PFAS, colloquially known as “forever chemicals”), all of which is being dumped into the River we drink out of. Rather than treating the leachate, Coffin Butte dumps the problem on the Corvallis Wastewater Treatment Plant and two Salem wastewater treatment plants. The most (only) cost-effective solution overall seems to be to prevent PFAS from getting into water in the first place, but of course the dump is effectively an engine for putting PFAS into water and then into the environment.

Everything I've heard to date suggests that the county has been ignoring the facts. Instead, the Planning Commission is being told to cleave to a very narrowly defined financial arrangement that ignores the impact of the dump on our lives for the sake of other people's profits and some meager payoffs for country government.

I hereby hold you accountable: not only for the answer to my questions, but also for the lives of your neighbors, your children, and for the future of our community. You represent people who may not know the facts, but who will surely bear the consequences of those facts.

Why am I here? I'm not here as an adversary; I'm not here to "win" a decision. I am here to serve my neighbors and my kids — the people you represent.
I hope you will welcome VNEQS as allies in the work of composting our trash, to enrich rather than poison our childrens' future, and the future of the land we love and call home.

Respectfully submitted,
Kiko Denzer
Philomath, OR

Links to accompany Oct 22, 2024 VNEQS presentation "Coffin Butte Landfill and the Future of Benton County"

July 2024 video footage of huge dust plume at Coffin Butte Landfill drifting into surrounding neighborhood:

https://www.coffinbuttefacts.org/wp-content/uploads/page/gallery/Landfill-dust-video-7-25-24.mp4

Copenhill, Denmark - where the cleanest (and most beautiful) waste-to-energy power plant in the world is also a destination with a ski slope, hiking trails, climbing walls and more:

https://www.youtube.com/watch?v=pOqocj2h6EM

Potent Planet Warming Gas from Landfills

https://www.cnn.com/2024/03/28/climate/us-landfills-methane-pollution-climate/index.html

A potent planet-warming gas is seeping out of US landfills at rates higher than previously thought, scientists say

By Rachel Ramirez, CNN
3 minute read
Updated 2:23 PM EDT, Thu March 28, 2024

Methane plumes observed by Carbon Mapper during aerial surveys at a landfill in Georgia.
Carbon Mapper
CNN —

Garbage piling up in landfills isn't just an eyesore, it's also a climate nightmare, belching out large amounts of planet-warming methane gas. In the United States, the problem could be much worse than previously thought, according to a new study measuring methane pollution at hundreds of landfills across the country.

Scientists flew over more than 200 landfills across 18 states from 2018 to 2022, in what they say is the largest measurement-based survey of America's landfills. Their results revealed average methane emissions were much higher than those officially reported, according to the study published Thursday in the journal Science.

Methane — an invisible, odorless gas with over 80 times more warming power than carbon dioxide in the near-term — is produced by various sources, the biggest of which are oil and gas and agriculture. Landfills tend to be a less well-known methane source, but they also have a huge impact, estimated at around 20% of global human-caused methane emissions.

Landfills produce methane when organic waste such as food scraps, paper and wood decompose without oxygen, creating the perfect environment for methane-producing bacteria.

Most landfills in the US are federally required to measure methane emissions four times a year through walking surveys using handheld sensors. The accuracy of these surveys can vary, as people tend to avoid areas that are unsafe to walk through, including steep slopes and where garbage is actively being dumped, according to the study.

"Those types of measurements really are not designed to do anything in terms of emissions," but rather just detect methane "hotspots," Daniel Cusworth, lead author and scientist with the non-profit Carbon Mapper, told CNN.

Estimates of landfill methane emissions therefore tend to be based on models rather than direct measurements — but this means potential gaps in data. Advanced monitoring systems using remote sensing from aircraft, drones and satellites can provide a more accurate and comprehensive picture, the report noted.

Using airborne imaging spectrometers, the scientists detected methane plumes at 52% of the landfills they measured. This far exceeds the rate of methane detection in airborne studies undertaken for the oil and gas sector, the report notes.

The results show current reporting systems, such as the Environmental Protection Agency's Greenhouse Gas Reporting Program (GHGRP), are missing large methane sources, the scientist concluded. Average methane emission rates from landfills were 1.4 times higher than those being reported to the GHGRP, the report found.

The study also found landfill methane emissions were generally much more persistent than those from oil and gas production, with 60% lasting for multiple months or even years.

"When we would come back and survey again later in a few weeks or a few months … or over the course of a few years, we always saw [the methane]," Cusworth said.

Rob Jackson, professor of environmental science at Stanford University, who was not involved with the study, said landfills were "super-emitters."

"Airborne data such as these verify what we've been seeing on the ground for decades," he told CNN.

Unfortunately, the problem of landfills is unlikely to go away anytime soon. "Even in a future where there is not a reliance on fossil fuels, humans will likely still be generating waste," Cusworth said. "Even if we transition to cleaner fuels, we're still going to be dealing with waste management."

Scientists say the rapid reduction of methane is one of the most effective ways to slow climate change because of its powerful short-term planet-heating impact.

Yet most methane policies in the US target the oil and gas industry. "If we're going to hit our climate targets, reductions in methane emissions can't come from oil and gas alone," Cusworth said. "Landfills should be garnering a similar type of attention as oil and gas."

US landfills are major source of toxic PFAS pollution, study finds

New research shows toxic ‘forever chemicals’ gas may escape landfills and threaten the environment

https://www.theguardian.com/environment/article/2024/aug/09/pfas-landfills-us

US landfills are major source of toxic PFAS pollution, study finds

New research shows toxic ‘forever chemicals’ gas may escape landfills and threaten the environment

Tom Perkins
Fri 9 Aug 2024 08.00 EDT Last modified on Fri 9 Aug 2024 08.01 EDT

Toxic PFAS “forever chemicals” that leach from landfills into groundwater are among the major pollution sources in the US, and remain a problem for which officials have yet to find an effective solution.

Now new research has identified another route in which PFAS may escape landfills and threaten the environment at even higher levels: the air.

PFAS gas that emits from landfill waste ends up highly concentrated in the facilities’ gas treatment systems, but the systems are not designed to manage or destroy the chemicals, and much of them probably end up in the environment.

The findings, which showed up to three times as much PFAS in landfill gas as in leachate, are “definitely an alarming thing for us to see”, said Ashley Lin, a University of Florida researcher and the lead author of the study.

“These findings suggest that landfill gas, a less scrutinized byproduct, serves as a major pathway for the mobility of PFAS from landfills,” the paper’s authors wrote.

PFAS are a class of about 16,000 compounds used to make products resistant to water, stains and heat. They are called “forever chemicals” because they do not naturally break down and have been found to accumulate in humans. The chemicals are linked to cancer, birth defects, liver disease, thyroid disease, plummeting sperm counts and a range of other serious health problems.

As researchers have begun to understand the chemicals’ dangers in recent years, the focus has largely been on water pollution, and regulators have said virtually all leachate from the nation’s 200 landfills contain PFAS. But scientists are beginning to understand that PFAS air pollution is also a significant threat.

The chemicals concentrate in landfills because they are widely used across dozens of industries and are in thousands of consumer products that end up in the facilities at their lives’ end. As the products decompose, the chemicals can turn into gas and be released into the air.

Much of that can be captured by landfills' gas collection systems. The captured gas in some cases is run through filters or burned off in a flare. However, PFAS are notoriously difficult to destroy, and flares are not an effective way to eliminate them.

Typically, flares or incineration will simply break down PFAS into smaller forms of the chemicals instead of fully destroying them, and that waste will be sent into the air. For now, there is no clear picture of the levels, or how landfills can get a handle on the problem.

"That is a good question," Lin said. "We need to understand that management aspect and what can happen with the different types of treatment technologies in place."

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Occurrence, Fate, and Transport of Contaminants in Indoor Air and Atmosphere June 26, 2024

Landfill Gas: A Major Pathway for Neutral Per- and Polyfluoroalkyl Substance (PFAS) Release

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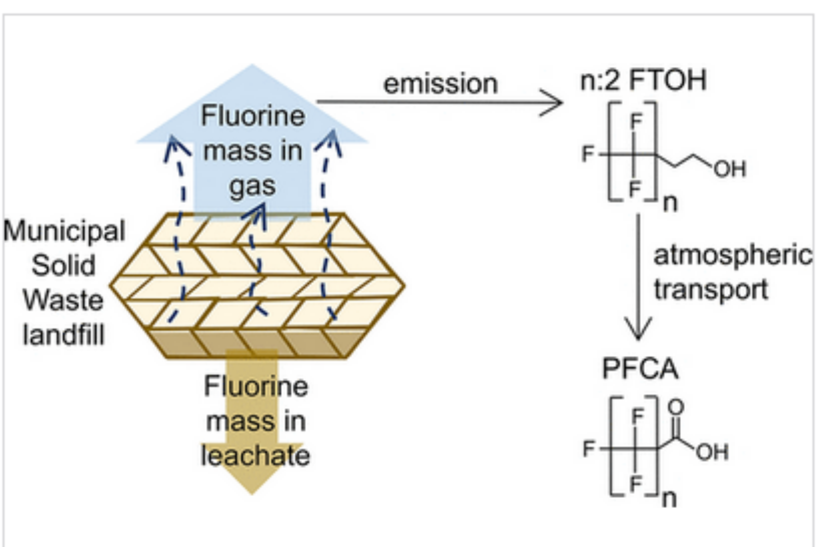
Access Through Your Institution

Other Access OptionsSupporting Information (1)

Abstract



The undisclosed and ubiquitous use of perfluoroalkyl and polyfluoroalkyl substances (PFAS) in consumer products has led to a growing issue of environmental pollution, particularly within the solid waste community, where the fate of volatile (neutral) PFAS in landfilled refuse is not well understood. Here, three municipal solid waste landfills in Florida were assessed for neutral PFAS in landfill gas and ionic PFAS in landfill leachate to compare the relative mobility between the two pathways. Landfill gas was directly sampled using a high volume, XAD-2 resin based sampling approach developed for adsorption and analysis of 27 neutral PFAS. Across sites, 13 neutral PFAS were identified from fluorotelomer alcohol (FTOH), fluorotelomer olefin (FTO), secondary FTOH, fluorotelomer acetate (FTOAc), and fluorotelomer methyl acrylate (FTMAc) classes; however, FTOHs dominated concentrations (87–97% total neutral PFAS), with most detections surpassing utilized calibration levels. Even under conservative assumptions, the mass of fluorine leaving in landfill gas (32–76%) was comparable to or greater than the mass leaving in landfill leachate (24–68%). These findings suggest that landfill gas, a less scrutinized byproduct, serves as a major pathway for the mobility of PFAS from landfills.

LANDFILL FIRES

THEIR MAGNITUDE, CHARACTERISTICS, AND MITIGATION

MAY 2002/FA–225

Federal Emergency Management Agency
United States Fire Administration
National Fire Data Center

FA–225

LANDFILL FIRES

THEIR MAGNITUDE, CHARACTERISTICS, AND MITIGATION

MAY 2002

Prepared by

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for

Federal Emergency Management Agency

United States Fire Administration

National Fire Data Center

U.S. FIRE ADMINISTRATION MISSION STATEMENT

As an entity of the Federal Emergency Management Agency, the mission of the U.S. Fire Administration is to reduce life and economic losses due to fire and related emergencies through leadership, advocacy, coordination, and support. We serve the Nation independently, in coordination with other Federal agencies and in partnership with fire protection and emergency service communities. With a commitment to excellence, we provide public education, training, technology, and data initiatives.

CONTENTS

ACKNOWLEDGMENTS

EXECUTIVE SUMMARY

- Regulation
- Characteristics
- Extinguishing Landfill Fires
- Prevention
- Statistical Analysis
- Case Studies

SOURCES OF DATA

WHY STUDY LANDFILL FIRES?

CHARACTERISTICS OF LANDFILLS

- Municipal Solid Waste Landfill
- Other Types of Landfills
- Landfill Emissions
- Number of Landfills
- The Development of Landfill Regulation1

CHARACTERISTICS OF LANDFILL FIRES

- Surface Fires
- Underground Fires
- Health Effects of Landfill Fires

EXTINGUISHING LANDFILL FIRES

- Wind/Weather
- Water Supply
- Multi-Agency Response
- Personnel Safety
- Access to and Maneuverability of Heavy Equipment
- Logistics
- Environmental Impact
- Landfill Contents

LANDFILL FIRES: STATISTICAL ANALYSIS

- Type of Landfill Fires
- Causes of Landfill Fires
- When Landfill Fires Occur

LANDFILL FIRE PREVENTION

- Landfill Management
- Methane Gas Detection and Collection

CASE STUDIES

- Finland
- Canada
- Hawaii
- Other Examples

CONCLUSION

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Rodney Slaughter	Rodney Slaughter is the President of Dragonfly Communications Network, a fire service training and consulting firm.
Todd Thalhamer	Todd Thalhamer, P.E., is a waste management engineer with the California Integrated Waste Management Board. Mr. Thalhamer specializes in investigating and mitigating landfill and tire fires for the State of California.
Dr. Tony Sperling	Dr. Sperling is the President of Sperling Hansen Associates and the founding partner of Landfillfire.com (http://www.Landfill-fire.com). Since 1997, he has specialized in landfill fire risk reduction training and landfill fire extinguishment on more than 30 landfill fire projects.

EXECUTIVE SUMMARY

Landfills can be controversial in and of themselves. Homeowners and business owners tend not to support the siting and development of landfills in their neighborhoods due to perceived notions about noxious fumes, health and environmental effects, and adverse influences on property values. Fires occurring in landfill sites are an ongoing, complex problem that has existed for decades.

Although relatively uncommon, fires in landfills generally receive substantial media attention and have the potential to become politically damaging events. Landfill fires threaten the environment through toxic pollutants emitted into the air, water, and soil.

Landfill fires are particularly challenging to the fire service. A large landfill fire normally requires numerous personnel and a significant period of time before it is contained. Both of these circumstances can strain a jurisdiction, particularly one dependent on volunteer staffing.

Landfill operators, members of the fire service, and community residents need to learn as much as possible from past experience to prevent and mitigate future landfill fires.

REGULATION. In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA), which gave the Environmental Protection Agency (EPA) the authority to control hazardous waste from "cradle-to-grave." RCRA covers the generation, transportation, treatment, storage, and disposal of hazardous waste and provides a framework for the management of non-hazardous wastes. A turning point in landfill regulation and remediation occurred in 1980, first with the "Superfund" legislation, followed by the Hazardous and Solid Waste Amendments (HSWA) in 1984, which finally gave the EPA regulatory authority over landfills. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), known as Superfund, governs closed and abandoned hazardous material waste sites, provides for the liability of persons responsible for the release of hazardous materials at these sites, and established a trust fund to provide for cleanup where no responsible party could be identified.

CHARACTERISTICS. The most common type of landfill is one that is designed to accept municipal solid waste (MSW). Other types of landfills include hazardous materials landfills, construction and demolition landfills, and industrial landfills. Each type of landfill has specific characteristics based on the type of waste it is designed to accept.

The passage of liquid through solid waste in a landfill creates leachate, which contains potentially dangerous pollutants. As such, landfills must operate in a manner that protects the environment, particularly surface and ground waters, from leachate contamination. To do this, landfill designs generally incorporate a composite liner and a leachate collection system, and landfill procedures require that the waste collected each day be completely covered.

Because of the methods normally adopted to deposit, compact, and cover waste in landfills, the decomposition of waste is largely anaerobic, which results in the production of large quantities of methane and carbon dioxide. Landfills are the largest source of methane emissions in the United States; in 1999, 35 percent of methane emissions were from landfills. Methane is highly flammable and plays a large role in the ignition of landfill fires.

EXTINGUISHING LANDFILL FIRES. The different dynamics, characteristics, and regulations of landfills and the fires that occur in them suggest that firefighting tactics need to be determined on a case-by-case basis depending on the materials buried in the landfill, which materials have ignited, depth of the fire, and the fire's ignition source. Challenges explored in this report include wind/weather; water supply; multi-agency response; personnel safety; access to, access by and maneuverability of heavy equipment; logistics; environmental impact; and landfill contents (potentially hazardous or illegal).

PREVENTION. Fire prevention actions can reduce property damage and the risk of injury and death, as well as decrease health and environmental hazards associated with landfill fires. As a rule, the cost of prevention is less expensive than the cost of fighting and cleaning up a fire. In many cases, particularly at larger landfills, fire prevention activities are mandated by law. The principal methods for landfill fire prevention include effective landfill management and appropriate methane gas detection and collection.

STATISTICAL ANALYSIS. Data from the National Fire Incident Reporting System (NFIRS) does not include MSW landfills as a fixed property use category. Rather, the NFIRS data set includes a category for "dump or sanitary landfill" under NFIRS Fixed Property Use code 932. Although this definition is broader than the definition of a landfill, it is the closest match available in NFIRS. Based on extrapolation of the NFIRS data, each year in the United States an average of 8,400 dump and landfill fires are reported to the fire service. This represents less than a half percent of all reported fires. Undoubtedly, some landfill fires go unreported because they burned undetected or were on private property and extinguished by the landfill operator. Reported fires are responsible for less than 10 civilian injuries, 30 firefighter injuries, and between $3 and $8 million in property loss each year.[1] Deaths (civilian or fire service) are rare in these fires. Since NFIRS represents a sample of data, it may be that fatalities occurred during the study period and were not reported or captured in the data.

CASE STUDIES. A sample of landfill fires throughout the world sheds light on the landfill fire problem. Waste disposal practices and the regulation of landfill sites are similar in the comparison countries. Landfill fires have been investigated and studied in more detail in these jurisdictions than in the United States. In addition to presenting U.S. case studies, this report includes brief synopses of interviews and media reports detailing landfill fires in the United States and the lessons that were learned from them.

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[1] National estimates are based on NFIRS data (1996–1998) and the National Fire Protection Association's (NFPA) annual survey, *Fire Loss in the United States*.

LANDFILL FIRES

THEIR MAGNITUDE, CHARACTERISTICS, AND MITIGATION

Fires occurring at landfill sites across the United States are an ongoing, complex problem that has existed for decades. Landfill fires threaten the environment through toxic pollutants emitted into the air, water, and soil. These fires also pose a risk to firefighters and civilians who are exposed to the hazardous chemical compounds they emit. The degree of risk depends in part on the contents buried in the landfill, the geography of the landfill, and the nature of the fire. There can be great difficulty in the detection and extinguishment of landfill fires, which is compounded because these fires often smolder for weeks under the surface of the landfill before being discovered.

This report was prepared by TriData Corporation, Arlington, Virginia, under contract to the Federal Emergency Management Agency, U.S. Fire Administration (USFA), National Fire Data Center. It presents an overview of the landfill fire problem. Issues examined include the landfill components that create fire hazards; the effect of Environmental Protection Agency (EPA) regulations and landfill cleanup efforts; a profile of landfill fires including their characteristics, methods of extinguishing, and safety issues for firefighters; prevention efforts to reduce landfill fires; and past examples of significant landfill fires and lessons learned.

SOURCES OF DATA

Data on the number of municipal solid waste (MSW) landfill sites in the United States and their current regulations regarding disposal, including those open for disposal and those retired from service, were obtained from the EPA. Data and regulation information pertaining to the Superfund project, including current maps outlining ongoing landfill cleanup efforts, were also obtained from the EPA.

The EPA derives their landfill statistics from *BioCycle* magazine, which conducts an annual survey called “The State of Garbage in America.” *BioCycle* magazine sends the survey to state officials and follows up the collected data with phone calls, e-mails, and letters to obtain as complete and accurate information on each participating state as possible. The survey collects data on MSW disposal practices in the United States, including information on national recycling rates, number of municipal solid waste landfills, and disposal rates.

Other information on landfill definitions, landfill dynamics, landfill regulations, and chemical compounds contained in emissions were derived from several sources within the EPA.

Landfill fire statistics presented here are based on data from the National Fire Incident Reporting System (NFIRS). NFIRS, established in 1975, is a data system maintained by USFA and today is the largest fire data set in the world. Not all fire departments participate in NFIRS, but the distribution of participants in NFIRS is reasonably representative of the entire nation, even though the sample is not random. Since the data set is incomplete and represents only a sample of American fire departments (<40 percent), many of the numbers in this analysis are national estimates or percentages rather than raw totals or absolute numbers.

Technical information on the characteristics of landfill fires was gathered from sources ranging from the textbook *The Essentials of Firefighting*[2] to various international studies on landfill fires.

Interviews were conducted with fire department representatives who have dealt with landfill fires. Examples of these fires are included in the report, along with lessons learned by the departments in suppressing the fires. Media reports (newspapers, magazines) provided further information about those fires discussed during the interviews.

WHY STUDY LANDFILL FIRES?

Landfills tend to be controversial in and of themselves. Homeowners and business owners may not be inclined to support new siting or development in their areas due to perceived notions about noxious fumes, health effects, and adverse influences on property values. As such, landfill fires can raise political issues and have implications for elected officials on election day. Further, the costs associated with fire suppression and environmental monitoring during a landfill fire can be enormous. This raises questions as to who is responsible for those costs—the municipal jurisdiction, a private company that operates the landfill, a combination of both, or some other entity.

Although relatively uncommon, fires in landfills generally receive substantial media attention. In some cases, landfill fires can smolder for weeks, producing odorous and noxious smoke that can be a community annoyance and that pose a health risk to civilians, firefighters, and others who are exposed.

Depending on the type of landfill and its contents, the smoke from a landfill fire may contain dangerous chemical compounds, which can cause respiratory disorders and other medical conditions. Even if the smoke is benign, it can still aggravate existing respiratory conditions and reduce visibility around the landfill. In addition, contrary to conventional thinking, the use of large amounts of water to suppress a landfill fire can actually make the fire worse by increasing the rate of aerobic decomposition, which increases the heat available inside the landfill. Further, runoff from suppression efforts can overwhelm a landfill's leachate collection system and contaminate ground or surface water sources.

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[2] *Essentials of Firefighting 4th Edition*, International Fire Service Training Association, 2001.

Landfill fires are particularly challenging to the fire service. A large landfill fire will generally require numerous personnel and significant amounts of time to contain. Both of these circumstances can strain a jurisdiction, particularly one dependent on volunteer staffing. Depending on the type and location of the fire, extinguishing it may require specialized personnel and equipment that may not be immediately available. For example, fires involving hazardous materials require specially trained personnel who are equipped with specialized protective gear. Underground fires generally necessitate the use of heavy equipment (bulldozers, excavators, etc.) to dig out burning waste to be extinguished. Fire may also compromise the structural integrity of a landfill, posing a collapse hazard for personnel operating on the fireground.

Because these fires are relatively uncommon, it is important for communities and the fire service to learn as much as possible from past experience to prevent and mitigate future landfill fires and, if one occurs, to understand the best methods for extinguishing it.

CHARACTERISTICS OF LANDFILLS

Landfills have a variety of unique characteristics, which are primarily determined by the type of waste they are designed to accept. Landfills are regulated by different agencies at the federal, state, and local levels. (Regulatory mechanisms are discussed in detail later in this report.)

The characteristics of landfills constructed before 1984, however, may not conform to those discussed in this section. Prior to 1984, no federal agency had the jurisdiction to regulate landfills. Although some state-based agencies may have had regulatory authority before then, older landfill sites may have accepted both hazardous and nonhazardous waste if they were in operation prior to federal or state regulation. Further, older facilities may not have been constructed with leachate collection systems, gas-monitoring systems, or composite liners that meet the specifications required today.

MUNICIPAL SOLID WASTE LANDFILL. The most common type of landfill is designed for the disposal of municipal solid waste. MSW includes household waste such as product packaging, food scraps, furniture, clothing, and grass clippings. In 1999 alone, Americans generated nearly 230 million tons of MSW.[3] Table 1 illustrates the components of the MSW produced in 1999 by material category. Only 57 percent of this waste, however, went to a landfill for disposal; the remainder was either recovered through recycling (28 percent) or incinerated (15 percent).[4]

The Code of Federal Regulations (CFR) defines an MSW landfill (MSWLF) as "a discrete area of land or an excavation site that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile…MSWLF unit may also receive other types of RCRA [Resource Conservation and Recovery Act] Subtitle D wastes, such

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[3] U.S. Code of Federal Regulations, 40 CFR 258.2 (Title 40–Protection of Environment Chapter I–Environmental Protection Agency. Part 258 – Criteria For Municipal Solid Waste Landfills).

[4] *Municipal Solid Waste Basic Facts*, Environmental Protection Agency, Office of Solid Waste, January 4, 2002. http://www.epa.gov/epaoswer/non-hw/muncpl/facts.htm.

Table 1. Components of MSW Produced in 1999 (prior to recycling)[5]

Component	Percent of Waste
Paper	38.1
Yard Waste	12.1
Food Waste	10.9
Plastics	10.5
Metals	7.8
Rubber, Leather and Textiles	6.6
Glass	5.5
Wood	5.3
Other	3.2

as commercial solid waste, nonhazardous sludge, conditionally exempt small quantity of generator waste and industrial solid waste. Such a landfill may be publicly or privately owned."[6]

The passage of liquid through the solid waste in a landfill creates leachate. Leachate is defined as "a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste."[7] As such, MSW landfills must operate in a manner that protects the environment, particularly surface and ground waters, from leachate contamination. To do this, MSW landfills generally use a combination of a composite liner and a leachate collection system. A composite liner "combines an upper liner of a synthetic flexible membrane and a lower layer of soil at least 2 feet thick with a hydraulic conductivity of no greater than 1×10^{-7} cm/sec"[8] (Figure 1). A leachate collection system consists of a network of pipes that collect the leachate. The collected leachate is typically pumped to the surface of the landfill so that it can be treated and decontaminated. "The leachate collection system must be designed to keep the depth of the leachate over the liner to no greater than 30 centimeters."[9]

While an MSW landfill is in operation, waste is disposed of in layers. These layers are compacted to the smallest practical volume and covered with earthen material at the end of each operating day, except at facilities exempt from cover placement or that use an alternate daily cover such as a tarp.

When a landfill reaches its capacity for waste disposal, a final cover is constructed. The final cover must be designed and constructed to minimize the flow of water into the closed landfill. It must also contain an erosion layer to prevent the disintegration of the cover. This layer must be composed of a minimum of 6 inches of earthen material capable of sustaining plant

[5] *Municipal Solid Waste in the United States: 1999 Facts and Figures,* Environmental Protection Agency.
[6] U.S. Code of Federal Regulations, 40 CFR 258.2 , op. cit.
[7] Ibid.
[8] *Criteria for Solid Waste Disposal Facilities: A Guide for Owners/Operators,* Environmental Protection Agency, EPA/530-SW-91-089, March 1993.
[9] Ibid.

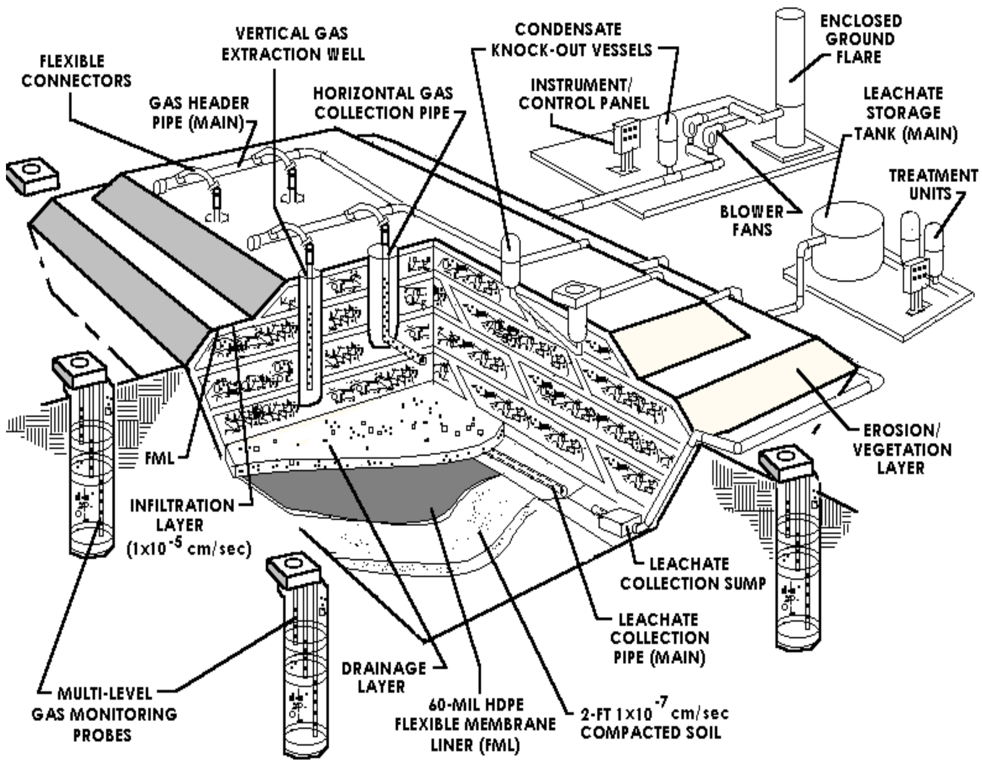

Figure 1. Landfill Components[10]

growth. An independent engineer must certify that the landfill was closed in accordance with federal regulations. For the next 30 years, landfill owners or operators are required to maintain the integrity of the final cover, monitor groundwater and methane gas, and continue leachate management. Finally, the property deed must reflect the property's prior use as a landfill, which restricts the future development of the site.[11]

OTHER TYPES OF LANDFILLS*.* Some types of waste (e.g., industrial waste and hazardous waste) cannot necessarily be disposed of in an MSW landfill. Instead, these materials must be disposed of in specially designed landfills or in MSW landfills in limited quantities.

Construction and Demolition. Waste from construction and demolition (C&D) projects, including untreated lumber, drywall, plaster, plumbing materials, etc., is not considered MSW. These wastes can be deposited either in MSW landfills or in specially constructed C&D landfills that are required to meet less stringent regulations than MSW landfills. Based on anecdotal remarks by landfill fire suppression professionals, C&D landfills are at a much higher risk for a significant fire than other types of landfills.[12]

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[10] Courtesy of the California Integrated Waste Management Board.
[11] *Criteria for Solid Waste Disposal Faciliities,* op. cit.
[12] From information received in e-mail correspondence with Dr. Tony Sperling, P.Eng.

Industrial. Each year, about 7.6 billion tons of industrial waste are generated and managed by manufacturing facilities. The majority of this waste is wastewater or non-wastewater sludges and solids. Nearly 97 percent is wastewater managed in surface impoundments; the remainder is managed in landfills, waste piles, and land application units.[13] Industrial waste is classified as neither MSW nor hazardous waste under RCRA Subtitle C, which places industrial landfills under the regulatory authority of states and local government, not the federal authorities.

Hazardous Materials. In 1999, 1.4 million tons of hazardous waste were disposed of in landfills.[14] Hazardous waste landfills are similar in character and design to MSW landfills, but they are required to meet more stringent regulations for leachate collection and decontamination.

LANDFILL EMISSIONS. Landfill emissions are the result of the decomposition of organic materials in the landfill (including yard waste, household waste, food waste, and paper). Because of the nature of the construction of landfills, this decomposition is anaerobic[15] and results in the production of large quantities of methane (which is highly flammable) and carbon dioxide. In fact, landfills are the largest source of methane emissions in the United States, accounting for 35 percent of methane emissions in 1999.[16] MSW landfills generate about 93 percent of U.S. landfill emissions; industrial landfills account for the remaining emissions.[17] Methane emissions from landfills are affected by site-specific factors such as waste composition, available moisture, and landfill size.[18] Approximately 28 percent of the methane generated in landfills in 1999 was recovered.[19] The remainder of landfill-generated methane was dispersed in the air.

Approximately 50 percent of gas emitted from landfills is methane; carbon dioxide accounts for about 45 percent, and the remainder is composed of nitrogen, oxygen, hydrogen, and other gases.[20] Both methane and carbon dioxide are greenhouse gases that pose environmental problems. Of the two gases, methane is far more potent than carbon dioxide. Methane has a global warming potential (GWP)[21] of 21 over a 100-year period. This means that on a kilogram-for-kilogram basis, over a 100-year period, methane is 21 times more potent than carbon dioxide in causing climate change.[22]

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13 *Guide for Industrial Waste Management*, Environmental Protection Agency, EPA530-R-99-001, June 1999.

14 *National Biennial RCRA Hazardous Waste Report*, Environmental Protection Agency, EPA530-S-01-001, June 2001, p. ES-8.

15 An *anaerobe* is an organism, such as a bacterium, that can live in the absence of atmospheric oxygen. Conversely, an *aerobe* is an organism that requires oxygen to live.

16 *Inventory of U.S. Greenhouse Gas Emissions and Sinks,* Environmental Protection Agency, EPA 236-R-01-001, April 2001, p. ES-19.

17 U.S. Methane Emissions 1990-2000: Inventories, Projections, and Opportunities for Reductions, Environmental Protection Agency, EPA 430-R-99-013, September 1999 , p. 2-1.

18 Inventory of U.S. Greenhouse Gas Emissions and Sinks, op. cit.

19 Ibid.

20 *Landfill Methane Outreach Program*, Environmental Protection Agency, FAQ Sheet, June 2001.

21 The term *global warming potential* has been developed by the EPA to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas. This measurement of GWP relies on carbon dioxide as the reference gas. The GWP of a greenhouse gas is the ratio of global warming (both direct and indirect) from one unit mass of a greenhouse gas to one unit mass of carbon dioxide over a set period of time.

22 Climate Change, Methane and Other Greenhouse Gases, Environmental Protection Agency, July 2001.

Current EPA regulations under the Clean Air Act and the New Source Performance Standards and Emissions Guidelines specify that many landfills must collect and combust landfill gas (regulated by size of the landfill). To comply with these regulations, landfill owners can either burn the gas off by flaring[23] it or capture the gas by installing a "landfill gas-to-energy" system. (This is discussed in detail later in this report.)

In addition to regulations governing the emission of landfill gases, federal law also regulates the incineration or open burning of waste. Federal law specifically prohibited open burning of MSW at municipal landfills in 1979 (40 CFR 257).[24] The incineration of MSW is strictly regulated by a variety of federal, state, and local policies.

NUMBER OF LANDFILLS. The amount of MSW produced in the United States has risen substantially over the past 50 years, from 88.1 million tons in 1960 to 230 million tons in 1999.[25] On the other hand, the number of landfills has significantly decreased over the last 10 years, from about 8,000 in 1988 to about 2,200 in 1999.[26] Figure 2 shows the decline over the past 14 years; Figure 3 and Table 2 show the number of landfills per state. This decrease in the number of landfills is generally due to stricter regulations imposed by the EPA regarding landfill gas emissions, safety regulations, and content regulations of a landfill. Over the same period, the size of the remaining landfills has grown steadily to accommodate the increased production of MSW.

The number of landfills recorded by the EPA, however, does not take into account all of the individual, and in many cases illegal, dumping sites that were common in the early 1980s. Many businesses, factories, and enterprises had their own dumping sites where they disposed of various types of unregulated wastes. This was a widespread practice before environmental groups began lobbying against such sites and publicizing links between diseases such as cancer and the dumping of hazardous chemicals and toxic wastes that were contaminating water, soil, and air.

THE DEVELOPMENT OF LANDFILL REGULATION.[27] The EPA was established in 1970 after scientists, elected officials, and citizens recognized the need to protect the environment. The new agency was pieced together from programs elsewhere in the federal government, including from the Department of Health, Department of the Interior, and Food and Drug Administration. It was not until 1984 that the EPA gained regulatory authority over landfills. Over the intervening years, various legislative acts have strengthened the EPA's regulatory authority over these sites.

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA), which gave the EPA the authority to control hazardous waste from the "cradle-to-grave." RCRA covers the generation, transportation, treatment, storage, and disposal of hazardous waste and provides a

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23 In this context, *flaring* is the controlled burning of methane collected from a landfill.

24 "Volume III–Area Sources, Chapter 16, Open Burning," R*evised Final: Emission Inventory Improvement Program Document Series,* Environmental Protection Agency, Section 2.1, January 2001.

25 *Municipal Solid Waste in 1999: Facts and Figures,* Environmental Protection Agency. Some EPA sources quote this numbers as being closer to 2,300.

26 *Environmental Fact Sheet, Municipal Solid Waste Generation,* Environmental Protection Agency, 1998.

27 Information on federal regulations was taken from the EPA website, Major Environmental Laws. http://www.epa.gov/epahome/laws.htm.

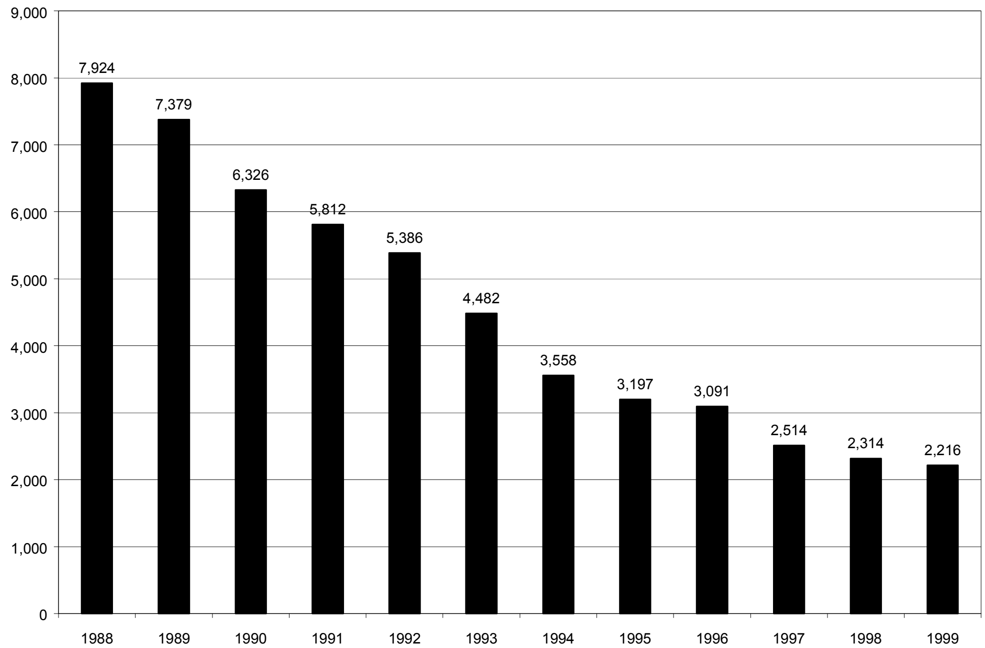

Figure 2. MSW Landfills in the United States, by Year[28]

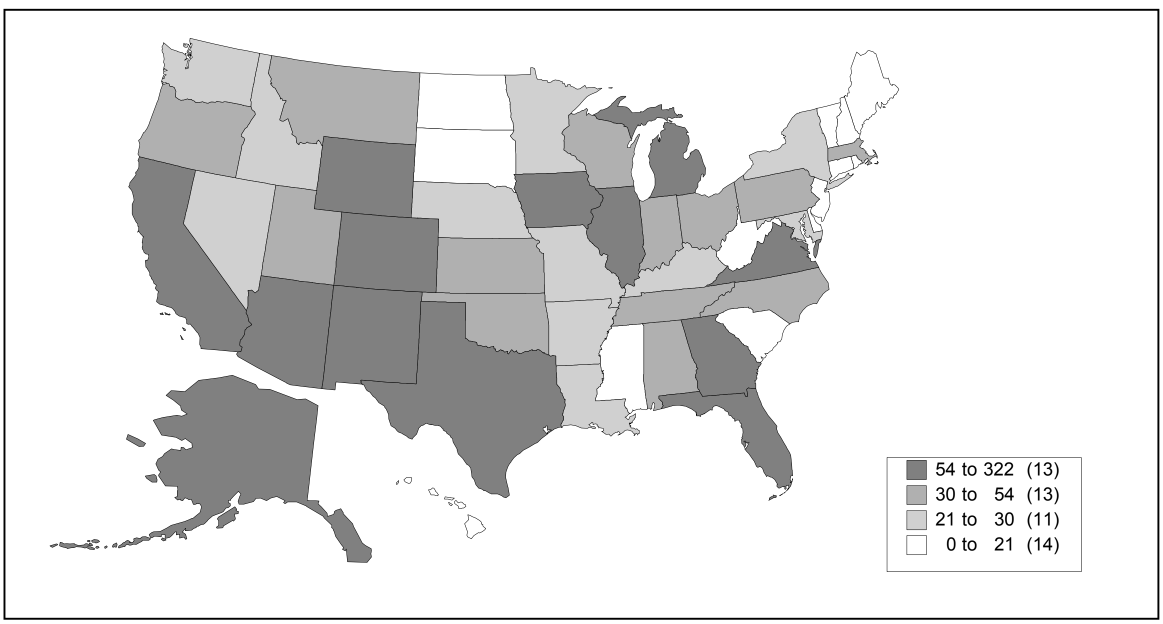

Figure 3. Distribution of Landfills[29]

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28 *Municipal Solid Waste in 1999*, op. cit., p. 15.
29 *BioCycle,* June 1999.

Table 2. Landfills by State[30]

State	Landfills	State	Landfills	State	Landfills
Alabama	30	Kentucky	26	New York	28
Alaska	322	Louisiana	25	Ohio	52
Arizona	54	Maine	8	Oklahoma	41
Arkansas	23	Maryland	22	Oregon	33
California	188	Massachusetts	47	Pennsylvania	51
Colorado	68	Michigan	58	Rhode Island	4
Connecticut	3	Minnesota	26	South Carolina	19
Delaware	3	Mississippi	19	South Dakota	15
District of Columbia	0	Missouri	26	Tennessee	34
Florida	95	Montana	33	Texas	181
Georgia	76	North Carolina	35	Utah	45
Hawaii	8	North Dakota	15	Vermont	5
Idaho	27	Nebraska	23	Virginia	70
Illinois	56	Nevada	25	Washington	21
Indiana	45	New Hampshire	19	West Virginia	19
Iowa	60	New Jersey	11	Wisconsin	46
Kansas	53	New Mexico	55	Wyoming	66

framework for the management of nonhazardous wastes. RCRA focuses only on active and future facilities.

The turning point in landfill regulation and remediation occurred in 1980, first with the Superfund legislation, then by the Hazardous and Solid Waste Amendments (HSWA) in 1984, which finally gave the EPA regulatory authority over landfills.

Technically known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Superfund legislation governs closed and abandoned hazardous material waste sites, provides for the liability of persons responsible for the release of hazardous materials at these sites, and establishes a trust fund to provide for cleanup where no responsible party could be identified.

In 1984, the HSWA amended RCRA. HSWA required the phasing out of land-based disposal of hazardous waste and gave the EPA regulatory authority over landfills. The final major piece of legislation, the Superfund Amendments and Reauthorization Act (SARA), was passed in 1986 as an amendment to CERCLA. SARA increased the participation of states in the Superfund program and expanded the size of the cleanup trust fund.

In recent years, federal, state, local, and private programs have increased the emphasis placed on reducing the production of municipal waste to conserve resources and reduce pollution while delaying the entry of waste into the waste collection and disposal system. “Source

[30] Ibid.

reduction" focuses on designing, manufacturing, purchasing, or using materials in ways that reduce the amount or toxicity of trash created.

Some such programs include "pay-as-you-throw," where residents pay for each can or bag of trash they have collected for disposal rather than funding this collection by a flat rate or through the tax base. This provides tangible financial benefits for households that reduce the amount of waste they produce. Other programs target businesses and corporations in an effort to promote waste-reducing manufacturing processes and business practices.[31] The benefits of these practices include a reduction of the combustible material that enters the waste stream. Although MSW facilities will still contain large amounts of combustible materials, this reduction in waste can be a factor in the reduction of landfill fires.

CHARACTERISTICS OF LANDFILL FIRES[32]

Landfill fires fall into one of two categories, surface and underground fires. Depending on the type of landfill and type of fire, landfill fires can pose unique challenges to the landfill/ waste management industry and the fire service. This section addresses the particular challenges and the specific types of fires found in landfill sites and describes their characteristics and causes.

SURFACE FIRES. Surface fires involve recently buried or uncompacted refuse, situated on or close to the landfill surface in the aerobic decomposition layer, generally 1 to 4 feet in depth.[33] These fires can be intensified by landfill gas (methane), which may cause the fire to spread throughout the landfill.

Surface fires generally burn at relatively low temperatures and are characterized by the emission of dense white smoke and the products of incomplete combustion. The smoke includes irritating agents, such as organic acids and other compounds. When surface fires burn materials such as tires or plastics, the temperature in the burning zone can be quite high. Higher temperature fires can cause the breakdown of volatile compounds, which emit dense black smoke. Surface fires are classified as either accidental or deliberate.

Surface fires include the following:

- *Dumping of undetected smoldering materials into the landfill.* Hot load fires are caused by the disposal of refuse that is still burning on arrival to the landfill (e.g., cleared brush).
- *Fires associated with landfill gas control or venting systems.* Landfill gas control systems can themselves pose a fire hazard. Landfill gas (predominantly methane) can be

[31] "Source Reduction and Reuse," Environmental Protection Agency, April 23, 2002. http://www.epa.gov/epaoswer/non-hw/muncpl/sourcred.htm.
[32] Much of this section represents a synopsis of a report prepared for the New Zealand Ministry of the Environment. The report, *Landfill Guidelines: Hazards of Burning at Landfills*, was published in December 1997.
[33] E-mail correspondence with Todd Thalhamer, California Integrated Waste Management Board.

ignited as it escapes from the vents or from leaks in the collection pipe network. Excessive gas extraction can also be a fire cause. The vacuum created by excessive extraction can increase the airflow and thereby increase the oxygen level in the landfill, which can cause underground fires (as discussed further in the following section).

- *Fires caused by human error on the part of the landfill operators or users.* Landfill operators and users can cause fires through careless smoking on the landfill, which can ignite waste or landfill gas. Also, as some hazardous substances can ignite when mixed, operators must take care to prevent the dumping of reactive materials into the landfill.

- *Fires caused by construction or maintenance work*. Fires can occur while construction and maintenance takes place, including fires caused by sparks from vehicles used in the landfill (dump trucks, bulldozers, backhoes, etc.). A surface fire could also be ignited when drilling or while driving metal pipes through layers of buried waste if a hard object buried in the landfill is struck. Usage of welding or electrical equipment on site poses a fire hazard, due especially to the increased presence of methane gas.

- *Spontaneous combustion of materials in the landfill*. The mixing of certain materials in a landfill can result in spontaneous combustion. Even in small quantities, some chemicals can ignite if exposed to one another. Also, some materials, such as oily rags, can spontaneously combust under certain conditions. Spontaneous combustion can also result from bacterial decomposition, which is discussed in more detail later in this section.

- *Deliberate fires, which are used by the landfill operator to reduce the volume of waste*. Landfills contain refuse such as dry garden waste, grass, leaves, and branches. Sometimes these materials are deliberately set on fire to reduce refuse volumes, reduce operating costs, and increase a landfill's operating life. This is an accepted practice under strictly controlled conditions.[34] Uncontrolled, these deliberate fires could escalate into larger fires, cause explosions, or create hazardous products from the ash and residue burned.

- *Deliberate arson fires, which are set with malicious intent*. Arson is a serious problem in the United States; therefore, it is not surprising that landfills are targets for malicious fires.

UNDERGROUND FIRES. Underground fires in landfills occur deep below the landfill surface and involve materials that are months or years old.[35] These fires are generally more difficult to extinguish than surface fires. Underground fires also have the potential to create large

[34] This controlled combustion at landfills is regulated by U.S. Code of Federal Regulations, 40 CFR 60 (Title 40 – Protection of Environment Chapter I – Environmental Protection Agency. Part 60 – Standards Of Performance For New Stationary Sources).

[35] This report addresses operating landfills. Closed landfills are subject to a variety of restrictions on future development, maintenance, etc. It would be difficult to determine the frequency of fires in closed landfills because such sites are likely to be coded in NFIRS according to their property use at the time of the fire (e.g., open land, park, golf course).

voids in the landfill, which can cause cave-ins of the landfill surface. Further, they produce flammable and toxic gases (such as carbon monoxide) and can damage leachate containment liners and landfill gas collection systems.

The most common cause of underground landfill fires is an increase in the oxygen content of the landfill, which increases bacterial activity and raises temperatures (aerobic decomposition). These so-called “hot spots” can come into contact with pockets of methane gas and result in a fire. Of particular concern with these long-smoldering, underground fires is the fact they tend to smolder for weeks to months at a time. This can cause a build up of the byproducts of combustion in confined areas such as landfill site buildings or surrounding homes, which adds an additional health hazard.

Underground fires are often only detected by smoke emanating from some part of the landfill site or by the presence of carbon monoxide (CO) in landfill gas. In the event of an underground fire, CO may be present at toxic levels near the landfill’s surface. Generally an underground fire can be confirmed by:[36]

- Substantial settlement over a short period of time.
- Smoke or smoldering odor emanating from the gas extraction system or landfill.
- Elevated levels of CO in excess of 1,000 parts per million (ppm).
- Combustion residue in extraction wells or headers.
- Increase in gas temperature in the extraction system (above 140°F).
- Temperatures in excess of 170°F.

To confirm a subsurface fire using CO, the results must be acquired through quantitative laboratory analysis (using portable monitors may result in artificially high concentrations). In California, levels of CO in excess of 1,000 ppm are considered a positive indication of an active underground landfill fire. Levels of CO between 100 and 1,000 ppm are viewed as suspicious and require further air and temperature monitoring. Levels between 10 and 100 ppm may be an indication of a fire but active combustion is not present.[37]

HEALTH EFFECTS OF LANDFILL FIRES. In addition to the burn and explosion hazards posed by landfill fires, smoke and other byproducts of landfill fires also present a health risk to firefighters and others exposed to them. Smoke from landfill fires generally contains particulate matter (the products of incomplete combustion of the fuel source), which can aggravate pre-existing pulmonary conditions or cause respiratory distress. As with all fires, those in landfills produce toxic smoke and gases. The danger and level of toxicity of these gases depend on the length of exposure one has to them and on the type of material that is burning.

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[36] *Response to Landfill Fires Guidance Document*, California Integrated Waste Management Board, Internal Bulletin 2001.
[37] Ibid.

Underground fires can result in CO levels in excess of 50,000 ppm—the Occupational Safety and Health Administration (OSHA) permissible exposure limit for CO is 50 ppm. OSHA standards prohibit worker exposure to more than 50 parts of the gas per million parts of air averaged during an 8-hour time period. Carbon monoxide is harmful when breathed because it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen, which can cause permanent damage or death.[38]

Another serious concern in landfill fires is the emission of dioxins. Accidental fires at landfills and the uncontrolled burning of residential waste are considered the largest sources of dioxin emissions in the United States.[39] The term *dioxins* refers to a group of chemical compounds with similar chemical and biological characteristics that are released into the air during the combustion process. Dioxins are also naturally occurring and are present throughout the environment. However, exposure to high levels of dioxins has been linked to cancer, liver damage, skin rashes, and reproductive and developmental disorders.[40]

EXTINGUISHING LANDFILL FIRES

This section is not intended to address or recommend specific tactical approaches for landfill firefighting. It is important to note that the different dynamics, characteristics, and regulations of landfills and the fires that occur in them suggest that tactics need to be determined on a case-by-case basis depending on the materials buried, which materials have ignited, depth of the fire, and the fire's ignition source. This section explores some of the challenges posed in the suppression of landfill fires.

WIND/WEATHER. Wind and inclement weather can increase the health hazards for firefighters operating on the fireground (e.g., in extremely hot or cold weather) and can directly affect fire spread.

WATER SUPPLY. The use of water to suppress landfill fires is controversial. The application of large volumes of water may actually exacerbate a fire by contributing to the process of aerobic decomposition. Further, adding water to the landfill creates additional leachate, which may overwhelm the leachate collection system in the landfill (if one exists). If the collection system is overwhelmed, the additional leachate could contaminate ground and surface waters surrounding the landfill. Depending on the landfill's location, there might not be an adequate supply of water available for fire suppression. Firefighters may have to establish a water supply using tankers and nearby static water sources (e.g., lakes, reservoirs).

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[38] *OSHA Fact Sheet, Carbon Monoxide Poisoning*, U.S. Department of Labor, Occupational Safety and Health Administration, 2002. http://www.osha.gov/OshDoc/data_General_Facts/carbonmonoxide-factsheet.pdf

[39] *Questions and Answers About Dioxins*, Environmental Protection Agency, July 2000, p. 6. http://www.epa.gov/ncea/pdfs/dioxin/dioxin%20questions%20and%20answers.pdf.

[40] Idem, p. 4.

Foam is an important consideration in landfill fire suppression. There are two primary types of firefighting foam. Class A foam is a special formulation of hydrocarbon surfactants. These surfactants reduce the surface tension of water, which provides for better water penetration and increased effectiveness. When aerated, Class A foam coats and insulates fuels, protecting them from ignition. Class B foam is used to extinguish fires involving flammable and combustible liquids. It is also used to suppress vapors from unignited spills of these liquids.[41] As with all fires, there are advantages and disadvantages to using foam during fire suppression operations on landfills. The on-scene incident commander makes the decision to use foam based on the specific tactical situation at hand.

MULTI-AGENCY RESPONSE. A major landfill fire will likely require the expertise of personnel from multiple agencies (e.g., the EPA, Department of Natural Resources). Some fire departments have Standard Operating Procedures in place that define all landfill fires as hazardous materials incidents, which require a specialized response. To ensure that all personnel (regardless of their agency affiliation) are operating according to the same plan, landfill fires require a strong Incident Command System.

PERSONNEL SAFETY. Fires, particularly those underground, can undermine the integrity of the landfill, which could cause a collapse under the weight of landfill employees, firefighters, or equipment. Such a collapse could necessitate a confined space, trench, or other type of technical rescue operation in addition to fire suppression.

Given the potential adverse effects of exposure to burning landfill contents or the smoke produced by a landfill fire, personnel may have to use specialized personal protective equipment, which may be difficult to obtain.

ACCESS TO AND MANEUVERABILITY OF HEAVY EQUIPMENT. To access waste below the landfill surface or move burning waste away from the landfill, it may be necessary to use heavy equipment such as bulldozers. Landfill operators may already own this equipment and have staff trained in its use. If not, this equipment will need to be located and brought to the fireground. If a fire affects the structural stability of a landfill, operating heavy equipment on the landfill surface would be dangerous. Finally, depending on the landfill's location and design, operating heavy equipment on the site could be quite difficult.

LOGISTICS. As with any protracted fire suppression operation, Incident Commanders at landfill fires must address a variety of logistical concerns to facilitate operations. These include rotating personnel on a regular basis, compensating personnel for overtime spent operating at the landfill or filling in at fire stations in the jurisdiction, keeping firefighters on the landfill hydrated and fed, and, keeping records for future reimbursement. (Depending on the nature and location of the incident, local fire departments can seek reimbursement from the federal government or the landfill operator for costs associated with fire suppression.)

ENVIRONMENTAL IMPACT. The smoke and runoff from landfill fires can be dangerous to those living in the area and to the environment. It is important that air and water quality issues

[41] *Essentials of Firefighting 4th Edition*, International Fire Service Training Association, 2001, p. 500.

be addressed early in a fire suppression operation to prevent contamination as much as possible. As mentioned earlier, water used to suppress a landfill fire can overwhelm a facility's leachate collection system, if one exists (older facilities may have been constructed prior to regulations requiring leachate collection systems).

LANDFILL CONTENTS. Fires occurring in landfills where hazardous wastes are buried can be particularly difficult. In past years, illegal dumping of hazardous and toxic materials in landfills and other dumping sites was relatively common. When a fire occurs and rescue workers have wrong or misleading information about the buried contents (e.g., illegal or unknown toxic or radioactive wastes), the fire suppression operation can be extremely dangerous.

Although not a landfill fire, the Wade Dump fire in February 1978 clearly illustrates the dangers posed by fires involving unknown hazardous materials. Firefighters responded to a suspected tire fire at an abandoned rubber shredding plant on the Delaware River outside of Philadelphia. They were unaware that the property's owner and namesake, Melvin Wade, had transformed the plant into one of the most toxic hazardous waste dumpsites in U.S. history. By the night of the fire, more than 3 million gallons of cyanide, benzene, toluene, and other chemicals were stored on the site—plus thousands of junk tires. The burning chemicals produced multicolored smoke and noxious fumes, which alerted firefighters to the unusual nature of the fire they were fighting. Intensified by chemicals and other fuels, the fire raged for hours. Drums of chemicals exploded, injuring firefighters and even damaging fire trucks. As the night progressed, firefighters and other emergency workers noticed that the chemicals were dissolving their protective gear and making it difficult for them to breathe; more than 40 firefighters were sent to a nearby hospital for treatment. Over the past 20 or more years, dozens of those who were present at the Wade Dump fire have become ill, and many have died from cancers and other diseases. Melvin Wade and others responsible for creating the toxic site were found criminally responsible for their actions.[42]

LANDFILL FIRES: STATISTICAL ANALYSIS

Data from the National Fire Incident Reporting System (NFIRS) does not include MSW landfills as a fixed property use category. Rather, the NFIRS data set includes a category for "dump or sanitary landfill: included are refuse disposal areas, trash receptacles, and dumps in open ground" (NFIRS Fixed Property Use code 932). Although this definition is broader than the definition of a landfill, it is the closest match available in NFIRS. As such, despite the broader definition, this section refers to these fires as *landfill fires* for the sake of clarity.

Based on extrapolation of the NFIRS data, each year in the United States an average of 8,400 landfill fires are reported to the fire service. This represents less than a half percent of all reported fires. Undoubtedly, some landfill fires go unreported because they burned undetected or they were on private property and extinguished by the landfill operator. Reported fires are responsible for less than 10 civilian injuries, 30 firefighter injuries, and between $3 and

[42] This paragraph is a synopsis of an investigative report published by the *Philadelphia Inquirer* in April 2000.

$8 million in property loss each year.[43] Deaths (civilian or fire service) are rare in these fires; since NFIRS represents a sample of data, it may be that fatalities occurred during the study period and were not reported or captured in the data.

TYPE OF LANDFILL FIRES. Table 3 shows the five types of fires that occur on landfills. The prevalence of refuse fires is not surprising, but it is interesting that other types of fires occur on landfill properties. Vehicle fires involve dump trucks, compactors, and other vehicles commonly found in landfills. Brush fires may occur when landfill fires spread to the surrounding lands. Structure fires at landfill sites probably involve small offices or other facilities constructed for the landfill staff.

Table 3. Types of Fires Occurring on Landfills[44]

Type of Fire	Percent of Fires
Refuse	77
Trees, brush, grass	12
Outside structure, where material burning has value	6
Vehicle	4
Structure	1

CAUSES OF LANDFILL FIRES. Over half of the landfill fires reported to NFIRS have no information available as to the primary ignition factor. This makes it particularly difficult to accurately pinpoint the cause of landfill fires. Of those fires with reported ignition factors, nearly 40 percent are of an incendiary or suspicious nature. Another 20 percent are attributed to lit or smoldering materials that have been abandoned or discarded, which include cigarettes, matches, or ashes that were discarded without being properly extinguished. Spontaneous heating accounts for about 5 percent of landfill fires. Other leading factors influencing fire ignition include rekindling from a previous fire and inadequate control of open fires.

WHEN LANDFILL FIRES OCCUR. Landfill fires occur most often between March and August. This half-year period accounts for nearly 60 percent of landfill fires, with the peak (11 percent) occurring in July (Figure 4). This monthly incidence of fires generally applies to the major causes of landfill fires (incendiary/suspicious and smoldering materials). Rekindled fires and spontaneous ignition fires, however, are exceptions. Rekindled fires have a peak period in April and May that accounts for one-third of these fires with an additional peak in July (15 percent). Landfill fires that result from spontaneous combustion gradually increase as the weather warms, dropping in September. The peak period, however, occurs in October and November, when 22 percent of the spontaneous combustion fires occur. Figure 5 illustrates the incidence of spontaneous combustion fires by month.

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[43] National estimates are based on NFIRS data (1996–1998) and the National Fire Protection Association's (NFPA) annual survey, *Fire Loss in the United States*.

[44] U.S. Fire Administration NFIRS data (1996–1998).

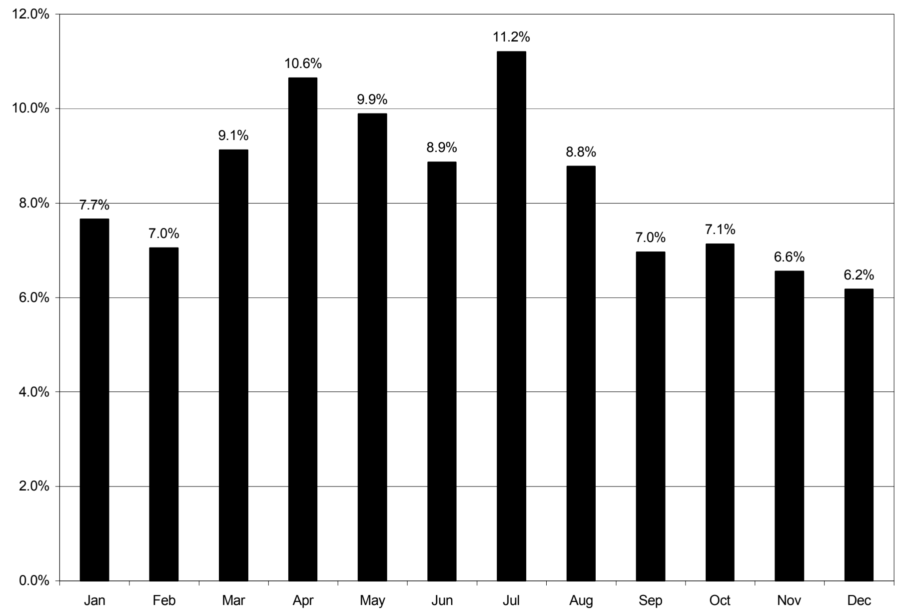

Figure 4. Incidence of Landfill Fires by Month[45]

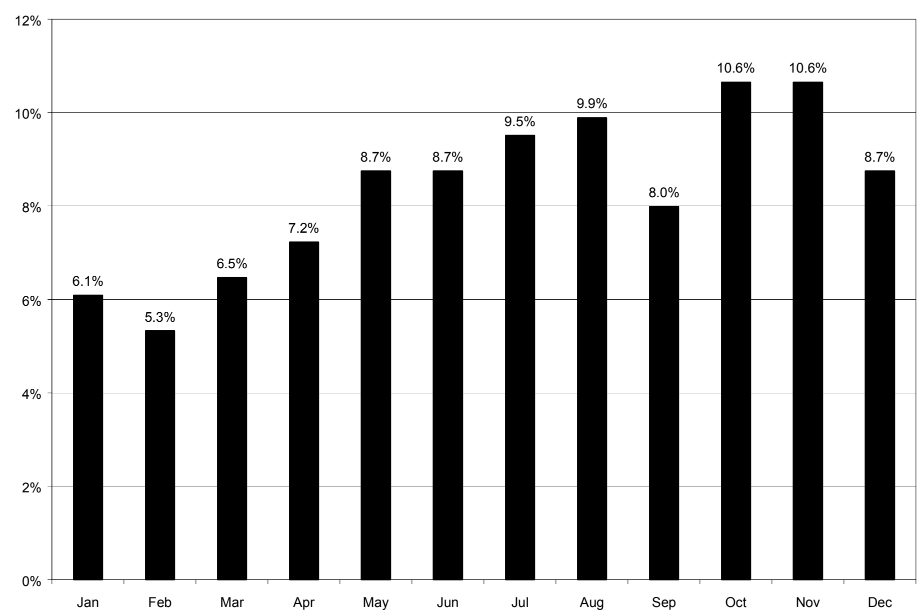

Figure 5. Incidence of Spontaneous Combustion Landfill Fires by Month[46]

45 Ibid.
46 Ibid.

The spring peaks in rekindled fires and the fall peaks in spontaneous combustion fires may result from increased winds during these months as many landfills may have inadequate caps (particularly if they use alternate daily covers) to prevent air infiltration. Inadequate caps can allow large volumes of air to enter the landfill, accelerating the oxidation reaction. The air intrusion is due, in part, to the differential in barometric pressure between the landfill and the atmosphere. This condition occurs most frequently in the late fall and spring with the large, naturally occurring atmospheric changes in conjunction with land surface heating and cooling. The increased oxidation raises the temperature in the landfill and can increase spontaneous combustion events. Some of the rekindled fires may be the result of earlier smoldering underground fires that, with the increase in airflow brought by winds, are oxygenated enough to break through to the surface.[47]

LANDFILL FIRE PREVENTION

Fire prevention can reduce property damage, injury, health, and environmental hazards of landfill fires. The cost of prevention is usually much less expensive than the cost of fighting and cleaning up a fire. In many cases, particularly for larger landfills, fire prevention activities are required by law. This section outlines some of the principal methods in landfill fire prevention.

LANDFILL MANAGEMENT. Effective landfill management is a vital key to efficient landfill fire prevention tactics. Management measures include prohibiting all forms of deliberate burning, thoroughly inspecting and controlling incoming refuse, compacting refuse buried to prevent hot spots from forming, prohibiting smoking onsite, and maintaining good site security.

METHANE GAS DETECTION AND COLLECTION. Landfill gas emissions can be a hazard to the environment and to the health of residents surrounding landfill sites. Methane gas, a flammable gas, can present a fire hazard. Federal regulations require all MSW landfill operators to monitor the emission of methane on a quarterly basis. If methane levels in or around the landfill become explosive, the landfill operator must take immediate steps to mitigate the danger. The operator must also implement a remediation program to prevent future explosive buildups.[48]

Federal regulations currently require MSW landfills that opened after November 8, 1987, and have a capacity of over 2.5 million cubic meters to install a gas collection and control system.[49] These regulations, however, affect only about 4 percent of operating landfills in the United States as the vast majority of landfills do not have such a large capacity.[50] Some states, however, (e.g., California) have stricter regulations for gas collection systems, which affect a higher percentage of facilities; these jurisdictions may include closed facilities as well.

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[47] E-mail correspondence with Dr. Tony Sperling and Todd Thalhamer.

[48] U.S. Code of Federal Regulations, 40 CFR 258.23 (Title 40–Protection of Environment Chapter I–Environmental Protection Agency. Part 258 – Criteria for Municipal Solid Waste Landfills).

[49] U.S. Code of Federal Regulations, 40 CFR 60.33c (Title 40–Protection of Environment Chapter I–Environmental Protection Agency. Part 60 – Standards of Performance for New Stationary Sources).

[50] *Air Rule for Municipal Solid Waste Landfills*, Environmental Protection Agency, January 10, 2002. http://www.epa.gov/reg3artd/airregulations/ap22/landfil2.htm.

Methane gas collection systems actively remove landfill gas using gas recovery wells and vacuum pumps with an interconnected pipe network. Operators must take care to ensure the system is not overdrawn, which can lead to fire ignition. Once the gas is collected, landfill owners/ operators have two choices: (1) burn off the gas (flaring); or (2) convert the gas to an energy commodity.

Flaring. Burning landfill gas is the method most large landfills use (as opposed to the more costly waste-to-energy projects). Burning the landfill gas converts methane to carbon dioxide, which not only is less harmful to the environment, but also destroys the components of landfill gas that cause odor, stress vegetation, create smog, and increase the risk for fire or explosion.

Shallow gas venting trenches or gas venting pipes can also be installed in the landfill's surface. These vents allow gas from interior regions of the landfill to escape naturally to the surface where flares can burn off the gas.

Converting Landfill Gas to Energy. The conversion of landfill gas to energy turns this landfill byproduct into a marketable resource. The converted gas can be used to generate electricity, heat, or steam. According to the EPA, landfill gas is the only renewable energy source that, when used, removes pollution from the atmosphere.[51] By converting the landfill gas to energy, the harmful emissions causing global warming are removed from the air and converted to a useful form such as electricity to power a home. Reducing landfill gas emissions is imperative as it reduces local ozone levels and smog formation while simultaneously decreasing explosion and fire risks and unpleasant odors produced by the landfill.[52]

As of September 2001, the EPA estimates that there were more than 335 landfill gas recovery and utilization projects operating in the United States; another 500 landfills are considered good candidates for future program development.[53]

CASE STUDIES

A sample of landfill fires throughout the world sheds light on the landfill fire problem. Waste disposal practices and the regulation of landfill sites are similar in the comparison countries. Landfill fires have been investigated and studied in more detail in several countries outside the continental United States. The concluding portion of this section contains brief synopses of interviews and media reports detailing landfill fires in the United States and the lessons that were learned from them.

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[51] Landfill Methane Outreach Program, *Frequently Asked Questions*, Environmental Protection Agency, updated June 5, 2001. http://www.epa.gov/lmop/faq.htm.
[52] Ibid.
[53] Landfill Methane Outreach Program, *Current Projects and Candidate Landfills*, Environmental Protection Agency, January 10, 2002. http://www.epa.gov/lmop/projects.htm.

FINLAND.[54] An experimental study that sheds significant light on methods of extinguishing landfill fires was conducted in Finland in 1993. The study was conducted in two parts: a questionnaire was distributed to landfill operators throughout Finland, and an experimental landfill was constructed with similar characteristics to an MSW landfill. To determine the most effective methods for extinguishing landfill fires, an underground fire was ignited and allowed to burn in the experimental landfill. The fire was extinguished by smothering it with soil and dousing it with water.

From the questionnaires, the study determined that most landfill fires are small and tend to be of short duration. It concluded that using soil and water to extinguish the fires was insufficient and that a potentially significant factor in landfill fires is the improper compaction of waste in the landfill. The study suggested that one way to prevent landfill fires is to sufficiently compact all waste buried in the landfill site. Only one-quarter of the fires reported to the study team were underground; those fires were particularly difficult to extinguish and tended to last over 2 months. In fact, for underground fires, it was found that covering the smoldering refuse with layers of soil actually prolonged some fires. Another serious concern raised in the study was that by using water to extinguish landfill fires, the runoff could contaminate the surrounding soil and ground water.

Ultimately, based on both the questionnaire and the experimental landfill, the study concluded that the most effective way to suppress landfill fires is by digging out the burning material and cooling it with water, soil, or snow.[55]

CANADA.[56] In November 1999, a fire ignited at the Delta Shake and Shingle Landfill, a C&D landfill outside Vancouver, British Columbia. Although smoke and steam had been emanating from the landfill for weeks, the fire was finally discovered when flames broke through the landfill surface. The landfill operator originally attempted to extinguish the fire without fire department assistance; his efforts only served to exacerbate the fire. After several weeks, residents began to complain about the smoky haze hovering over Vancouver, and officials were concerned about air and water contamination from the suppression efforts. Ultimately, local officials declared a state of emergency and requested assistance from both the private sector and the provincial government.

To contain the fire and starve it of oxygen, officials covered the burning materials with a thick layer of refuse. Next, they determined that although using high-pressure water worked to extinguish the surface fire, it did not extinguish the burning refuse underground. To increase the water's effectiveness, firefighters misted the water and added Class A foam. Once the fire was contained, the firefighters used heavy machinery to excavate burning materials and move them to

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[54] Ettala et al., "Landfill Fires in Finland," *Waste Management & Research* (1996) 14, pp. 377-384.

[55] Other landfill fire suppression professionals, however, have found that landfill fires can be extinguished by excavating and extinguishing the burning debris layer-by-layer using soil and a suppressant agent, or simply by temporarily shutting down the gas extraction system.

[56] Sources for this section: "Landfill Fire in Delta Gets Provincial Emergency Funding," British Columbia Ministry of Environment, Lands, and Parks. Press Release 330-30:ELP99/00-340, November 30, 1999. Sperling, Tony. *Extinguishing the Delta Shake and Shingle Landfill Fire: Case Study*, Sperling Hansen Associates, January 18, 2002. http://www.landfillfire.com/delta1.html.

areas offsite where they could be fully extinguished. Firefighters used infrared technology to determine which loads were "hot" and required extinguishment and which ones were cool enough to be left alone. After the materials were fully extinguished using foam and water, they were returned to the reconstructed landfill.

A private contractor involved in the suppression effort summarized the following as lessons learned from this fire:

- Soil berms are effective at containing fire spread.
- Trenches that do not fully penetrate the refuse pile are ineffective; trenches should only be excavated if they penetrate the full thickness of the refuse to inert material.

HAWAII. In the late 1990s, fires in legal and illegal landfills were a serious concern for officials on all of the Hawaiian Islands. In July 1996, a fire at an illegal dumpsite in Lualualei, Oahu, attracted government and media attention. The site contained municipal waste, C&D debris, and hazardous materials. After explosions involving gas cylinders or drums, the State Department of Health hired a hazardous waste contractor to remove drums containing chemicals and some hazardous waste. Despite the attention, government officials had difficulty shutting down the dumpsite, as the property changed hands over the years and the cost of cleaning up the site exceeded the land's value.[57]

In January 1998, an odd odor at a C&D landfill in Ma'alaea led to the discovery of an underground fire.[58] Efforts to extinguish the fire with carbon dioxide were unsuccessful and, while the fire was contained, it smoldered for months.

Hawaii has less rigorous air quality standards than other areas of the United States because of its tradewinds, low population density, and isolation. Contractors are allowed to burn brush before depositing it in landfills. This practice decreases the waste volume and amount they are charged for using the landfills. Burned material goes through two inspection sites to check for "hot loads." In the Ma'alaea fire, it appears the ignition source was a smoldering palm tree. Palm trees are spongy inside and, though the outside may have appeared cool, the inside was still simmering. Once inside the landfill, the tree continued to smolder until it ignited surrounding waste.

Although relatively small, the fire sparked a debate involving the landfill operator, EPA, and different divisions of the Department of Health. The debate revealed that there were no regulations on methods to control landfill fires. This motivated government officials to develop guidelines that address underground fires and study the health effects of landfill fires. Also, the fire emphasized the need to thoroughly inspect suspected hot loads to ensure that smoldering materials do not accidentally enter the landfill.

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[57] "State Health Department To Close Illegal Dump in Lualualei," *Environment Hawaii*, Volume 11, Number 3, September 2000.

[58] "Ma'alaea Landfill Sparks State Effort To Develop Guidelines," *Environment Hawaii*, Volume 9, Number 4, October 1998.

OTHER EXAMPLES. The following examples were taken from media reports and interviews with fire officials in the affected jurisdictions. These examples shed light on firefighting tactics and local concerns associated with landfill fires.

Fairfax County, Virginia.[59] Fairfax County Fire Station 19 (Lorton) has two landfills within its call range. In November 2000, a fire broke out at the I-95 Landfill, near Lorton, VA. A 250-foot by 50-foot pile of debris, consisting of trees, stumps, and mulch, was ignited. Firefighters used water and foam to control and extinguish the fire. A fire technician who participated in the suppression effort stated that the most important tactic used in the fire was having firefighters and machinery overhaul the burning or smoldering areas to ensure that the fire did not rekindle.

Cumberland County, North Carolina.[60] In July 1998, flames at a landfill sent plumes of smoke over a large area. Firefighters were forced to contain the fire and let it burn since it was too hot for water to extinguish it effectively. An estimated 26 trailer loads of mulch were in the landfill. The mulch was very finely packed, the heat remained at the core, and water would not have cooled or extinguished the fire. Firefighters assured the fire did not spread to nearby tire piles by digging a ditch all around the fire, containing it. The fire burned itself out after several weeks.

Montezuma County Landfill, Colorado.[61] In June 2001, smoke from this 6-acre fire spread high over the Montezuma Valley. The 320-acre landfill was filled with compressed, baled trash and municipal and industrial waste.[62] Attempts were made to douse the fire with water, but they were ineffective. State landfill officials and other experts decided the best way to attack the blaze was to remove the smoldering bales of refuse, break them apart, and extinguish them individually. The cause of the fire was not determined. Landfill officials reported that confining the fire and smothering it proved to be the most effective method of extinguishing it.

Danbury, Connecticut.[63] In 1996 and 1997, numerous underground landfill fires occurred at the Danbury city landfill. These fires were caused by spontaneous combustion of decomposing waste and were rekindled and continued smoldering underground over 18 months. Different underground "hotspots" increased the intensity of landfill odors. These fires in the 47-acre landfill were the subject of extensive media coverage and residential complaints. As elsewhere, water was ineffective in extinguishing these fires, and its use added to the stench, causing additional citizen complaints. Residents filed lawsuits for damages caused by exposure to hydrogen sulfide gas from the smoke. As a result of the lawsuits, the landfill was forced to close. A 40-foot high permanent flare had to be installed to burn off landfill gas and reduce the odors.

Bend, Oregon.[64] A youth fell into a burning sinkhole on the site of an old landfill and suffered third-degree burns across 30 percent of his body. The youth and his friend had noticed a thin trail of smoke coming from the ground while walking home and went to investigate. There

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[59] Telephone interview with David Sweedland, Technician, Fairfax County Station 19, and *I-95 Landfill Debris Fire*, Fairfax County Fire and Rescue Department News Release, November 7, 2000.

[60] *Landfill Fire Continues To Burn,* WRAL 5 Cumberland County News, July 30, 1998.

[61] "Landfill Fire Fills Valley With Smoke," *Cortez Journal,* June 19, 2001.

[62] Telephone interview with Montezuma County Landfill official.

[63] *The News-Times*, Danbury, CT, December 1996–October 1997.

[64] "Youth Slips Into Burning Bend Sinkhole," *The Oregonian,* December 28, 1991.

was a small hole at the surface. While investigating the hole, the ground collapsed around the youth. The sinkhole was on a parcel of park district land on the outskirts of Bend, Oregon. The former landfill was owned by the county, and the land was later given to the park district. The original dump was used for wood waste. The decomposing waste smoldered and ignited through spontaneous combustion. Burned out pockets caused the landfill's earthen cover to weaken and collapse. Most of the problem areas were along the edges of the landfill where the earthen cap was the thinnest. The park district originally planned to put children's baseball fields on an unused portion of the old landfill, but reconsidered after conferring with the local Department of Environmental Quality.

Colerain Township, Ohio.[65] In 1996, the Colerain Township landfill experienced a major landslide that filled a nearby limestone quarry with acres of landfilled waste. The quarry was being excavated to hold additional waste in the landfill site when the landslide occurred. The area that had collapsed was dangerous; garbage was exposed and equipment was buried underneath, which made removal of the waste dangerous. The landfill officials could not move equipment to the site due to enormous voids in the exposed area; they feared bulldozers would be swallowed into the pile.

A series of four fires subsequently ignited, covering a 35-acre area. The first was a small 100-square-yard fire ignited by lightning. The second fire was as a result of combustion of decomposing waste and lasted 7 days covering a 20-acre area. Firefighters used pumped water and heavy equipment to tear down the fire area and then smothered it with dirt. Fifteen to 20 million gallons of water were used in the 7-day period. The last two fires were also a result of spontaneous combustion, but they were smaller in size. Water and heavy equipment were used to extinguish these two fires as well. Ultimately, restoring the landfill took approximately 2 years to complete.

San Bernardino County, California.[66] In 1999, funding was approved for the cleanup of a smoldering fire at an illegal dumpsite in Cajon Pass. The illegal dumpsite had been in operation for about 3 years. At the time of the fire, the dumpsite contained 200,000 cubic yards of waste, which filled an area about 60 feet high and 450 feet long. Most of the waste consisted of rubble, telephone poles, railroad ties, whole trees, shrubs, and large stumps. About 80,000 cubic yards (60,000 tons) were organic wastes, which spontaneously ignited, causing the fire. The smoldering fire posed a significant risk to nearby residences, wildlands, power lines, and railroad tracks, and it threatened serious water contamination. Agencies from the state and local level were involved in the funding effort.

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[65] Telephone interview with Ohio Colerian Township Dept. of Fire and EMS Fire Chief Bruce Smith.

[66] *State Waste Board Approves Funding for Cajon Pass Dump Cleanup,* California Integrated Waste Management Board, May 27, 1999, 99-053. http://www.ciwmb.ca.gov/pressroom/1999/may/nr053.htm.

CONCLUSION

Landfill fires are not common occurrences. When they do occur, however, they tend to attract a great deal of public attention and challenge the fire service. Illegal dumping continues to be a problem for regulatory agencies and the fire service. Illegal sites are particularly hazardous to firefighters, because the firefighters may be unaware of the presence or nature of chemicals or other toxic substances involved in the fire. Landfill fires in regulated facilities also challenge Incident Commanders, who must make a series of tactical decisions in a situation far different from that found at a "normal" structure fire.

Closed landfills are another area of concern, from both a regulatory and a fire service perspective. By federal law, landfill operators must commit to maintaining a landfill for at least 30 years after it has closed. Landfills continue to emit methane and other dangerous gases even after they are closed. As a result, buildings constructed on former landfills are often required to have automatic methane detectors, which sound an audible alarm in the event that methane levels become unsafe. Construction on closed landfills must not damage the final cover or the existing liners and leachate collection system. The true implications of closed landfills are not clear, largely because, for data collection purposes, these sites are likely coded not as landfills but as the property use at the time of an incident (fire, explosion, etc.).

Through EPA regulation and cleanup efforts of landfills, landfill fires are less likely to contain toxic chemicals than they were decades ago. Also, fire departments are gaining the experience to more efficiently and safely extinguish the fires that occur. Working in conjunction with the public and landfill operators, the fire service can reduce the occurrence of landfill fires, thereby better protecting the public, the environment, and emergency responders.

Lightning strike causes huge explosion at Oxford recycling plant

Witnesses report large ‘fireball’ in sky at Severn Trent Green Power facility but no one is thought to have been injured in the blast

Donna Ferguson
Mon 2 Oct 2023 17.33 EDTLast modified on Thu 11 Apr 2024 10.57 EDT

A lightning strike at a recycling plant in Oxford caused a huge gas explosion and local power outages.

Eyewitnesses reported hearing a loud bang and seeing a “fireball” lighting up the sky.

Emergency services are attending the scene, but a representative from Severn Trent Green Power told the PA news agency that no one was injured in the incident.

Video and images shared on social media show a pyramid of flames on the horizon, inside a yellow and orange mushroom-like shape.

Severn Trent Green Power confirmed that biogas from a container had ignited at its Cassington AD Facility, near Oxford airport, at about 7.20pm and it was working with emergency services to secure the site.

The facility processes more than 50,000 tons of solid and liquid waste each year.

Ana Cavey, who lives in Somerton, about 15 miles north of Oxford, told Sky News: “We’ve had the most unbelievable thunder and lightning storm ever … it came out of nowhere and the noise was incredible.”

She said her power had been cut off for most of the evening and has only just come back on.

Another witness told the Oxford Mail they saw a “strange pulsing sky out of our windows”.

Power outages have been reported in Witney, Burford, Chipping Norton and Milton-under-Wychwood, according to the BBC.

Other witnesses reported seeing “orange lightning” and hearing what sounded like a car crash outside their home. “The sky was glowing for about two minutes and then it just disappeared,” one person wrote on social media.

A statement from Thames Valley police said: “Our officers are currently at the scene of a fire at a waste plant near Yarnton, Oxfordshire.

“It is believed that lightning struck gas containers at the site during bad weather this evening, causing a large fire.”

The Met Office had issued a yellow weather warning for thunderstorms in Oxford on Monday evening.

Lightning Propagation Through the Earth and its Potential for Methane Ignitions in Abandoned Areas of Underground Coal Mines

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Abstract. **Strong circumstantial evidence suggests that lightning has initiated methane explosions in abandoned and sealed areas of underground coal mines. The Mine Safety and Health Administration (MSHA) investigated several of these occurrences within recent years. The investigated explosions occurred at significant depths, ranging from 500 ft to 1200 ft. Data from the National Lightning Detection Network indicate a definite correlation between the times and locations of the explosions with those of specific lightning strikes. This paper addresses the question, "Can lightning cause potential differences capable of igniting methane-and-air mixtures at overburden depths at which underground coal mining occurs?" A mine depth of 600 ft was selected for this initial study. Computer simulations were performed, with and without the presence of a metal-cased borehole extending from the surface to the mine level. CDEGS™ software from Safe Engineering Services & Technologies, Ltd (SES) was used for the simulations.**

I. INTRODUCTION

Electrical shock, visible sparking from underground equipment, premature detonation of explosives, and methane explosions have been experienced in underground mines during thunderstorms. These incidents have been particularly well documented in shallow coal mines in South Africa [1, 2, 3], with the vast majority occurring at mining depths of 300 ft or less. In recent years, several methane explosions in the United States have also been attributed to lightning. However, these explosions occurred at depths ranging from 500 to 1200 ft, which are significantly deeper than any of the incidents experienced in South Africa.

The explosions in the United States took place in abandoned and sealed areas of underground coal mines. In some instances, steel-cased boreholes were located in the vicinity of the explosions. Data obtained from The National Detection Network were used to determine the number and magnitude of cloud-to-earth lightning strikes within a 10-mile radius of the explosion areas at the estimated times of the explosions. An analysis of the data revealed that the magnitudes of the strikes ranged from 16 kA to 112 kA [5].

Explosions can occur if lightning causes electric sparks with sufficient energy in a methane/air mixture with methane concentrations between 5-15% [4]. (The minimum energy requirement of only 0.3 mJ occurs with a methane concentration of 8.5%.) Pockets of explosive methane/air mixtures are not uncommon in abandoned and sealed areas of coal mines. Lightning-related sparking underground can result from transient voltage surges on metal structures, such as conveyors or rails, where small discontinuities occur within the structure. It is also believed that the dissipation of lightning in rock strata may cause sparks with sufficient energy to ignite a methane/air mixture [1].

Lightning can penetrate an underground mine by two mechanisms – propagation through the overlying strata and conduction through metallic structures extending from the surface to the mine [1]. With the first mechanism, a lightning strike at the surface propagates downward through the earth in a radial fashion. Analyses of tunneling accidents in the Swiss Alps show that lightning strikes are capable of penetrating significant depths of overburden with enough energy to detonate explosives [6]. The depth of penetration was shown to be proportional to soil resistivity. In other words, lightning will penetrate deeper in soils with higher resistivity. Uniformly elevating the soil's potential, with respect to remote earth, by itself may not necessarily create problems since potential differences are not present in localized areas. However, large conductive structures that are grounded at remote locations can distort local current distributions and result in potential gradients. Geological faults, although not discussed in this paper, can also significantly distort current distribution through the overburden.

The second lightning-penetration mechanism results from a direct strike to a metallic structure that extends from the surface to the mine, such as cables, conveyor structures, water pipes, and borehole casings. The attenuation of such a strike depends on the surge impedance of the structure and how effectively the structure is grounded.

This paper addresses both lightning propagation methods. A simplified model of an abandoned area of a coal mine is created. Rails from the underground transportation system are used as conductive structures that are grounded at remote locations, and a row of 6-ft roof bolts is positioned perpendicular to the rails. A double-exponential current surge is used to simulate a lightning strike and is injected into the earth at the surface. The CDEGS software first performs a Fast Fourier Transform (FFT) to convert the lightning strike from the time domain to the frequency domain. Current distributions, scalar potentials, and electromagnetic fields are then computed for selected frequencies at specified observation points. This information provides insight into the frequency response of the earth and associated metal conductors. Finally, an inverse FFT is then used to obtain time-domain ground potential rises (GPR) for specified conductor segments in the system. Computational methods for the CDEGS software can be found in references [7], [8], and [9].

II. Model Development

A. Physical Model

The physical model is structured to create a situation where the GPR (ground potential rise) can be calculated at two nearby conductor segments to determine if a significant potential difference exists. A worst-case scenario would be if one conductor segment were part of a tire-mounted mining machine whose frame is tied to the safety ground bed on the surface, which could be a few miles from the equipment location. However, the explosions occurred in sealed areas, and cables and conductors are not permitted to extend beyond this area. Therefore, a more realistic situation was selected in which the two conductor segments reside in a rail and a roof bolt, with the roof bolt being located directly above the rail. Fig. 1 depicts the situation to be modeled and consists of a partially caved area of a coal mine. The plan view of Fig. 1 shows a 4000 ft by 4000 ft area to be modeled. The rail system spans the area in the *x* direction, while the roof bolts span the area in the *y* direction. A 500-ft length of the rail system on each end is located under caved material, while the remaining center portion of the track entry remains open. Thus the rails are essentially grounded at remote locations, with respect to the roof bolts. The roof-bolt entry remains open so that the roof bolts are located a few feet above the rails in the *z* direction, as shown in the side view of Fig. 1. The side view also shows the strike point where the voltage surge enters the earth, directly above the crossover point of the rails and the roof bolts.

The actual model was simplified to reduce the number of conductor segments, which in turn reduces the simulation time. (The maximum length of a conductor segment was set at 10 ft, which is less than one-sixth the wavelength of the highest frequency expected. Even with the simplified model, processing time can exceed 24 hr for each simulation when run on a Pentium™ III computer.) Figure 2 shows the simplified model for the situation defined in Fig. 1. A single, cylindrical rail, with the same cross-sectional area of a typical 60-lb/yd rail, is used instead of two separate rails. Since the portion of the CDEGS software used for this study does not permit modeling of void areas in the earth, such as mine openings, some approximations have to be used to model this situation. To accommodate this limitation, the 3000-ft center portion of the rail is modeled as a coated conductor, with a 1-ft thick coating. The coating is assigned the same resistivity and permitivity as air. The 500-ft end portions of the rail are left uncoated in intimate contact with the soil. Again, to reduce the number of conductor segments, only a single row of roof bolts is used. Steel conductors, 6-ft long with a 5/8-in. diameter, are used to model the roof bolts. The steel conductors for the rail and the roof bolts are assigned a relative resistivity of 17 and a relative permeability of 300. A copper rod, driven three feet into the earth, is located on the surface directly above the crossover point of the roof bolts and rail. This rod is used for injecting the lightning surge into the earth for *Scenario 1*. An observation surface is positioned horizontally, between the roof bolts and the rail. The intersecting points of the observation grid are used to calculate the scalar potentials in the soil.

Typical overburden consists of many layers of various types of strata, and the resistivity of each layer can vary dramatically. The composition of overburden is site specific, and discontinuities and geological faults can affect its electrical properties. However, to make the problem manageable, a uniform layer of soil, with a 400 Ω-m resistivity, is used to model the overburden.

A steel-cased borehole is used in *Scenario 2*. The borehole, not shown in Figs. 1 or 2, extends from the strike point on the surface to within a foot of a roof bolt. The borehole casing was modeled as a 6-in diameter pipe with an interior diameter of 5 in. Similar to the rails, the casing was assigned a relative resistivity 17 and a relative permeability of 300.

B. Lightning Surge

A magnitude of 84 kA was selected for the lightning strike. This value is 75% of the highest value obtained from the National Lightning Detection Network data. The lightning surge was modeled as a current source with the following double exponential function:

$$I(t) = I_m \left[e^{-\alpha t} - e^{-\beta t}\right] \qquad (1)$$

with

$I_m = 85.69$ kA,
$\alpha = 1.42 \times 10^4$, and
$\beta = 4.88 \times 10^6$.

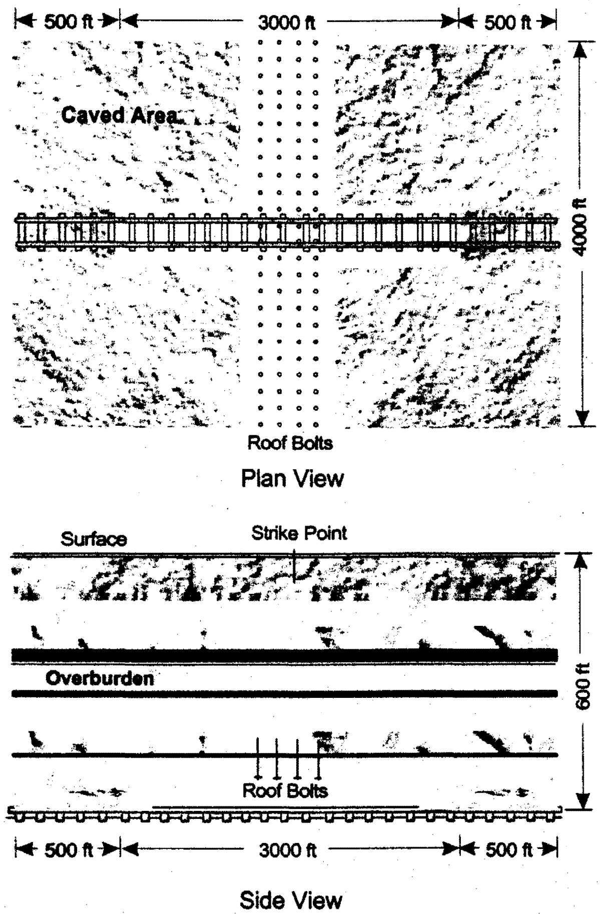


Fig. 1. Partially caved area of a coal mine to be modeled.

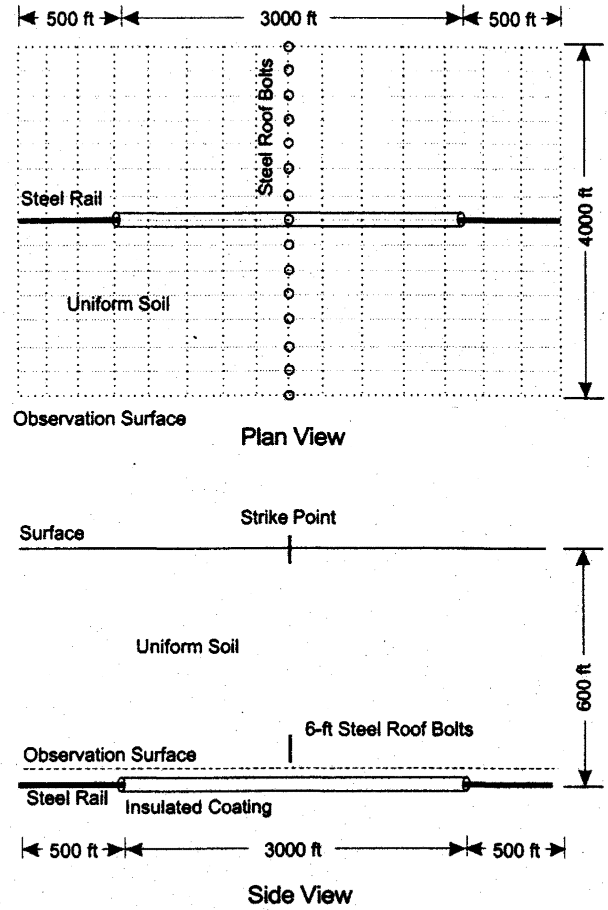


Fig. 2 Simulation model for Fig. 1.

These values result in a rise time of 1.2 μs to a peak current value of 84 kA. The surge decays to 50% of its peak value (42 kA) at 50 μs, as shown in Fig. 3a. Figure 3b shows that the waveform essentially decays to zero at 600 μs. This type of waveform is typically used for modeling lightning strikes [10].

III. Computer Simulations

The CDEGS software first uses a forward FFT to decompose the time-domain lightning surge of Fig. 3 into its frequency spectrum. It then selects a finite number of frequencies from this spectrum, based on the electromagnetic field response in the frequency domain. More frequencies with finer steps are selected in the regions where rapid changes occur. Electromagnetic fields are computed for defined observation points at each selected frequency to obtain the frequency spectrum of the fields. Finally, an inverse FFT is applied to the frequency spectrum of the computed electromagnetic fields, at the defined observation points, to yield the time-domain responses of the fields [9]. Simulations are performed for two scenarios. Figure 1 shows the physical model that is simulated in *Scenario 1*. *Scenario 2* is identical to *Scenario 1*, except that a steel-cased borehole is placed from the surface to within a foot of a roof bolt. The borehole is in intimate contact with the overburden for its entire length.

A. Scenario 1

Figure 2 depicts the model for *Scenario 1*. The frequency spectrum of the lightning surge in Fig. 3 ranges from dc to the mega-hertz range. Therefore, the model's unmodulated frequency response is first investigated. As an illustration, a per-unit current of $1.0 + j0.0\,A$ is injected into the strike point at the following frequencies: dc, 10 Hz, 100 Hz, and 1 kHz. Scalar potentials, based on the per-unit current, are calculated for each frequency at the intersecting points of the observation surface, illustrated in Fig. 2. The observation surface is a horizontal grid, located between the rail and the roof bolts, and consists of 81 profiles, with 81 points per profile. This arrangement results in a total of 6561 observation points, spanning the 4000 ft x 4000 ft area with a 50-ft spacing between adjacent points in the x and y directions. Figures 4, 5, 6, and 7 show the system's response to the per-unit current at the specified frequencies,

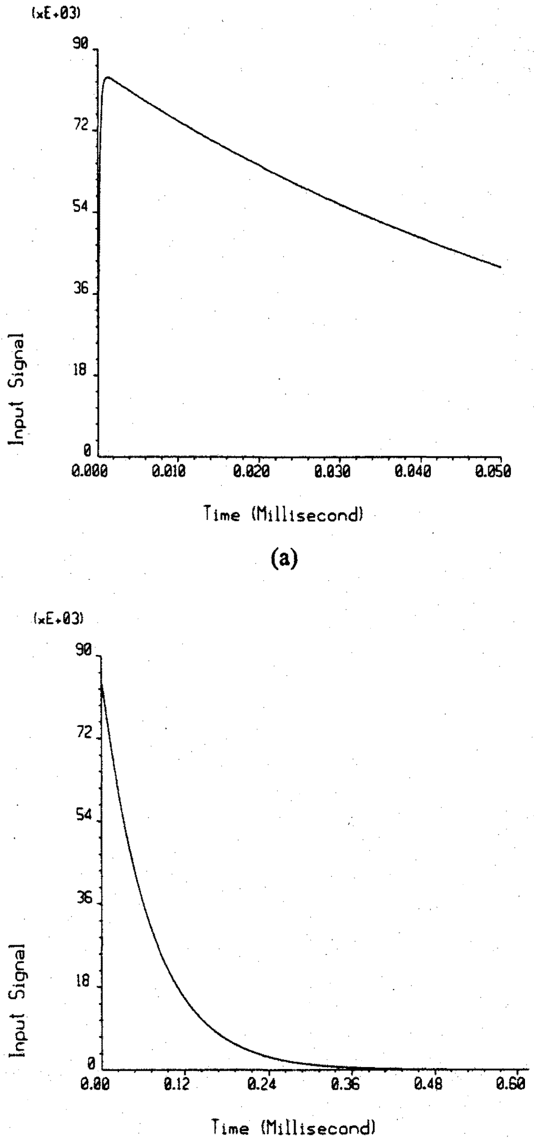


Fig. 3. Model of the lightning surge current.

respectively. Figures 4, 5, and 6 show that the three-dimensional perspectives for the scalar potentials at dc, 10 Hz, and 100 Hz are essentially the same, with peak values of approximately 0.35 V. Note the small distortion to the scalar potentials at dc and 10 Hz, due to the presence of the rail. This distortion essentially disappears at frequencies of 100 Hz and above. Attenuation of the scalar potentials becomes noticeable at 1 kHz, as shown in Fig. 7. The frequency spectrums (dc to 120 kHz) for the real and imaginary parts of the unmodulated scalar potentials are shown in Fig. 8.

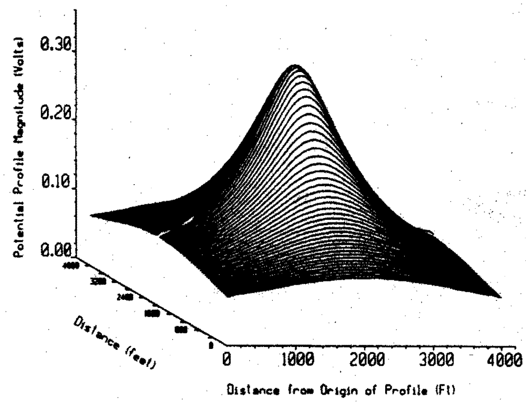


Fig. 4. Per-unit scalar potentials at dc for Scenario 1.

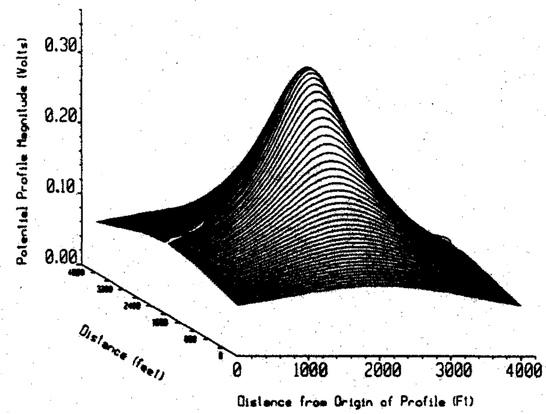


Fig. 5. Per-unit scalar potentials at 10 Hz for Scenario 1.

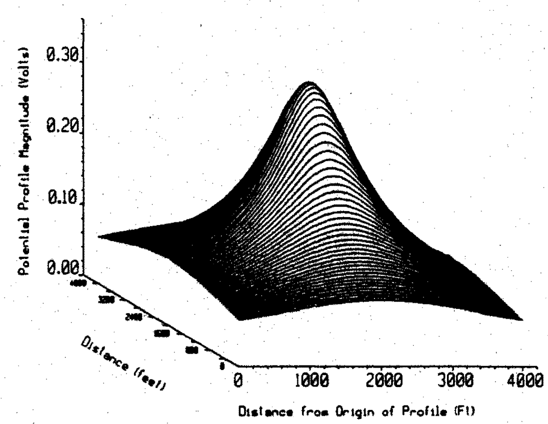


Fig. 6. Per-unit scalar potentials at 100 Hz for Scenario 1.

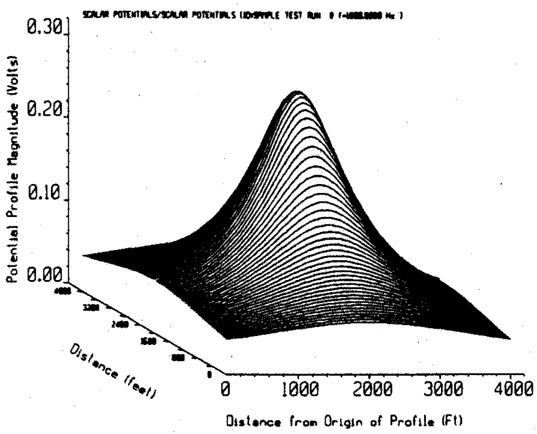
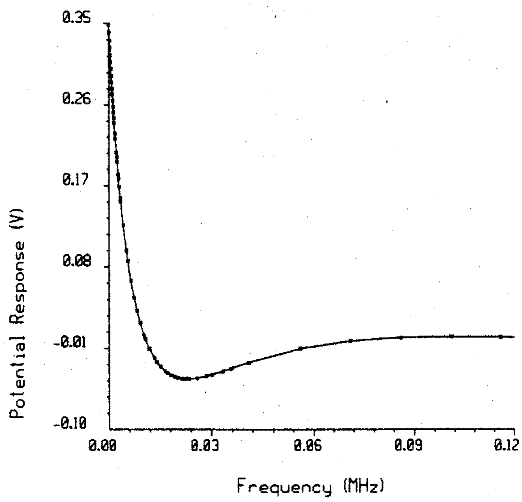
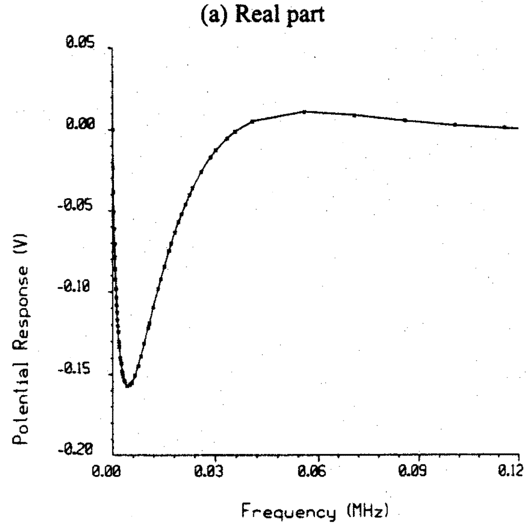


Fig. 7. Per-unit scalar potential at 1 kHz for Scenario 1.



(a) Real part



(b) Imaginary part

Fig. 8. Frequency spectrum of the unmodulated scalar potentials for Scenario 1.

Figure 8 shows that currents with frequencies above 100 kHz are essentially dissipated in the overburden prior to reaching the depth of the observation surface. Also frequencies below the 10-kHz range yield the greatest responses.

Figures 9, 10, and 11 show the per-unit GPRs for the conductor segments in the rail and the roof bolts at frequencies of dc, 10 Hz, and 100 Hz, respectively. A significant potential difference occurs between the roof bolts and the rail at the crossover point for dc and 10 Hz, as shown in Figs. 9 and 10. However, this potential difference vanishes at frequencies of 100 Hz and above, as shown in Fig. 11. Thus, the potential difference between the conductor segments is due solely to very-low frequency components.

An inverse FFT is used to compute the time-domain GPR in the roof-bolt and rail conductor segments at the crossover point, and the results are shown in Figs. 12 and 13, respectively.

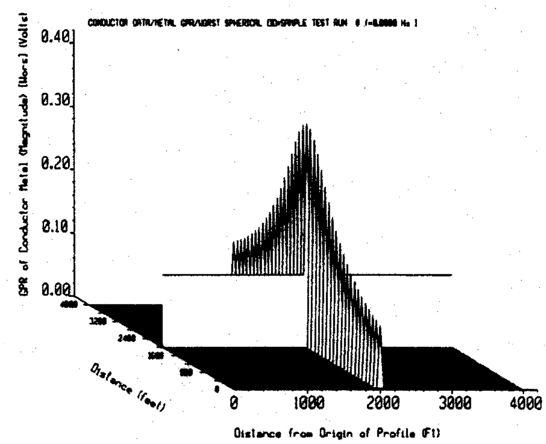


Fig. 9. GPR of rail and roof bolt segments at dc for Scenario 1.

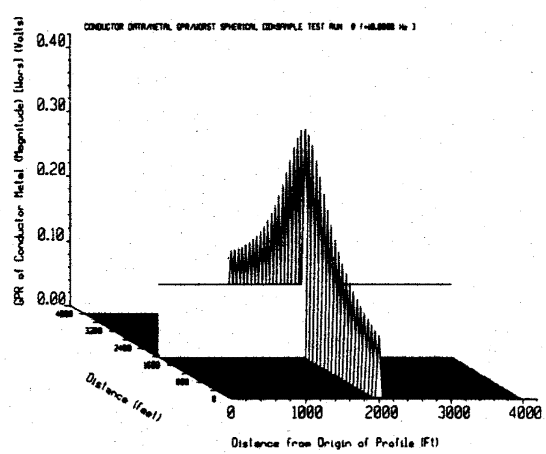


Fig. 10. GPR of rail and roof bolt segments at 10 Hz for Scenario 1.

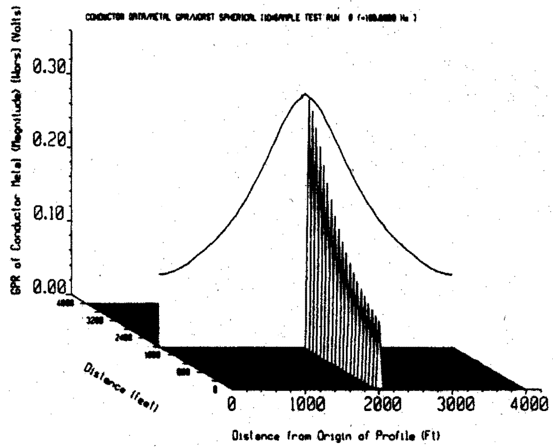


Fig. 11. GPR of rail and roof bolt segments at 100 Hz for Scenario 1.

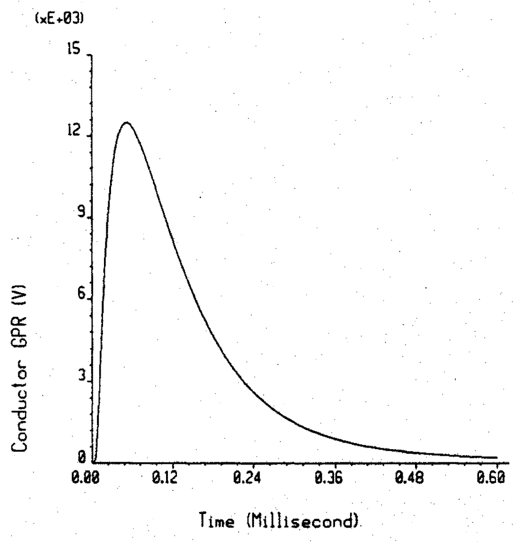


Fig. 12. Time-domain GPR of roof bolt at the roof-bolt/rail crossover point for Scenario 1.

The peak potential at the roof bolt is slightly greater than that of the rail, but both are near 12 kV. The waveform of Fig. 13 is subtracted from that of Fig. 12 in order to obtain the potential difference between the roof bolt and the rail, with the resulting waveform shown in Fig. 14. The potential difference has a peak value of 375 V. This voltage is certainly capable of generating an arc, but is relative small compared to the two GPRs. Given the assumptions and approximations made for defining this problem, as well as the limitations of the software, it is felt that this value does not provide conclusive evidence that the lightning strike is capable of initiating an explosion in *Scenario 1*.

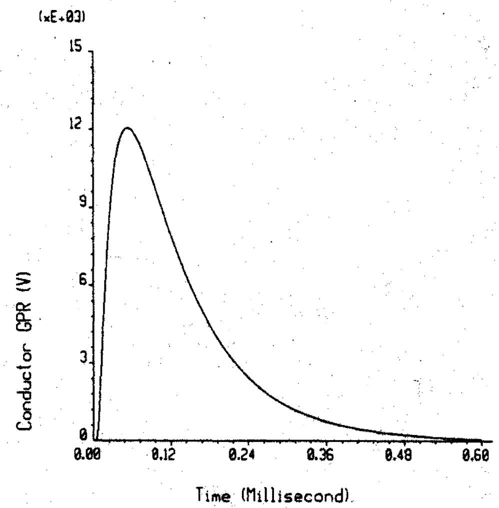


Fig. 13. Time-domain GPR of rail at the roof-bolt/rail crossover point for Scenario 1.

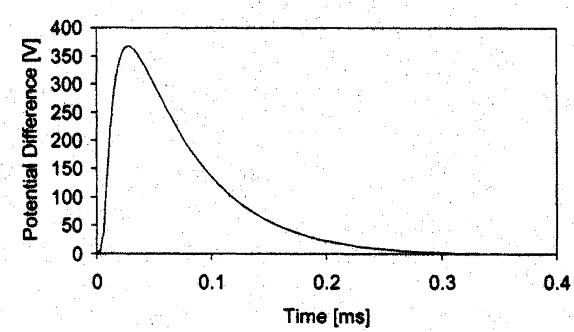
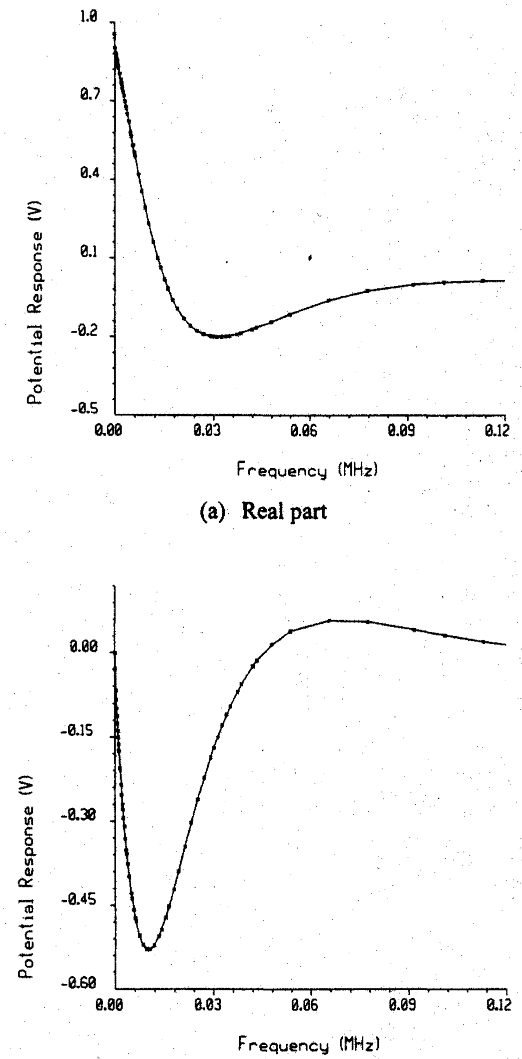


Fig. 14. Potential difference between roof bolt and rail for Scenario 1.

B. Scenario 2

Scenario 2 is essentially the same as *Scenario 1*, except that a steel-cased borehole, which extends from the surface to within one foot of a roof bolt, is included in the simulation model. As before, a per-unit current of *1.0 + j0.0 A* is injected into the strike point, and the borehole casing. The frequency spectrums (dc to 120 kHz) for the real and imaginary parts of the unmodulated scalar potentials are shown in Fig. 15. Similar to *Scenario 1*, currents with frequencies above 100 kHz are dissipated in the overburden prior to reaching the depth of the observation surface. For this scenario, frequencies below the 30-kHz range cause the greatest responses. As expected, the magnitudes of the unmodulated scalar potentials are significantly larger than those in *Scenario 1*. The time-domain GPRs in the roof-bolt



(a) Real part

(b) Imaginary part

Fig. 15. Frequency spectrum of the unmodulated scalar potentials for Scenario 2.

and rail conductor segments at the crossover point are shown in Figs. 16 and 17, respectively. The peak potentials in the roof bolt and rail have dramatically increased to 57 kV and 40 kV, respectively. The potential difference between the two conductor segments has a peak value of 15.6 kV and is presented in Fig. 18. Even with the assumptions and approximations made for defining this problem, the magnitude of this potential difference provides convincing evidence that the lightning strike is capable of initiating an explosion in *Scenario 2*, depending on the arrangement of conductors and physical conditions within the mine area.

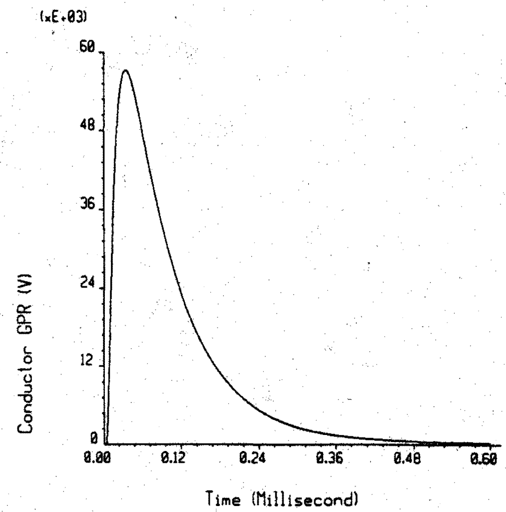


Fig. 16. Time-domain GPR of roof bolt at the roof-bolt/rail crossover point for Scenario 2.

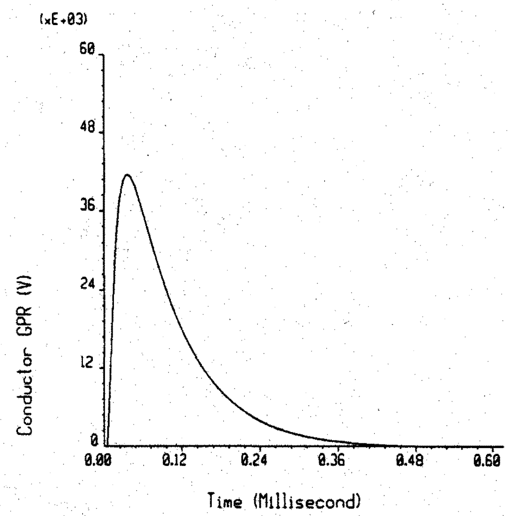


Fig. 17. Time-domain GPR of rail at the roof-bolt/rail crossover point for Scenario 2.

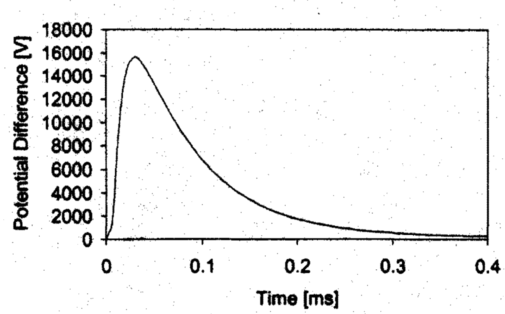


Fig. 18. Potential difference for Scenario 2.

IV. CONCLUSIONS

Two scenarios for a simplified model of an abandoned area of a coal mine were simulated. Rails from the underground transportation system were used as conductive structures that are grounded at remote locations, and a row of 6-ft roof bolts were positioned perpendicular to the rails. With *Scenario 1*, lightning was injected directly into the earth. A steel-cased borehole was added for *Scenario 2*. A double-exponential current surge, with a peak value of 84 kA, was used to simulate a lightning strike. CDEGS software from Safe Engineering Services & Technologies, Ltd was used for the simulations. CDEGS performed a Fast Fourier Transform (FFT) to convert the lightning strike from the time domain to the frequency domain. Current distributions, scalar potentials, and electromagnetic fields were computed for selected frequencies at specified observation points. An inverse FFT was used to obtain time-domain ground potential rises (GPRs) for specified conductor segments in the system.

The simulations showed that currents with frequencies below 10 kHz for *Scenario 1* and 30 kHz for *Scenario 2* cause the greatest contribution to the scalar potentials in the mine area. Peak values of 12 kV and 57 kV occurred between the roof bolt and remote earth for *Scenario 1* and *Scenario 2*, respectively.

For both scenarios, the potential differences between the roof-bolt and rail segments were solely due to very-low frequency currents, below 100 Hz. Values of 375 V for *Scenario 1* and 15.6 kV for *Scenario 2* were calculated. Given the assumptions and approximations made for defining this problem, as well as the limitations associated with any simulations, the authors feel that *Scenario 1* does not provide conclusive evidence that the lightning strike is capable of initiating an explosion and that further investigations need to be performed. However, *Scenario 2* presents very strong evidence that the presence of a steel-cased borehole dramatically enhances the possibility of lightning initiating an explosion in a mine at a 600-ft depth.

Future work will address the sensitivity of the model parameters, such as soil resistivity, depth of overburden, and diameter of the borehole casing. Simplified simulations will also be compared with a theoretical model to determine their level of agreement.

V. REFERENCES

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5.1 APPROVAL OF MEETING MINUTES

Benton County OREGON

Board of Commissioners

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MEETING MINUTES

BENTON COUNTY BOARD OF COMMISSIONERS
JULY 16, 2024

Present:	Xanthippe Augerot, Chair; Pat Malone, Commissioner; Rachel McEneny, County Administrator
Excused:	Nancy Wyse, Vice-Chair; Vance Croney, County Counsel
Elected Officials:	Sheriff Jef Van Arsdall; District Attorney John Haroldson
Staff:	Maura Kwiatkowski, Meeting Recorder; Cory Grogan, Public Information Officer; Rick Crager, Assistant County Administrator; Ryan Joslin, Assistant District Attorney; April Holland, Damien Sands; Health Services; Bailey Payne, Community Development
Guests:	John Harris, Horsepower Productions; Timothy Nierman, Diane Scottaline, Misha Marie, The Arc of Benton County; Brandon Pursinger, Association of Oregon Counties; Paul Nietfeld, Community Member

1. Call to Order and Introductions

Chair Augerot called the meeting to order at 9:00 AM. Introductions were made.

2. Review and Approve Agenda

The agenda was approved with no changes.

3. Proclamations

3.1 Proclaiming July 2024 as Americans with Disabilities Month in Benton County, Proclamation P2024-016

Timothy Nierman from The Arc of Benton County read the proclamation aloud.

MOTION: Malone moved to adopt Proclamation P2024-016 proclaiming July 2024 as Americans with Disabilities Month in Benton County. Augerot seconded the motion, **which carried 2-0.**

4. Comments from the Public

Paul Nietfeld addressed the Board regarding the landfill, potential expansion, and revenue as a follow-up to his March 2023 testimony. First, the BCTT (Benton County Talks Trash) final report did not provide guidance on expected future landfill revenue to Benton County, but estimates for expected future landfill surcharge revenue can be generated from the fee schedule in the 2020 landfill franchise agreement and the intake tonnage projections provided by the landfill operator as part of the solid waste process workgroup effort, which projected that volumes will continue to run close to the level of the intake tonnage cap for as long as the cap is in place, meaning about 1.05 million tons per year.

Second, for the landfill franchise agreement, the base franchise fee will drop from $3.5 million in 2024 to $2.5 million next year if expansion is not approved. However, and this is important, at the current and projected intake tonnage levels, it is the per-ton host fee that determines the total payout to the county for each calendar year, not the franchise fee. Because of this, the county will meet or exceed its expected landfill surcharge revenue for the 2023-25 biennium without any expansion approval and would continue to receive about $3.6 million per year from the landfill beyond the current biennium without an expansion. For example, in calendar year 2025, the no expansion host fee figure of about $3.43 per ton, at an expected intake rate of 1.05 million tons per year, generates a total 2025 calendar year revenue of $3.6015 million with no expansion. Benton County's landfill surcharge for revenue goals for the current biennium can be achieved without expansion of the landfill, and future biennia would continue to see $7-plus million per biennium surcharge revenue figures at this intake level without expansion approval. Note: all revenue figures quoted are non-inflation adjusted dollars.

Third, given the above, it should be clear to all involved in landfill-related decisions that the integrity of the county budget is not dependent on approval of a landfill expansion. This is good news. Nietfeld indicated he would follow up by email to the commissioners and Jennifer Ambuehl (Financial Services providing the calculations for the information presented today.

In relation to Work Session Item 5.1, Nietfeld expressed deep appreciation of Benton County's efforts in support of citizens with mental health issues and particularly to the Benton County Sheriff's Office for the professionalism, competence, and understanding of its deputies in dealing with citizens suffering with these burdens.

5. Work Session

5.1 Behavioral Health Deflection Program Briefing

Holland and Crager provided an update on House Bill (HB) 4002 regarding funding appropriated to counties for deflection programs to help support a behavioral health deflection program. Benton County will receive at least $231,000 for this purpose.

The current priority is to establish a program coordinator to fulfill the duties required by the legislation, including coordinating with partners such as the District Attorney's Office, law enforcement, and behavioral health service providers. Staff is working on a position description for a program coordinator, which is a requirement of HB 4002. The current plan is for the program coordinator to be assigned to the Health Department, but this could change.

The meeting packet included a draft workflow, which is a framework staff is working on, and discussions will continue. The Criminal Justice Council (CJC) notified the county our application had been deemed intact. The grant committee will meet August 1 to decide on Benton County's final resource allocation; Crager expressed optimism regarding the county's funding prospects

The draft framework provides that eligible individuals will be those cited with possession of a controlled substance misdemeanor who are residents of Benton County with no history of violent crime or sex offenses, no outstanding out-of-county warrants, and not subject to a restitution order. Individuals may also potentially be referred by emergency response teams or social service providers. Participation would be voluntary.

Discussions with the District Attorney's Office include working to define the requirements for an individual to be considered successful. When has an individual completed the right steps in the program to move away from the citation? A required regional symposium is scheduled for July 24 in Bend, and five Benton team members will attend. Our draft framework will be part of the discussions at the symposium, and county team members will receive guidance to help improve on progress to this point. There will be a debrief team meeting afterward to further refine the framework. Holland has worked on a draft position description for the program coordinator. Getting this position in place is a very important element. The tentative go-live date for the program is January 1, 2025.

Holland added that a great deal of learning has been occurring; there have been many conversations with multiple partners to determine where to begin with the program, how to build something that includes all the necessary elements, and to build something that can be scaled as we demonstrate success to serve even more people.

Van Arsdall and Haroldson expressed their support for program development and thanked county staff for their efforts to secure grant funding to establish the program.

Crager noted that Sara Hartstein (Health) is working to leverage opioid settlement funds and utilizing additional behavioral health resources through the current contract with the Oregon Health Authority. Some community partners have indicated their Measure 110 resources could potentially be available to support the program. Crager sees the potential to also add additional partners to the effort.

Augerot cited the importance of leveraging multiple funding sources and indicated there may be an opportunity with US Bureau of Justice assistance grants.

Malone requested a specific definition of deflection. Holland suggested deflection is a community-centered practice offering an alternative to entering the justice system and wrapping people in a system of care, including treatment and other basic needs. Augerot added the intent is to reach people before they officially enter the justice system. Haroldson remarked that deflection is another form of moving a case from a traditional track; sometimes referred to as diversion, conditional discharge, or a pre-charging agreement to move someone away from the traditional justice system.

In response to a question from Malone, Crager indicated the grant is a one-time appropriation; the program will need sustainability. There will be ongoing legislative discussions, and the indication from the state is that we should expect resources beyond the 2023-25 biennium.

Augerot pointed to the role of community health centers in the process, as well as that of the Coordinated Homeless Response Office. Crager indicated the county's Juvenile Director is also a partner; the entire county is coming together to support a deflection program.

Crager and Lindsey Goodman will track program requirements and deadlines until the program coordinator is in place.

McEneny indicated staff would return in November with another update on the deflection program.

5.2 Proposed County Timber Revenue Options

Representing the Association of Oregon Counties and the Council of Forest Trust Land Counties (CFTLC), Pursinger briefed the Board on the state's proposed Habitat Conservation Plan (HCP) and the impacts of the HCP on county timber revenue.

The CFTLC is made up of 15 counties on the west side of the state. In the 1930s and 1940s, these 15 counties deeded in trust to the state, forest lands for long-term forest management. This arrangement is unique among Oregon counties.

In March 2023, the Legislative Coastal Caucus sent a letter to the Governor, which advised the proposed HCP being created by the Oregon Department of Forestry (ODF) would significantly impact communities. The Governor's April 2023 response expressed interest in working to solve the problem, assuming the HCP goes into effect.

In August 2023, former CFTLC Chair David Yamamoto of Tillamook County received an invitation from Governor Kotek's Natural Resources Advisor to begin conversations to identify the financial impact of the proposed HCP on trust land counties and how to mitigate the anticipated revenue decrease. Then-Commissioner Yamamoto asked for others from CFTLC to participate in the discussions. Five commissioners were selected to represent each of the five CFTLC districts: Yamamoto representing Tillamook; Commissioner Bangs representing Clatsop; Washington Commissioner Willey representing District 3 (Washington, Clakamas, and Columbia); Linn Commissioner Tucker representing District 4 (Benton, Lincoln, Linn, Marion, and Polk); and Coos Commissioner Sweet representing District 5 (Coos, Douglas, Josephine, Klamath, and Lane).

Meetings began in September 2023, and the purpose was to identity the magnitude of the proposed HCP impact. Fourteen of the 15 CFTLC counties would be impacted by the HCP; Klamath would not be impacted. Of the 14 impacted, there is a 10-year historical average of 239 million board feet harvested from state forests. ORS 530.110 provides that counties and the ODF share in all revenue generated from timber harvest. Counties receive 63.75 percent of that revenue, and ODF keeps 36.25 percent. ORS 530.115 requires that counties share the 63.75 percent. Counties keep 10 percent; and after that, the County School Fund (CSF) receives 25 percent of the remainder. After the CSF allocation, any special taxing district that overlays where the state forest land is located receives a portion of the remaining funds.

The 239 million board feet was generated across the 14 counties as the 10-year historical average. According to ODF, 185 million board feet is what could be expected to be harvested, which equals a reduction of 54 million board feet. Benton County has historically seen about three million board feet as its 10-year historical average. According to ODF, under the HCP, Benton would remain around three million board feet, which is something of an anomaly amongst the trust land counties.

Last year's stumpage was $496 per 1,000, but the expected 10-year historical average for stumpage is $411 per 1,000. This essentially correlates to a reduction of $22 million generated from state forests. How will this deficit be mitigated? Fifteen different proposals were discussed amongst the five commissioners, Pursinger, and three staff from the Governor's office. The goal was to identify changes that need to be made before the HCP would go into effect in 2026. The single opportunity to make changes will be in the 2025 legislative session.

The Governor's office identified three proposals on which to continue conversations. Of the amount allocated to counties, special districts, and schools, which of the three recipients will be affected by the $22 million reduction? Fifty percent of all revenue received by counties goes to schools. Overall, a third goes to the counties, a third goes to ODF, and a third goes to schools. School districts would be placed on the School Equalization Program. Four school districts are not currently in the School Equalization Program.

Pursinger provided an overview of the three options selected by the Governor:

Option 1: ODF absorbs the entire financial impact. Statute would need to change so that 82 percent goes to county special districts and schools. The remaining 18 percent would go to ODF. Potential pitfall of Option 1: a reduction of $22 million to the ODF State Forest Division (SFD). This means ODF SFD would not necessarily have the staff or resources to sell the timber contracts to ensure there is sufficient revenue generated for county special districts and schools.

Option 2: ODF would receive the same dollar amount as currently; the department would need to receive 47 percent instead of the current 36 percent. This would reduce the county's special districts and schools share to 53 percent, with an even split of 26.5 percent each. Option 2 was not well received by the counties, since the lands were county forests deeded in trust to the state to manage. One of the requirements under the statute for greatest permanent value is timber harvest. Seeing a reduction of that magnitude to the counties was not viewed favorably by the counties.

Option 3: The reduction would be experienced by the local school districts. This means 53 percent to counties and noneducational special districts and 47 percent to ODF. County special districts and ODF would receive the same amount as previously. School districts would be placed wholly on the School Equalization Program (SEP). This is not a simple or straightforward option. Four school districts in the state are not currently in the SEP because local revenues exceed the amount those districts would receive from the state. Those four districts are located in Tillamook and Clatsop Counties, two of the trust land counties. Additional conversations will be needed if Option 3 is the path selected and the SEP is able to make up the additional revenue needed to be allocated to the impacted school districts, not just the four not in the SEP. More conversations would also be needed with school administrators, school boards, teachers, etc. At this point, only the Governor's Office and the counties are engaged in the conversations.

On June 28, a CFTLC full membership meeting was held; Wyse attended and received information. The request from the Governor is that CFTLC provide by mid-August a recommendation as to which of the three options counties prefer. This allows one month to bring trust land counties back together to officially take (or not take) an official position. If the trust land counties decide to do nothing, it is a $22 million deficit that will affect the counties, ODF, and the schools.

Regarding impact specific to Benton County, the current 10-year historical average is at $411 per 1,000, or $375,000. According to ODF, with the anticipated annual harvest over the HCP lifespan of 70 years, Option 1 would result in $557,000 for Benton, Option 2

$359,000, and Option 3 $719,000. Last year, the stumpage price was $496 instead of the historical average of $411, so all numbers will increase by approximately $100,000. The current year stumpage price projection is $550 per 1,000. If timber prices continue to increase, all of these numbers will continue to increase. Conversely, if the market decreases, the county could potentially see a decrease, regardless of the option selected.

Augerot noted Benton County is fortunate the HCP impact is nearly neutral in terms of long-term revenue. She tends to favor Option 3 because it seems to be the direction other states, including Washington, are moving. Augerot believes educators, schools boards, and other educational interest groups would be strongly opposed to the change.

Malone asked about discussion regarding general fund dollars being put into the mix to soften the effects of whichever option moves forward. Pursinger indicated whichever option is moved forward, the recipient of the significant brunt of the $22 million reduction would be looking to the legislature for a general fund appropriation. Malone noted it is easy to argue that the HCP benefits all the people of Oregon with different effects on people in different counties. The state should soften the blow of whatever option ultimately moves forward.

Crager agreed with Augerot that Option 3 is likely the best option to minimize impact. Augerot pointed out that education will be at the forefront of the upcoming legislative session and that $22 million is not a significant amount in the context of education funding. It is, however, a huge impact at the county level.

Pursinger noted only one Benton County school district receives timber harvest revenue, which is the Philomath School District. Pursinger has heard thoughts similar to Augerot's expressed by other state land trust counties.

[Exhibit 1]

6. Consent Calendar

6.1 Approval of the April 2, 2024 Board Meeting Minutes
6.2 Approval of the April 16, 2024 Board Meeting Minutes
6.3 Approval of the May 7, 2024 Board Meeting Minutes

MOTION: Malone moved to approve the Consent Calendar. Augerot seconded the motion, **which carried 2-0**.

7. New Business

7.1 Oregon Cascades West Council of Governments Fiscal Year 2024-25 Membership Renewal and Dues

Kwiatkowski advised the Board the 2024-25 dues for the county's Oregon Cascades West Council of Governments membership were currently due and payable if the Board wished to continue the membership. Annual dues are $29,750.13, and this amount was included in the Board's 2023-25 budget.

MOTION: Malone moved to approve the Fiscal Year 2024-25 Oregon Cascades West Council of Governments membership renewal and payment of dues in the amount of $29,750.13. Augerot seconded the motion, **which carried 2-0.**

8. Other

No other business was conducted.

9. Announcements

Augerot noted the Open Streets Corvallis event scheduled for Sunday, July 21; it is an outstanding community event.

McEneny added that the Sheriff's Office will be competing in a charity softball game on July 24 at Coleman Field on the Oregon State University campus.

10. Adjournment

Chair Augerot adjourned the meeting 10:14 AM.

____
Xanthippe Augerot, Chair

____
Maura Kwiatkowski, Recorder

*Items denoted with an asterisk do not have accompanying written materials in the meeting packet.