



# Th-A1 Hazardous Materials & Adapting to Rising Tides

Presented by

**Ellen Dempsey**

**21<sup>st</sup> Annual California CUPA Training Conference**  
**February 25-28, 2019**  
**Anaheim**



[www.calcupa.org](http://www.calcupa.org)

# Instructor Biography

---

➤ UCLA- Environmental Science

- Harmful Algal Blooms

➤ Environmental Engineer



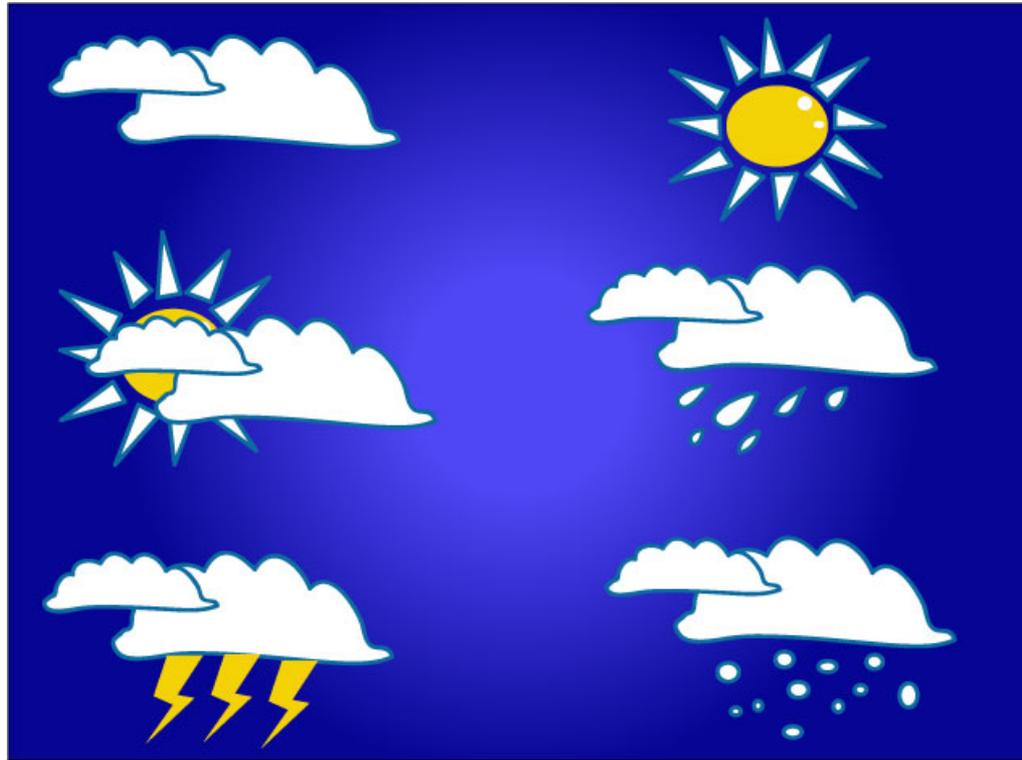
- Regulation and Reduction

➤ Contra Costa Health Services,  
Hazardous Materials Programs

- CUPA Inspector
- HMBP and Storm Water Lead
- HazMat Specialist, Incident Responder



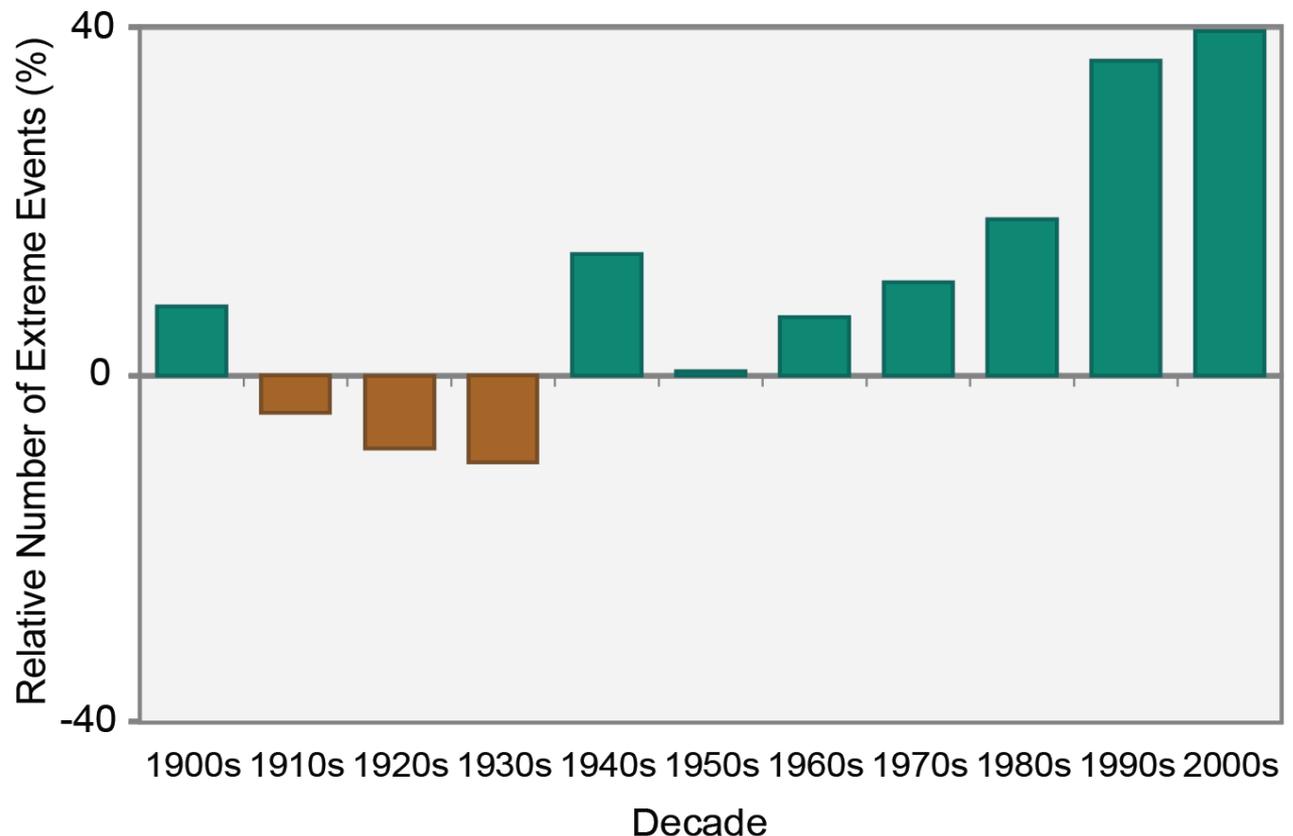
# WEATHER



# Extreme Weather on the Rise

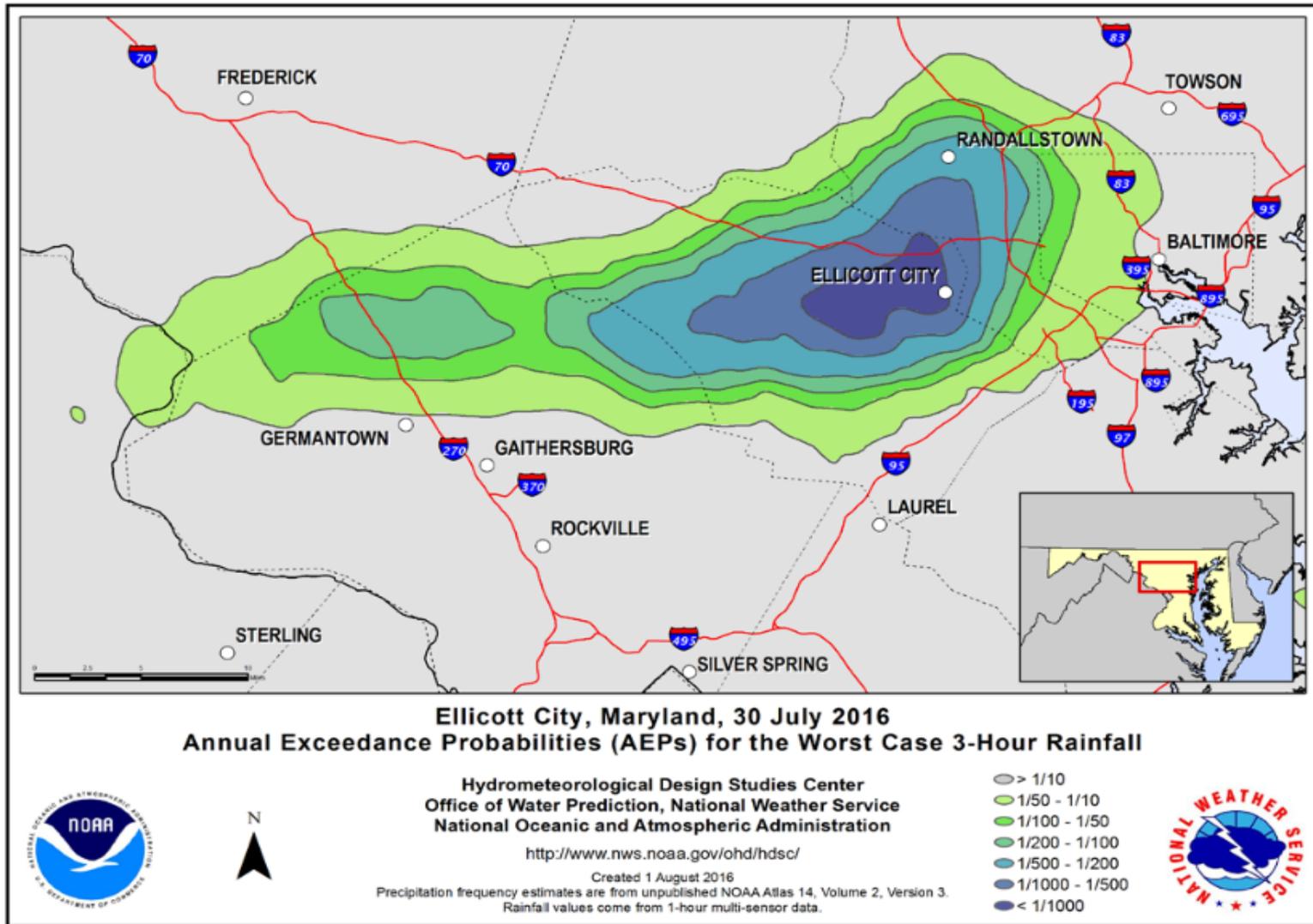
One measure of heavy precipitation events is a **two-day precipitation total** that is exceeded on average only once in a 5-year period, also known as the **once-in-five-year event**.

Observed U.S. Trend in Heavy Precipitation



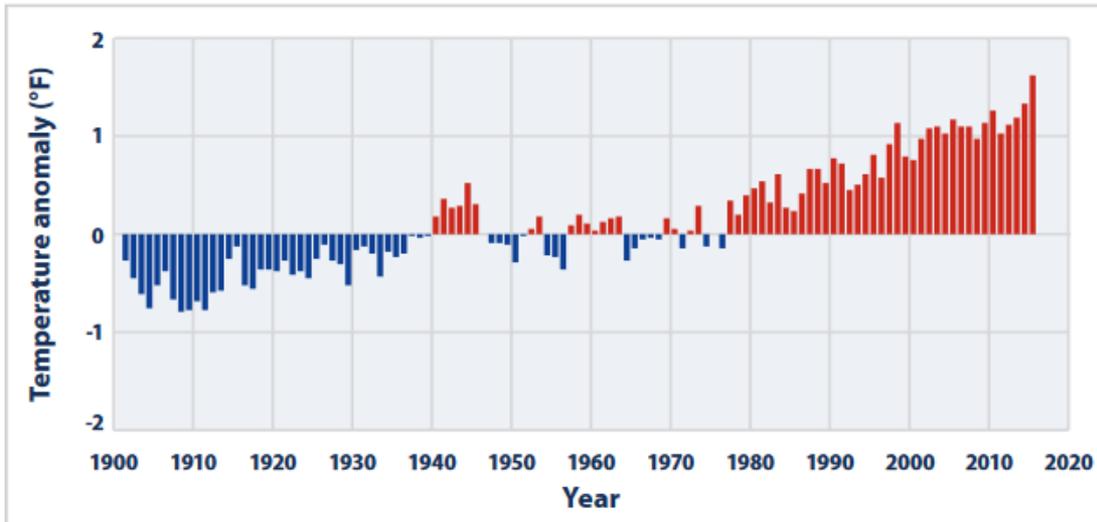
# Historic Flood Levels

2016 and again  
in 2018!



# Extreme Heat

Temperatures Worldwide, 1901–2015



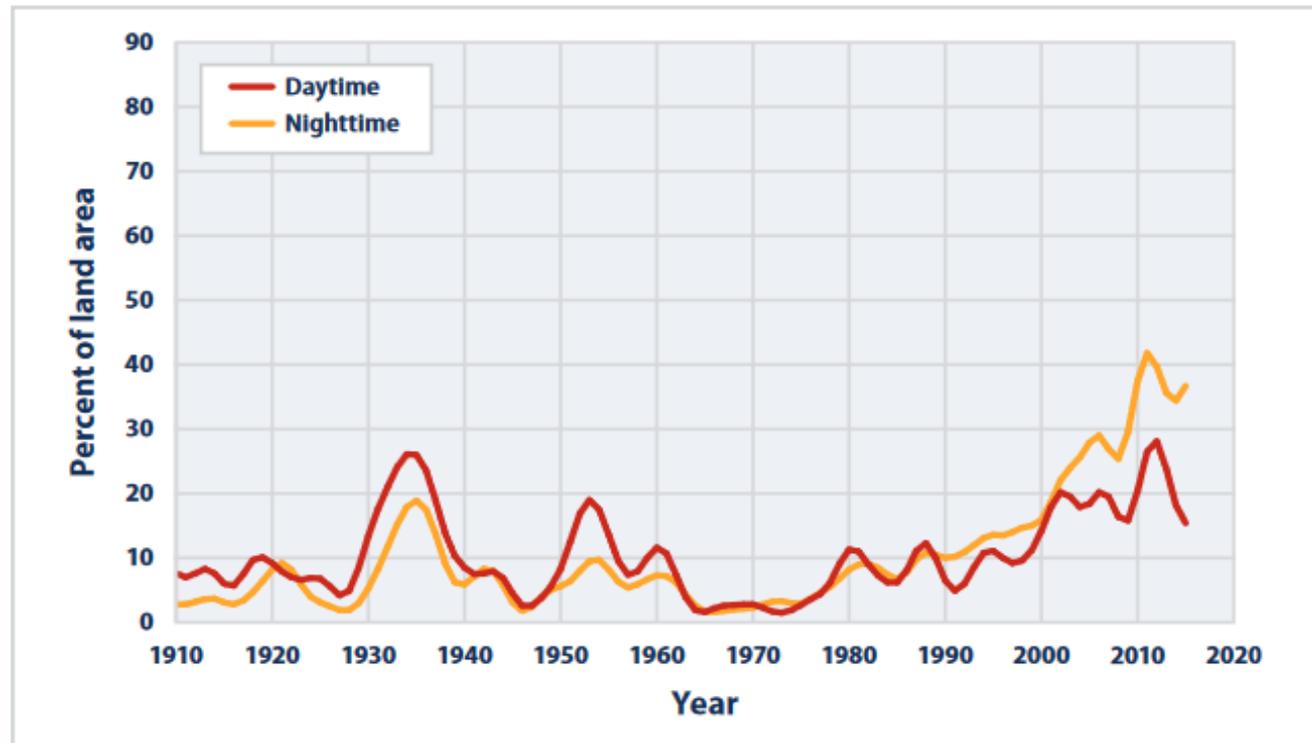
*This graph shows global annual average temperatures, compared with the 1901–2000 average. These data come from land-based weather stations and sea surface temperature measurements. The red bars indicate above-average surface temperatures and the blue bars indicate below-average temperatures (averaged across land and ocean). Source: U.S. EPA, 2016<sup>2</sup>*

Globally, the annual average temperature has been rising since the beginning of the 20<sup>th</sup> century, and temperatures are expected to continue to rise through the end of this century.

Worldwide, **15 of the 16** warmest years on record have occurred since 2000, with the exception of 1998.

# Less Cooling at Night

## Area of the Contiguous 48 States With Unusually Hot Summer Temperatures, 1910-2015



*This graph shows how larger parts of the contiguous 48 states are experiencing unusually hot temperatures during the months of June, July, and August. Unusually hot summer days (red line) have become more common over the last few decades, while unusually hot daily low temperatures (orange line), usually at night, are occurring in an even larger area of the United States. Source: Adapted from U.S. EPA, 2016<sup>2</sup>*

# California Wildfires



CAL FIRE

## NUMBER OF FIRES AND ACRES:

Interval	Fires	Acres
January 1, 2018 through December 2, 2018	6,228	876,225
January 1, 2017 through December 2, 2017	6,085	317,067
5 year average (same interval)	5,574	232,469
2018 Combined YTD (CALFIRE & US Forest Service)	7,510	1,671,313

(Statistics include all wildfires responded to by CAL FIRE in both the State Responsibility Area, as well as the Local Responsibility Area under contract with the department. Statistics may not include wildfires in State Responsibility Area protected by CAL FIRE's contract counties. Final numbers will be provided in the annual Wildfire Activity Statistics Report (Redbook) once it's published.)

# Floods in response to drought and fire



Flash flood water blackened by ash and debris from the Holy Fire rushes along Trabuco Creek and under Trabuco Canyon Road in Orange County, Calif., on Nov. 29, 2018

Extensive flooding that enveloped East William Street and William Street Park in San Jose, Calif. on Tuesday, Feb. 21, 2017

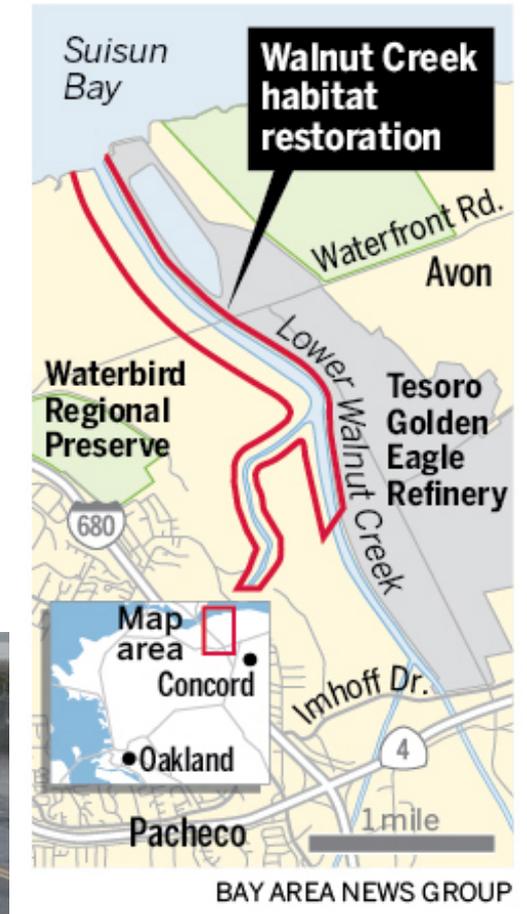


# Oroville Dam



# Coastal Flooding Occurring

- **Lower Walnut Creek Restoration Project**  
2014-Current
- Project goals: provide wetland habitat restoration, sustainable flood protection, and public access to this habitat area.
- As of 2019: Project is currently obtaining environmental permits and developing construction plans

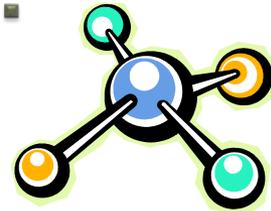


---

# How would you respond??

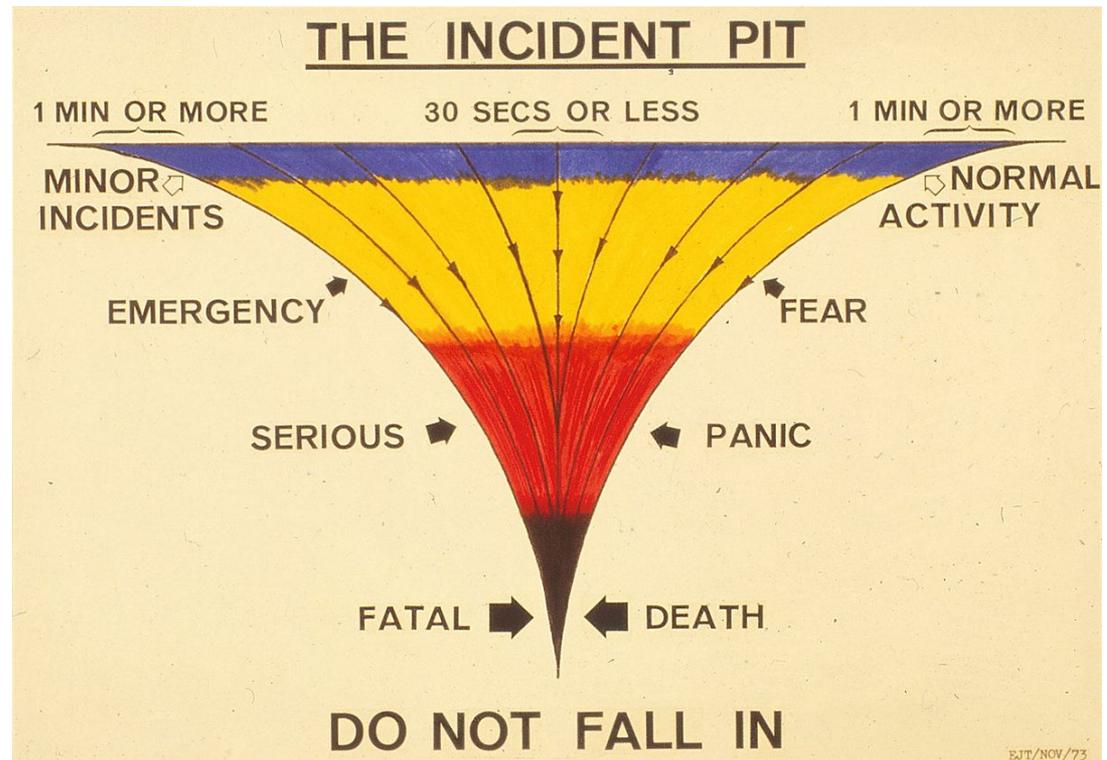


## As a regulator and/or emergency manager, how could you prevent a HazMat incident from occurring?



# Avoid the Incident Pit

- Perception
- Comprehension
- Projection



# Chemicals are all around us





# Hurricane Katrina and Rita

In 2005, Hurricanes Katrina and Rita littered the Louisiana coastal zone with **tens of thousands** of drums, cylinders, aboveground storage tanks, and other containers that contained crude oil, refined petroleum products, chemicals, and other hazardous materials. These pollution sources were a **threat to both public safety and the coastal environment.**

On 12 May 2006, a 50-foot tall oil storage tank was emptied of remaining oil and recovered by crane barge in the Mississippi River Delta. This removal action signaled the end of a **six-month emergency response action** and the conclusion of full-time marsh operations to recovery orphaned containers.

In what was likely the largest recovery effort of its kind, more than

**17,000 orphaned containers**, 55-gallons and larger, were recovered in wetland habitats of coastal Louisiana under an ESF-10 Mission Assignment to the U.S. Environmental Protection Agency (EPA). The EPA and United States Coast Guard (USCG) conducted the response action jointly in direct support to the State of Louisiana. NOAA provided the role of the Scientific Support Coordinator and coordinated the Environmental Unit functions for the Incident Command.



1 2:13PM

Container Assessment Team: Allison, Schacher Date: 01 Nov 2005 13:58:42 Lat: 29° 44' 31.95" Long: -89° 26' 1.36"



1 1:53PM



38 9:35PM

Container Assessment Team: Grinstead Date: 06 Nov 2005 10:42:16 Lat: 29° 4' 11.29" Long: -89° 10' 44.01"



6 10:41AM

# Hurricane Harvey

## August 25<sup>th</sup>, 2017



At least 88 deaths were blamed on Harvey. Some 80 percent were caused by drowning. Surprisingly, **just 22 percent** of the 37 deaths recorded in Houston's Harris County -- the epicenter of the disaster -- occurred **inside the 100-year flood zone**.

# Chemical Release at Arkema

---

Arkema  
Explosion-  
August 29<sup>th</sup>

Organic  
Peroxides



# Criminal Indictments

---

- A series of indictments by a Harris County grand jury say Arkema North America, CEO Richard Rowe and plant manager Leslie Comardelle acted "recklessly" after the plant caught fire as Harvey dumped record-setting rain on the area, something prosecutors say was preventable if the company had taken safety measures suggested by its insurance company a year prior.
- The CEO and Plant Manager may face up to 5 years in prison and \$1 million in fines
- Charges have been faced with criticism



# Chemical Release at Magellan

---

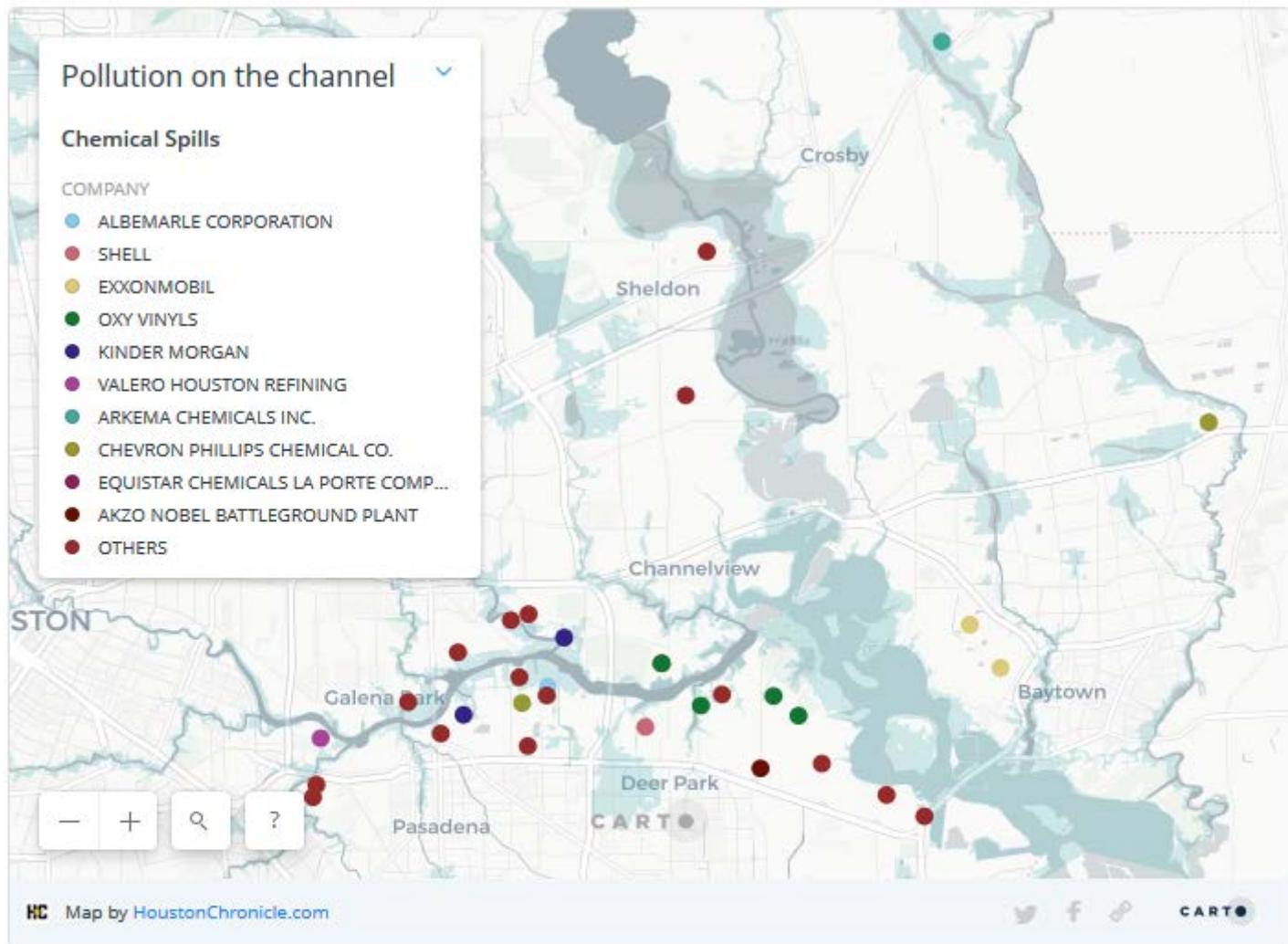
- The largest single release from Hurricane Harvey
- A spill from the failure of 2 above-ground storage tanks was measured at 10,988 barrels, or more than **461,000 gallons**, of gasoline
- Some of the spilled fuel flowed into a waterway adjacent to the ship channel, a heavily-industrialized area that's lined with dozens of petrochemical facilities

# Chemical Impact of Harvey

---

- In all, reporters cataloged more than 100 Harvey-related toxic releases — on land, in water and air.
- Regulators alerted the public to dangers from just two, well-publicized toxic disasters: the Arkema chemical plant northeast of Houston that exploded and burned for days, and a nearby dioxin-laden federal Superfund site whose protective cap was damaged by the raging San Jacinto River





**Sources:** Texas Commission on Environmental Quality, Texas General Land Office, Railroad Commission of Texas and Harris County Pollution Control Services Department, U.S. Coast Guard

*Graphic by Jordan Rubio | Data provided by the Associated Press*



What could the root cause of these events be?



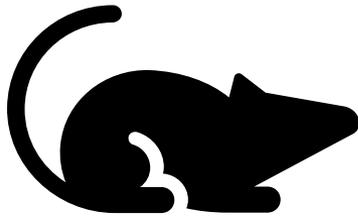
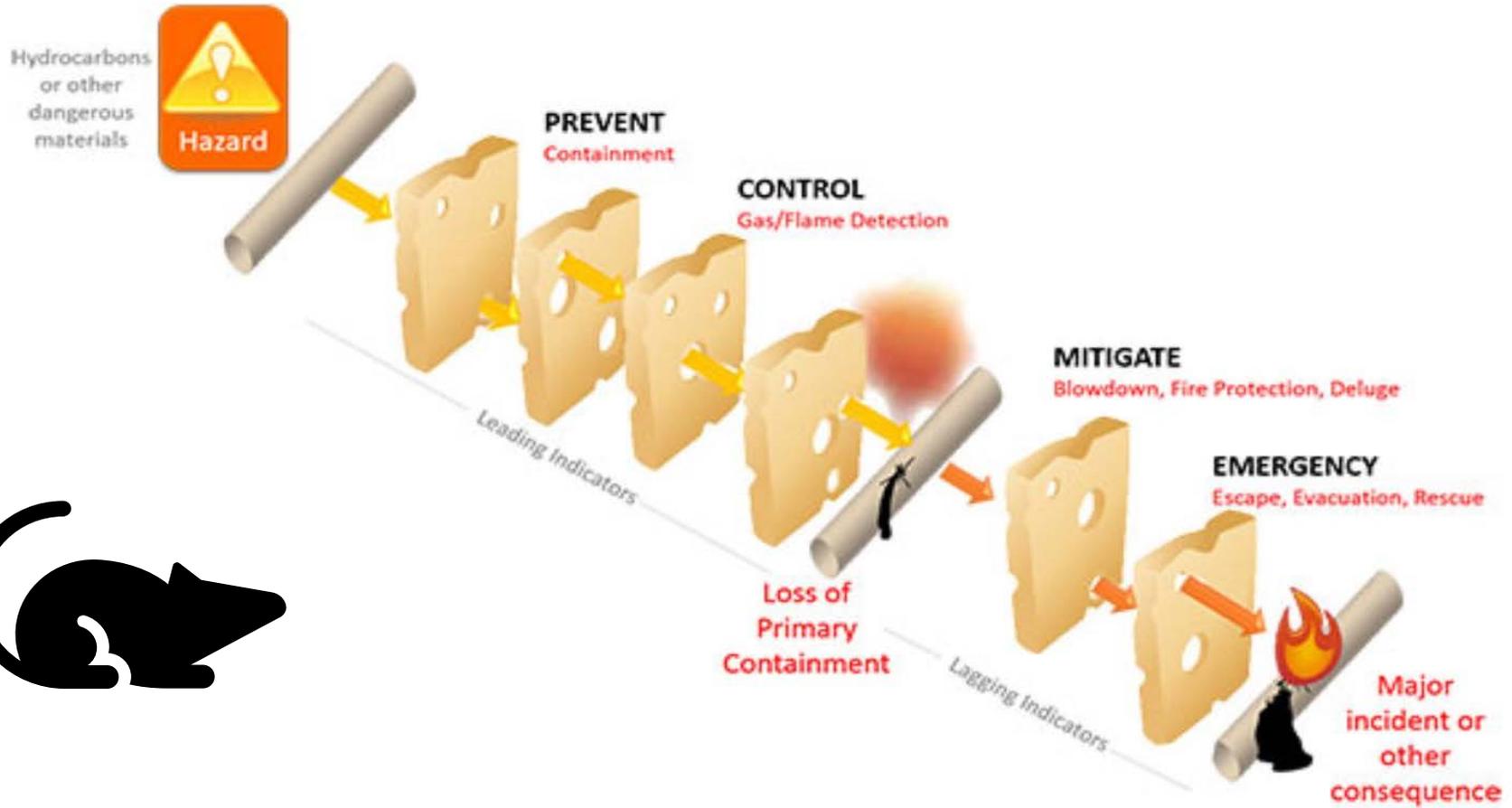
# Emerging Threats

---



- Watch/Warn
  - Pre-incident indicators “over the horizon”
- Identification of indicators of an emerging threat to prevent surprise
- Future cascading effects
- Prevention, Protection, Mitigation and Preparedness

# Pass the Cheese, Please





# Anthropogenic or Not..... Climate Change Is Happening!

If your not so sure.....

Policy-makers are convinced enough to change regulation and plans to include climate change!

# Changing Climate Means Changing Weather

---

Extreme weather events can have impacts on human health, limiting access to clean drinking water, food, and shelter and taxing people's ability to cope with heat, drought or flood.

- **More rain and flooding.** Warmer temperatures have led to more intense rainfall events in some areas. This can cause flooding – a risk to the environment and human health.
- **More extreme drought.** Warmer temperatures cause more evaporation, turning water into vapor in the air, and causing drought in some areas of the world. Places prone to drought are expected to become even drier over the next century. This is bad news for farmers who can expect fewer crops in these conditions.
- **Stronger hurricanes.** There is evidence that the number of intense hurricanes has increased in the Atlantic since 1970. This may also be true for tropical cyclones in other parts of the world. Scientists continue to study whether climate is the cause.
- **Heat waves.** It is likely that heat waves have become more common in more areas of the world.

# More Ocean, Less Ice

---



**Rising sea level is a threat** to coastal communities, wetlands, and coral reefs.

The water from the melted ice is added to streams and rivers and eventually makes its way to the ocean. Over the past 100 years mountain glaciers, Arctic glaciers, and Greenland's ice have **decreased dramatically in size**. Sea level rise is also happening because as **water warms**, it takes up more space – it expands larger.

# Plans already in play

- County Emergency Response Plan
- HazMat Area Plan
- Contra Costa Climate Action Plan
- California Climate Adaptation Strategy



# Emergency Services Sector Plan

---

## CalOES

- Preparedness
- Response
- Recovery
- Mitigation



**Cal OES**  
GOVERNOR'S OFFICE  
OF EMERGENCY SERVICES

## Northern California Catastrophic Flood Plan



# California Multi-Hazard Mitigation Plan

---

California added climate change to the 2007 version of its Multi-Hazard Mitigation Plan.

**“It was not until Hurricane Katrina drew the attention of the news media to scientific evidence on intensification of storm events that climate change was recognized as an emergency management topic,” the plan said.**

Contra Costa’s Hazard Mitigation Plan is currently under revision and will be including Adapting to Rising Tides data, which will be discussed during the presentation.



# The Flood Connection

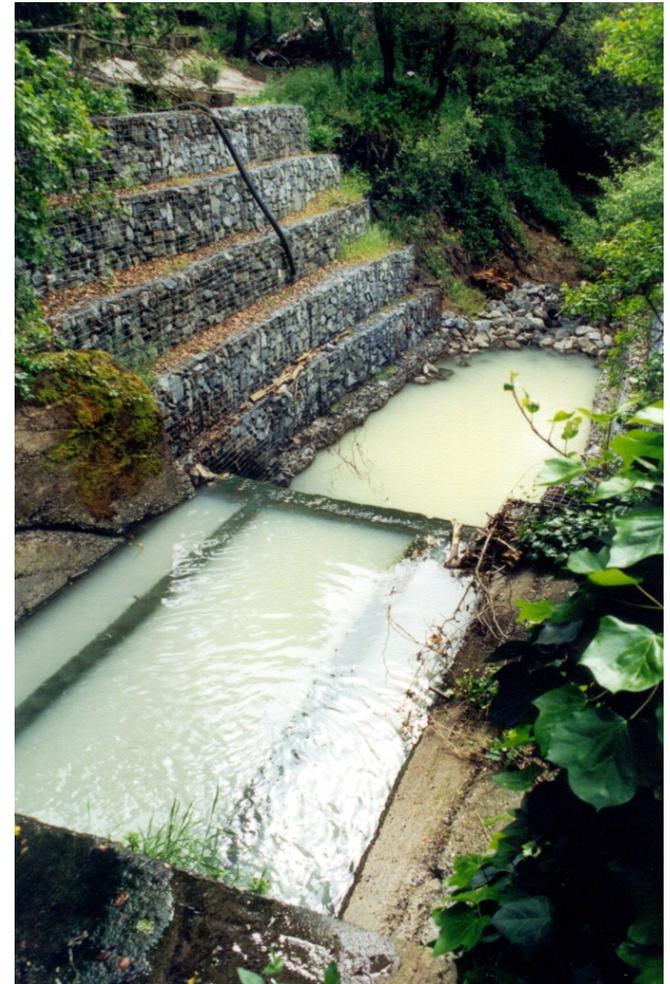
---

One infrequently studied problem in the natural hazards area is the **secondary effects** of flooding with respect to hazardous materials. During a flood, **hazardous materials incidents can occur** but may be overlooked because of concerns with the primary disaster impacts. These incidents may occur in a variety of ways. Old hazardous materials "dump" sites may be undermined and chemicals spread by flood waters. The **integrity of underground tanks** which store hazardous materials (e. g., gasoline or oil supplies) may similarly pose a threat. Barrels of stored chemicals or wastes can be moved by simply **floating away** and, since many of these containers are not labeled, they may constitute an **unknown** level of hazard. Unexpected hazardous materials problems could emerge in the post-impact period. (Laforanara et al)



# The Result: Spread

---



21<sup>st</sup> Annual California CUPA Training Conference  
February 2019

# What can I do about it?

## Adapting to Rising Tides

A regional program that uses findings, processes, tools and relationships built by ART and its partners to lead and support efforts that increase the resilience of Bay Area communities to sea level rise and storm events



San Francisco Bay Conservation  
and Development Commission

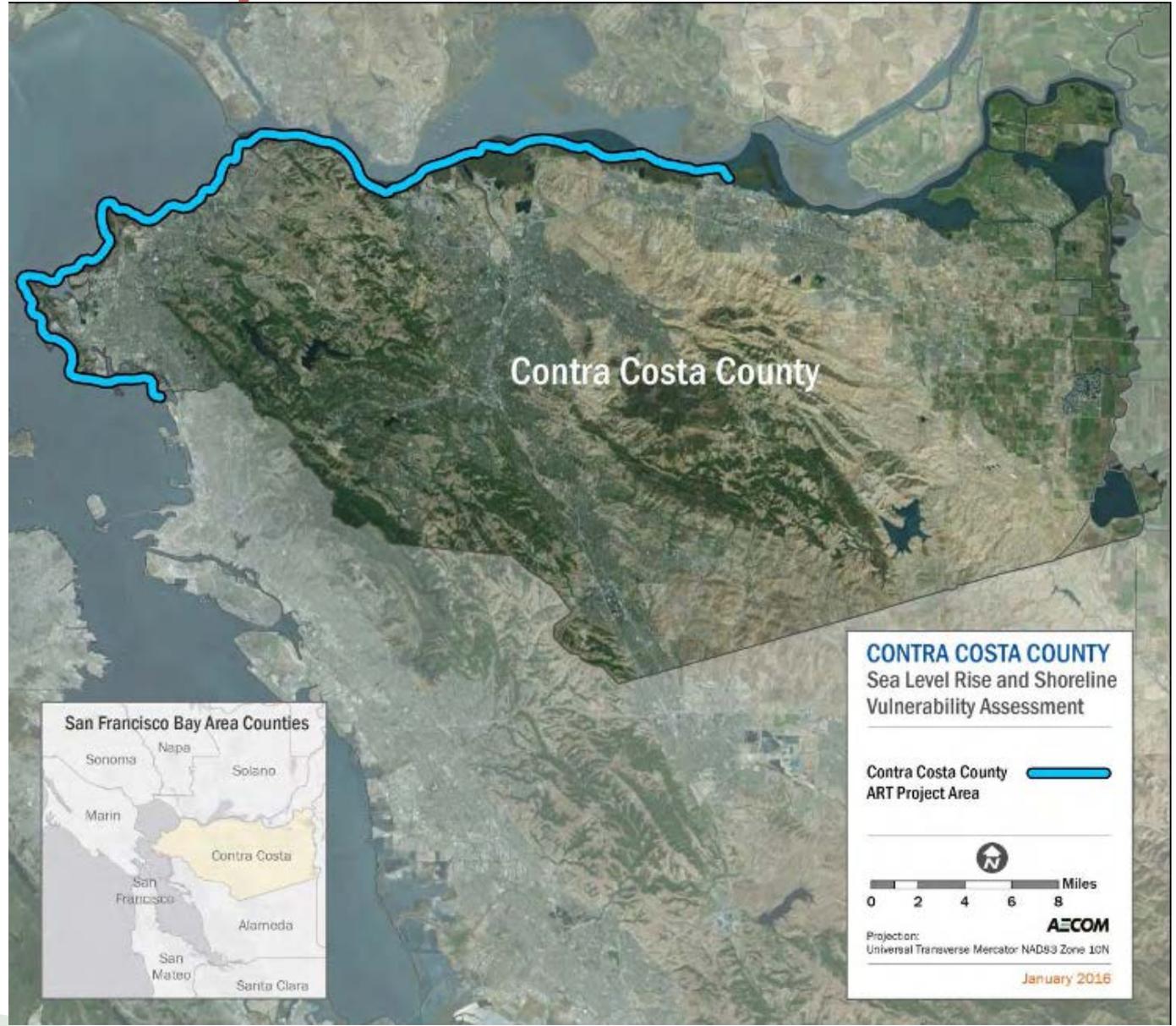
[www.adaptingtorisingtides.org](http://www.adaptingtorisingtides.org)

# Why focus on understanding and addressing flooding in the Bay Area?

- While storm events and sea level rise will be an issue for all of California, the Bay Area has unique challenges:
  - Some of the region's highest density development, including homes and job centers, are located on the shoreline
  - Many shoreline communities and businesses rely on ad-hoc flood protection, in some cases roadways or rail lines, to keep them dry during extreme high tides and storm events



# ART Program Project 2014-2016



# Stakeholder Working Group

ART Contra  
Costa Project

- **County Agencies:** Conservation and Development, Flood Control, Public Works, Health Services, Mosquito and Vector Control, Office of Emergency Services
- **Cities:** Planning and Public Works
- **Special Districts:** Water, Wastewater, Parks
- **Regional, State and Federal Agencies:** ABAG, MTC, Congestion Management/Transportation, NOAA, FEMA
- **Private Entities and Non-Governmental Organizations:** Power, rail, refineries, industrial alliances and councils, community based organizations



# ART Contra Costa Project

## Expected Project Outcomes

- A robust and transparent near county-scale assessment of current and future flooding
- A working group of public, private, and community stakeholders with capacity to further adaptation assessment and action
- An integrated understanding of how flooding could impact all frames of sustainability (society and equity, the environment, economy and governance)
- A clear and compelling case for taking action to solve near term issues and work together on longer term challenges



## **Community Characteristics**

Individuals, households, neighborhoods

## **Residential Housing**

Single-family, multi-family, mobile homes

## **Community Facilities and Services**

Public health infrastructure

Emergency facilities and services

Waste collection and transfer stations

Commercial land uses

## **Industrial Land Uses**

Industrial land uses

Brownfields

Hazardous Materials Sites

Landfills (closed and open)

## **Parks and Recreation Facilities**

Shoreline parks

Bay trail

Marinas

# **Sectors and Assets**

## **Water Management**

Water supply

Wastewater

Flood management

Stormwater infrastructure

## **Transportation**

Passenger and freight rail

Local, state, interstate roads

Bay trail

Seaport (Port of Richmond)

Marine oil terminals

## **Energy and Fuel Supply**

Pipelines

Refineries

Power generation

Power distribution

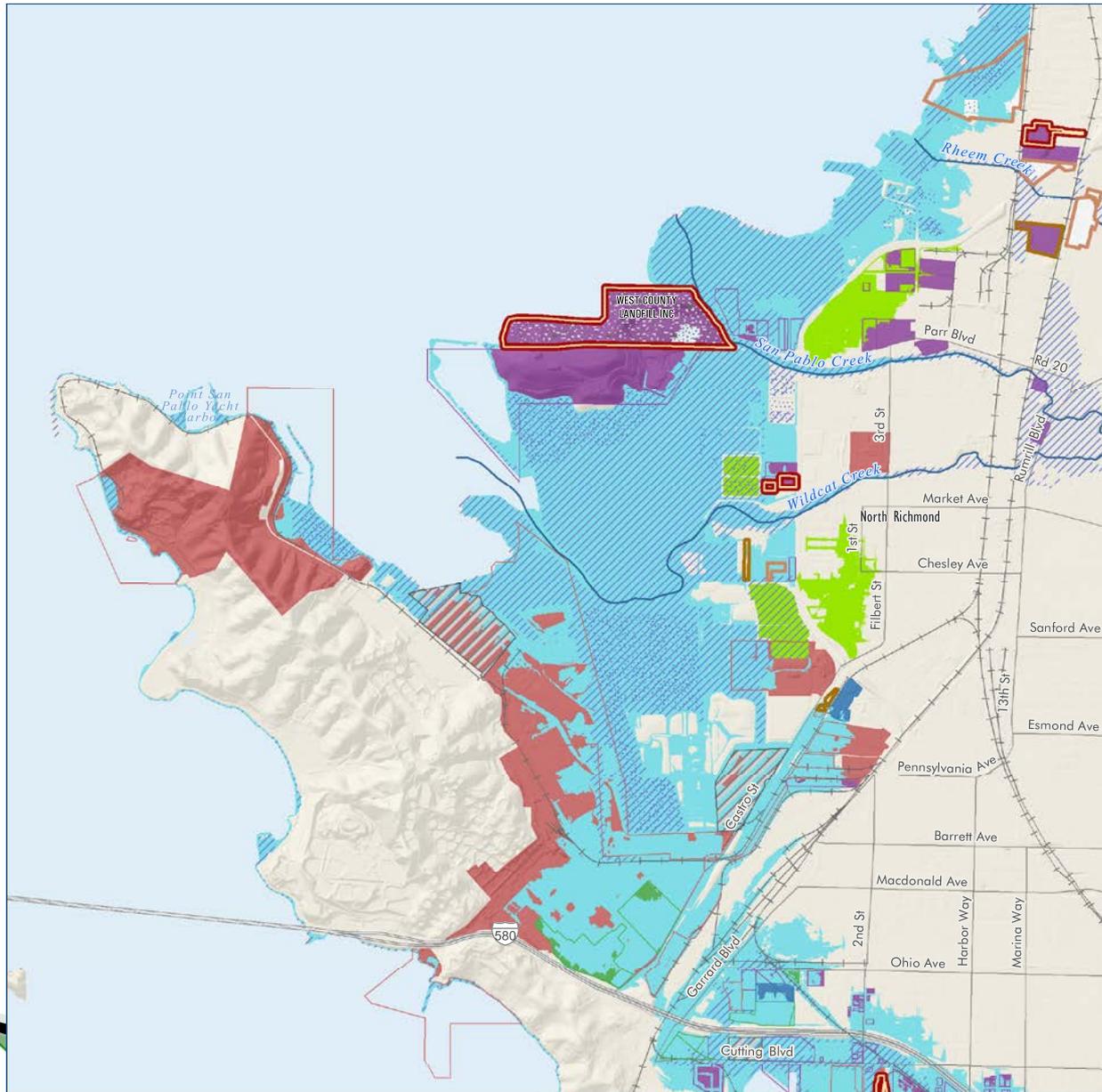
(substations)

# Shoreline Mapping and Analysis

- Ten new locally refined maps representing different amounts of sea level rise (0 to 66”) and tide levels (daily high tide to 100-year extreme tide)
- Mapping of the shoreline by type, location and elevation
- Analysis of where the shoreline may be too low resulting in overtopping



# Industrial Land Use Maps

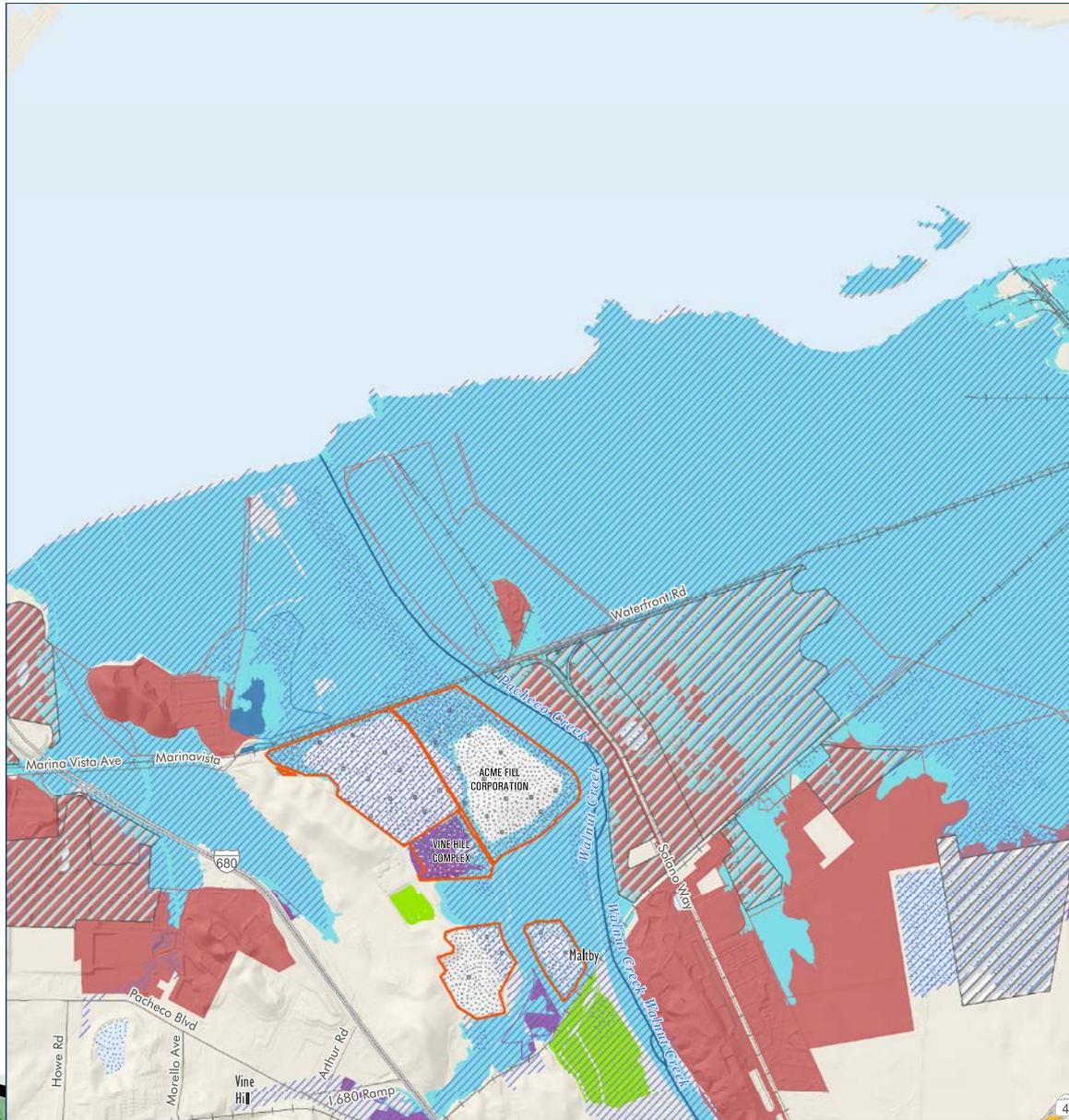


Certified O&M - Land Use Restrictions Only



Training Conference  
February 2019

# Industrial Land Uses



Certified O&M - Land Use  
Restrictions Only



# Visualization of 3', 6' and 9' flooding

---

➤ <https://youtu.be/K75YFndkAZY>



*This Photo* by Unknown Author is licensed under [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/)



Adapting to Rising Tides

# Bay Shoreline Flood Explorer

The Adapting to Rising Tides program has developed this website to help Bay Area communities prepare for the impacts of current and future flooding due to **sea level rise and storm surges** by learning about causes of flooding, exploring maps of flood risk along our shoreline, and downloading the data for further analysis. These maps increase understanding of what could be at risk without future planning and adaptation, helping Bay communities, governments, and businesses to drive action.

LEARN

EXPLORE

DOWNLOAD

ABOUT

## One Map, Many Futures

<https://explorer.adaptingtorisingtides.org/home>



21<sup>st</sup> Annual California CUPA Training Conference  
February 2019

# Findings: Hazardous Materials Sites

- 1287 Hazardous Materials Business Plan sites in the project area
- 226 sites are in the current 100-year floodplain, 76 of these are at greater risk due to sea levels rise
- 103 sites are not within the current floodplain but are at risk of future flooding due to sea level rise



## Key Issues:

Facilities may be particularly vulnerable if materials are stored at or below grade, are improperly contained, or if there is not time to safely shut down operations in advance of a storm

Managers and owners of sites not currently in the floodplain may not be aware of the flood risks, and therefore may not be planning, preparing or operating in a manner to reduce the impacts of flooding should they occur



# ART Project Outcomes

---

- **Action 1:** Develop and disseminate guidance to business and industry on the best practices for reducing the potential impacts of flooding and sea level rise on their facilities and the services and systems they rely on
- **Action 2:** Create a public-private shoreline working group tasked with developing a plan to fund and implement integrated shoreline solutions to reduce flood risk
- **Action 3:** Develop a county-wide program to monitor, maintain, and repair (as feasible) at risk shorelines most in need of intervention
- **Action 4:** Establish a public private partnership to better understand the consequences of flooding on commercial and industrial supply chains, employee access to job sites and the regional transportation networks goods and commuters rely on

# Direction?

---

- Where are we now?
- Where are we going?
- What next?
- What is HazMat doing?



[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)

# Contra Costa ART Project

➤ Final report has been released March 2017

Hazardous Materials Sites	Current 100-year Flood only	100-year Flood + Sea Level Rise (cumulative count)					
		1'	2'	3'	4'	5'	6'
Hazardous Business Plan	140	153	156	163	180	212	216
CalARP	2	4	5	5	5	5	5
CalARP + ISO	0	5	5	8	8	8	8
<b>Total</b>	<b>142</b>	<b>160</b>	<b>164</b>	<b>174</b>	<b>191</b>	<b>223</b>	<b>227</b>

Table 8. Hazardous materials sites outside of the current 100-year floodplane that could be exposed to sea level rise or are located in adjacent low-lying areas that could be inundated.

Hazardous Materials Sites	Sea Level Rise (cumulative count)						Low-lying, adjacent to 6 feet SLR
	1'	2'	3'	4'	5'	6'	
Hazardous Business Plan	0	1	1	13	70	103	ND

# Implementation Pathways

- Action 1: Develop and disseminate guidance to business and industry on the best practices for reducing the potential impacts of flooding and sea level rise on their facilities and the services and systems they rely on.
- Action 2: Create a public-private shoreline working group tasked with developing a plan to fund and implement integrated shoreline solutions to reduce flood risk
- Action 3: Develop a county-wide program to monitor, maintain, and repair (as feasible) at risk shorelines most in need of intervention.
- Action 4: Establish a public-private partnership to better understand the consequences of flooding on commercial and industrial supply chains, employee access to job sites and the regional transportation networks goods and commuters rely on.

# Adapting to Rising Tides Project and Hazardous Materials

---

## Steps in Implementation:

- **Identify** the businesses that handle hazardous materials that would be impacted by sea level rise and flooding the soonest.
- Develop **incentives** for these businesses to review their vulnerability to these impacts and change their management practices to address these impacts
- Develop **requirements and/or guidance** for businesses to review their vulnerability to these impacts and change their management practices to address these impacts.
- Consider **long-term zoning changes** that would exclude businesses that manage hazardous materials from areas subject to sea level rise and flooding.

# Adapting to Rising Tides Project and Hazardous Materials

---

## Key Objectives:

- Create **educational documents** to be distributed to business, by business type and risk area, with hard recommendations (ex. Provide containment measures for drums in at-risk locations).
- Use of the **Hazardous Materials Business Plan** to emphasize compliance in at-risk businesses, and possible use of an Ordinance to solidify flood risk as a threat for hazardous materials release under current regulations
- Participate in a **Shoreline Working Group**, as directed by the County, to address hazardous materials businesses directly adjacent to the shoreline in terms of sea level rise and flooding. Collaboration should include government, industry, rail, pipeline and other land uses.

# Educational Outreach

---

- Development of multi-step educational campaign to align with the 2018/2019 wet season
  - Develop guidance for those who would be impacted soonest
- Initial letter with basic information regarding CCHSHMP's involvement in the Adapting to Rising Tides program as well as basic steps any facility can take to be best prepared in a flood situation
  - Sent out in November 2018
- Development of Best Practice guidance

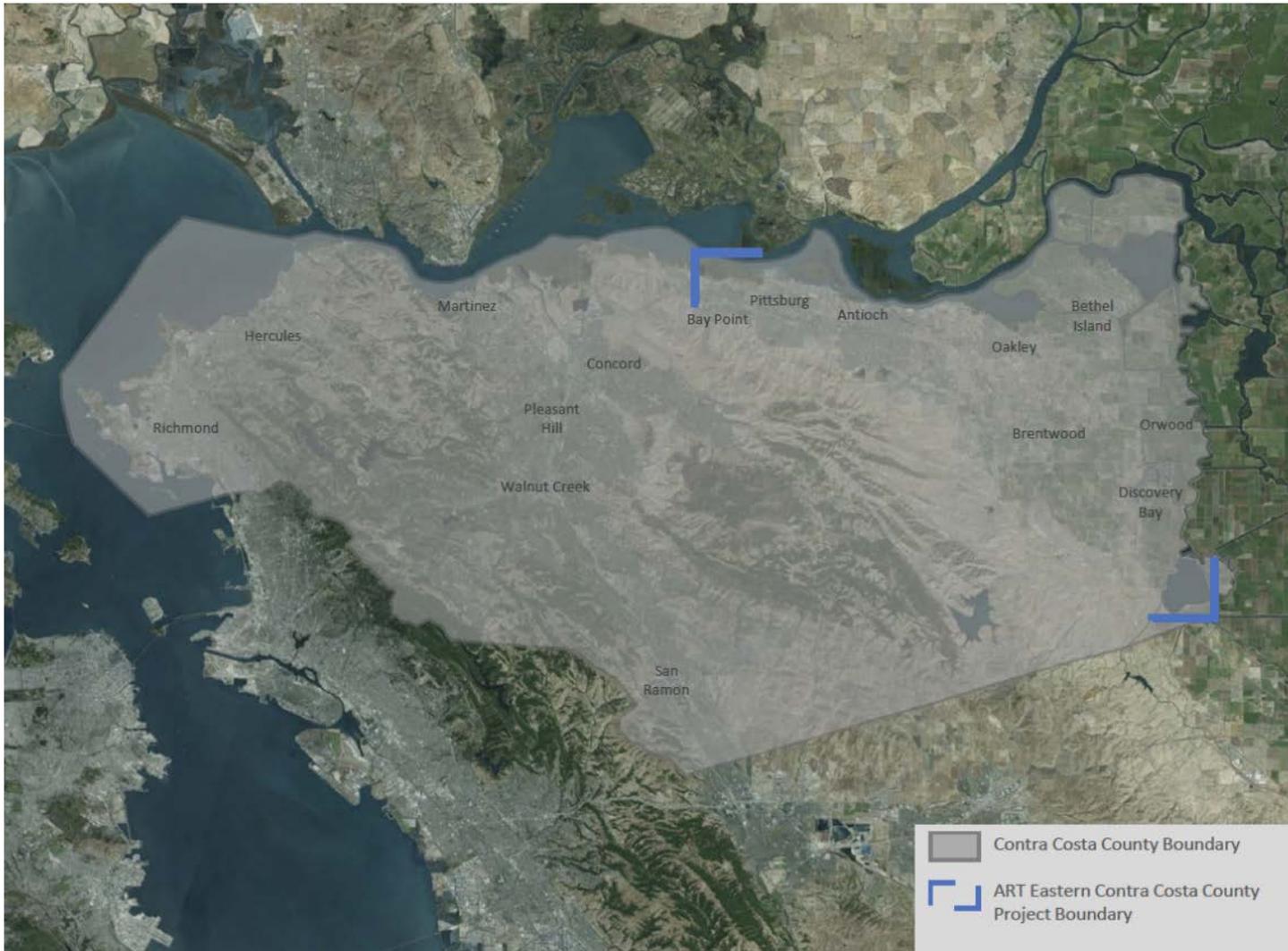
# Educational Outreach

---

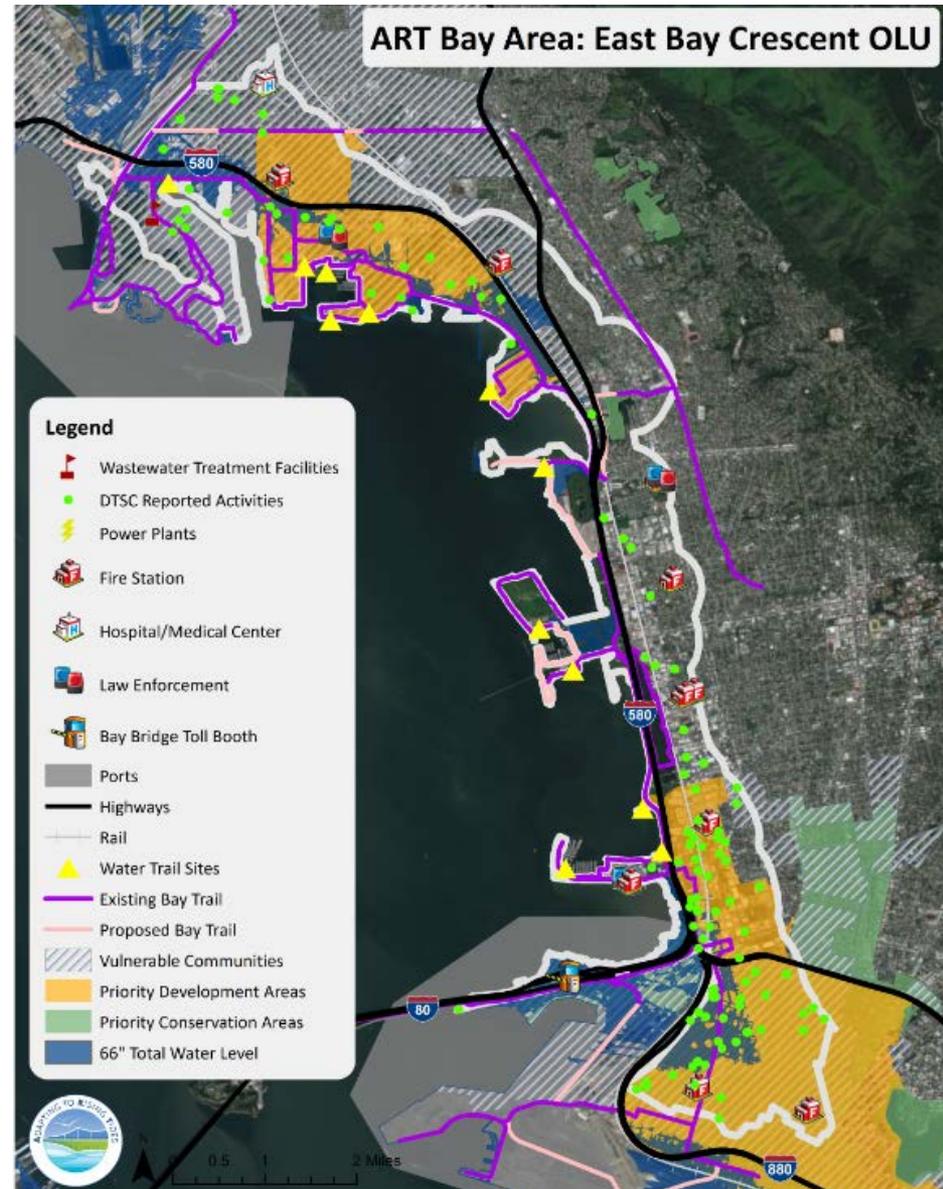
## Hazardous Materials Business Plan Compliance

- Continue to ensure **compliance** for facilities in regards to chemical storage and suggesting best management practices for storage
- Evaluation of facility's **Emergency Response Contingency Plan**
  - Template plan does not currently include flood as a specific risk
  - Possibility in the future?

# Eastern Contra Costa ART



# ART Bay Area



# Bay Area Wide ART- Transportation Specific Program

---

- CCHSHMP has been participating in the Bay Area Wide project which began in Spring of 2017
- The project will conduct a regional vulnerability assessment of the Bay Area's transportation infrastructure, Priority Development Areas (PDAs) and Priority Conservation Areas (PCAs) as identified in the Sustainable Communities Strategy (Plan Bay Area), and vulnerable and disadvantaged communities
  - CCHSHMP engaged particularly in Hazardous Materials Transportation Infrastructure

# Critical Transportation Pathways

GIS, shoreline businesses  
and emergency responders



FUNC2: Industrial land uses rely on roads, rail lines, pipelines, airports, seaports and marine terminals to ensure materials and supplies are imported, goods produced are exported, and employees can get to/from work. Many of these transportation systems are vulnerable to flooding and their disruption could impact operations at industrial facilities of all types.

- |       |   |
|-------|---|
| IL3.1 | Conduct a "hot spot" assessment to identify and evaluate vulnerable local and regional routes and nodes that are critical to maintaining industrial supply chains and ensuring employees can access industrial job sites                                  |
| IL3.2 | Implement an annual King Tide site monitoring and inspection program to document local and regional routes and nodes at early risk from flooding  |
| IL3.3 | Expand or form broad public-private partnerships to guide the planning and implementation of multi-objective transportation and goods movement improvements to ensure existing infrastructure and new investments are resilient to sea level rise impacts |

# 2018-19 Hazardous Materials Emergency Preparedness (HMEP) Planning Subgrant Program



# Hazardous Materials Emergency Preparedness Subgrant

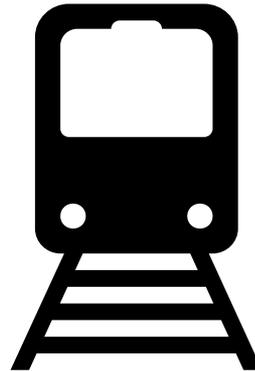
---

- CCHSHMP was selected by the Local Emergency Planning Committees to be awarded a subgrant as part of DOT's Pipeline and Hazardous Materials Safety Administration HMEP Grant
- Funds to be distributed to conduct a **Commodity Flow Study with Special Focus on Sea Level Rise and Flood Risk**
- Support given by Community Awareness Emergency Response (CAER) for the study

# Commodity Flow

---

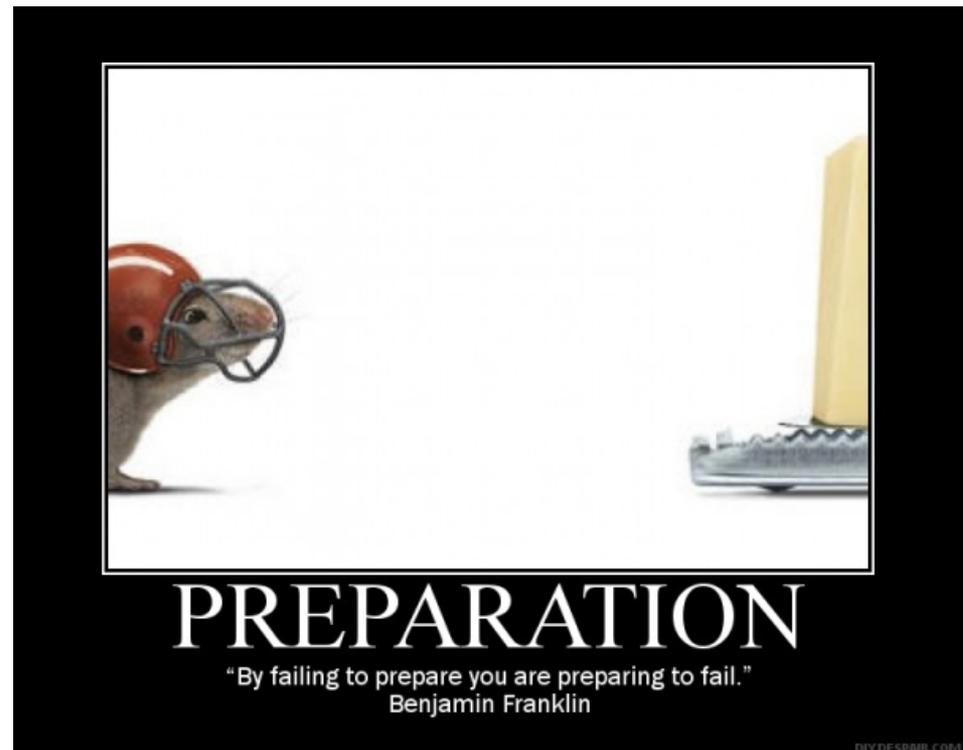
- Plans for the project?
- Where are we now?
- Uses for outcomes of the project?
  - Area Plan
  - GIS



# What can our regulated business do to prepare?

---

- Opportunity to engage in Commodity Flow Study to better understand vulnerabilities



# Role of our Industry Partners

---

- In order to develop the most useful Commodity Flow Study as possible “ground truth” information is critical
- Participation Opportunity
  - Chemicals of interest
  - Rail traffic in and out of facilities
  - Integral shipment lines that are at risk
    - Isolation from supply chain
    - Opportunities for alternative transportation
    - Products with little or no alternatives

# Questions

---

- Assess the threats and hazards to the area Community specific impact could be calculated
  - What gaps could be anticipated?
- Identify hazards present
  - Flooding can present challenges to public information/warnings, planning, supply chain and security, community resilience, logistics and supply chain management, mass care services, communications, economic recovery and housing
- What about HazMat, specifically?
  - HazMat businesses and transportation
  - Think about access to emergency services, hazmat transportation to and from facilities, access to workplaces, and container/equipment failures
  - Do you see increased risk?

# It's not just floods.....

Drought

Fire Risk

Infrastructure Failures

Increased Pesticide Use

Decreased Roadway Access

Loss of Communication

Transportation failures

**Just like we prepare for Earthquakes, shouldn't we be preparing for an influx of weather events, like floods, that can be caused by Climate Change?**

**Shouldn't we adapt to lessen the effects of Climate Change?**

# Keeping ourselves safe by keeping ourselves educated

Ellen Dempsey

Hazardous Materials Specialist II

Contra Costa Health Services,

Hazardous Materials Programs

Office: 925-335-3225

Cell: 925-239-3344

[Ellen.Dempsey@cchealth.org](mailto:Ellen.Dempsey@cchealth.org)



# Industrial Facilities and Flood Hazards in California Environmental Justice Communities

Presented by

**Karen Riveles**

**21<sup>st</sup> Annual California CUPA Training Conference**  
**February 25-28, 2019**  
**Anaheim**



[www.calcupa.org](http://www.calcupa.org)



Aerial view of Richmond, California

**GIS work performed by: Justin Remais, PhD and Alex Shi  
Environmental Health Sciences, School of Public Health  
University of California, Berkeley**

# Introduction

---

- Motivating concern: increases in frequency and severity of extreme weather/flooding in California
- Understand the interrelationships between flood hazards, key infrastructure, and vulnerable populations in California
- Synthesize geospatial information on industrial facilities in environmental justice communities with respect to flood risk under past, present, and future climate conditions
- Include contributions from storm surges, extreme weather events, and sea level rise
- Support planning efforts for adaptation strategies, mitigation, resilience, and preparedness



# Two Flooding Scenarios

---

Two flooding scenarios were chosen for comparison throughout the study, termed:

*high probability major flooding*

and

*low probability severe flooding*

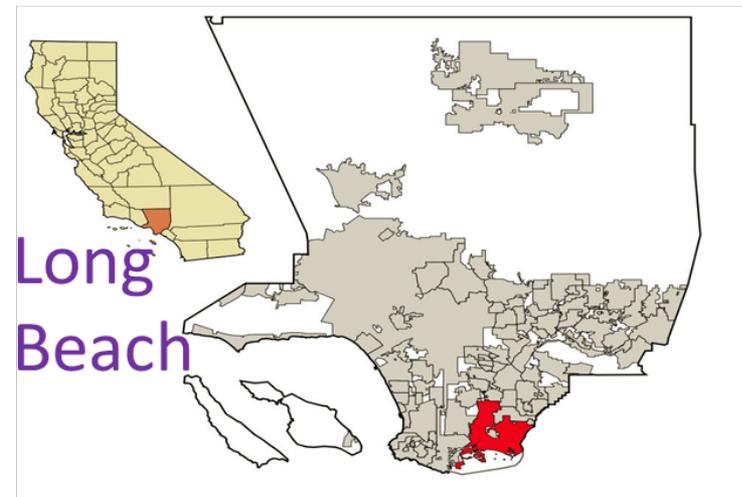
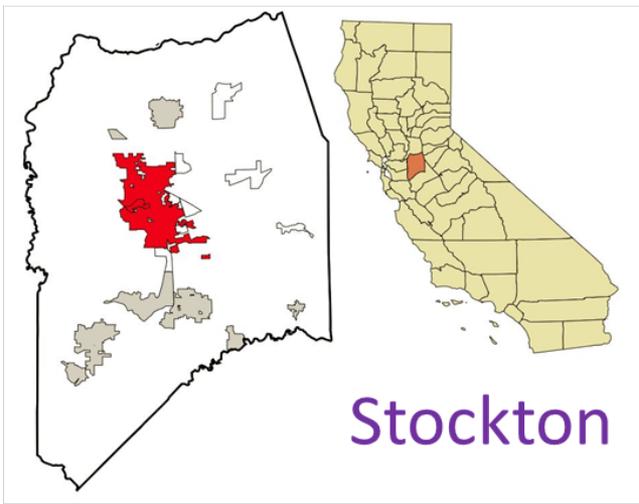
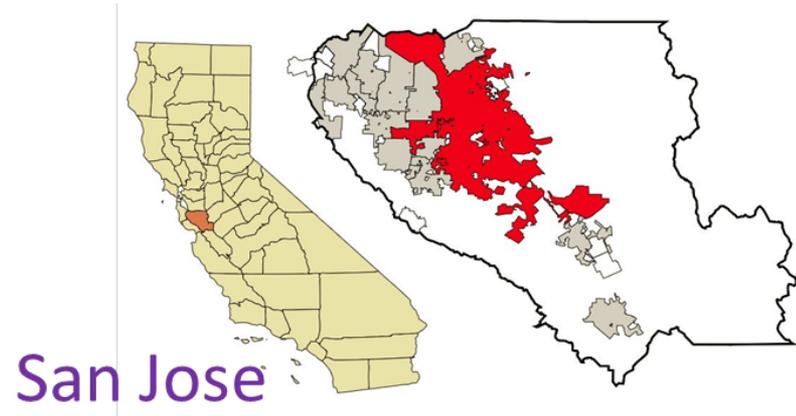
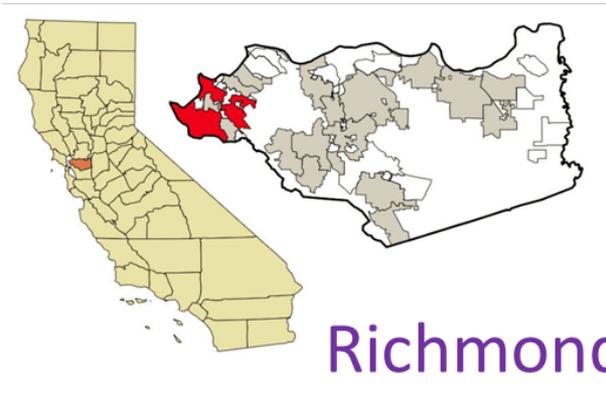
# Two Flooding Scenarios

---

0.3m and 2.0m represent low and high sea level rise scenarios associated with climate change as projected by the year 2100, per recent NOAA assessments

<b>Flooding scenario</b>	<b>Definition</b>
<b>High probability major flooding</b>	Floodplains extending from 100-year floods and storms (1% annual probability); includes 0.3 m of sea level rise in coastal areas
<b>Low probability severe flooding</b>	Floodplains extending from 500-year floods and storms (0.2% annual probability); includes 2.0 m of sea level rise in coastal areas

# Four Pilot Communities



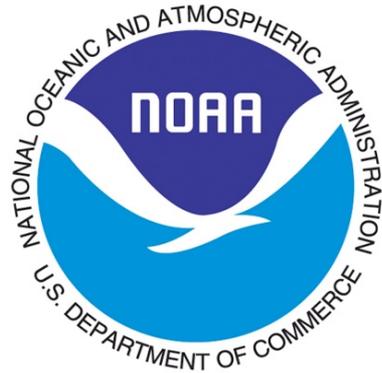


# Richmond: Flooding

- SF Bay Conservation and Development Commission's Adapting to Rising Tides (ART) Program assessment of sea level rise and extreme tide conditions;
- NOAA analysis of sea level rise and coastal inundation



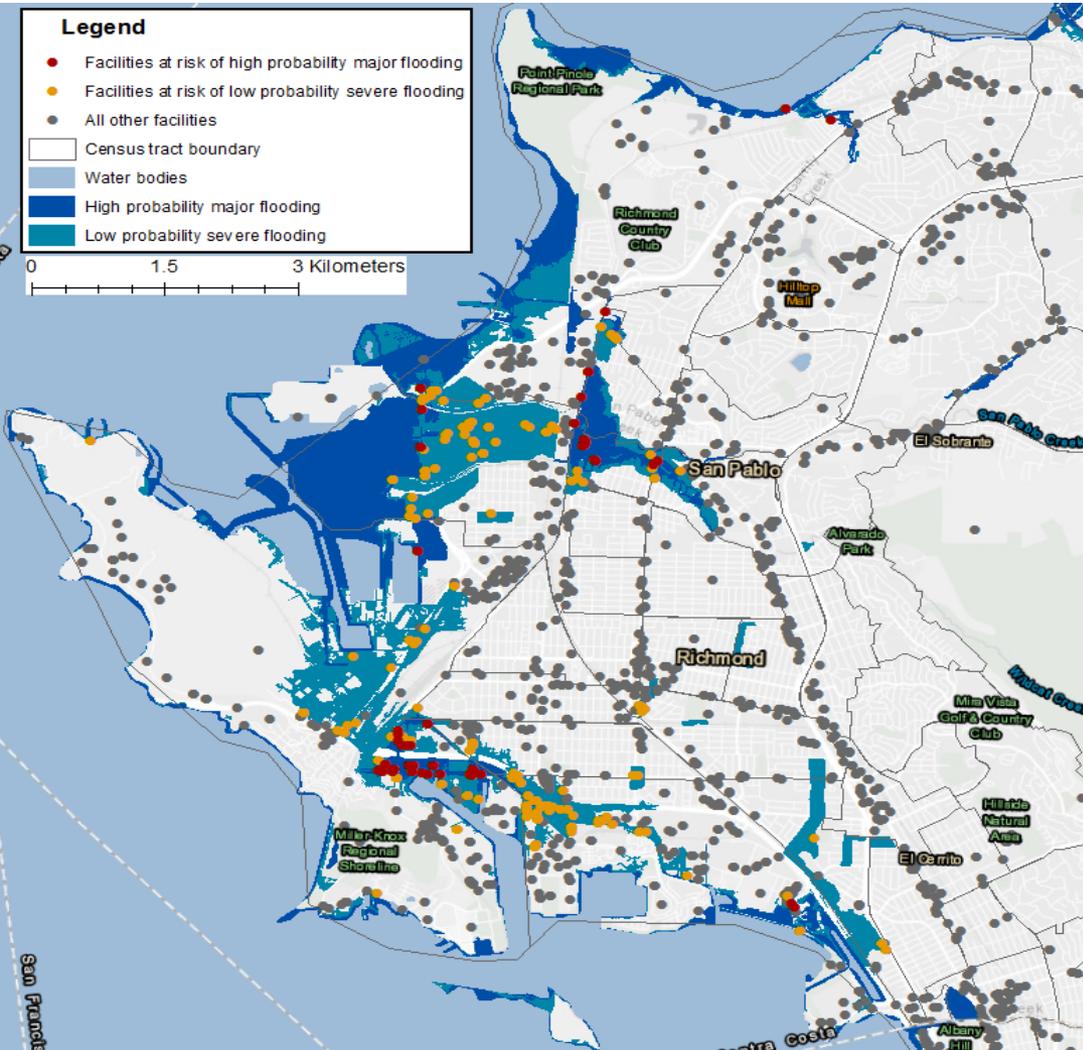
San Francisco Bay  
Conservation and Development Commission



- 45% of the population in the Richmond area lives in census tracts with facilities at risk of flooding
  1. With facilities at risk of **high probability major flooding** (34,705 people)
  2. With facilities at risk of **low probability severe flooding** (64,436 people)
  3. **Without facilities at risk of flooding** (77,540 people)

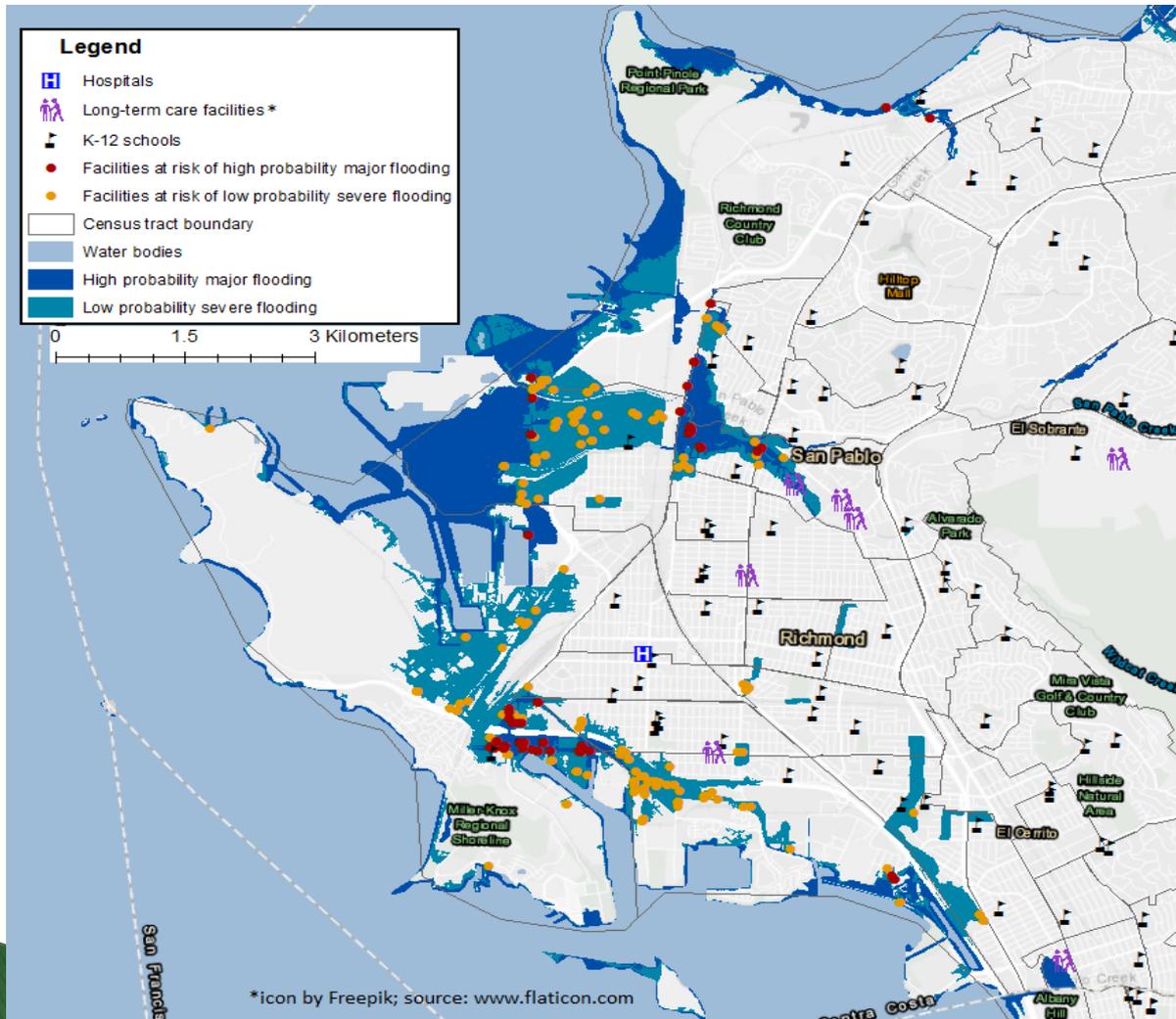
# Richmond: Industrial Facilities

Red: high probability major flooding; Yellow: low probability, severe flooding



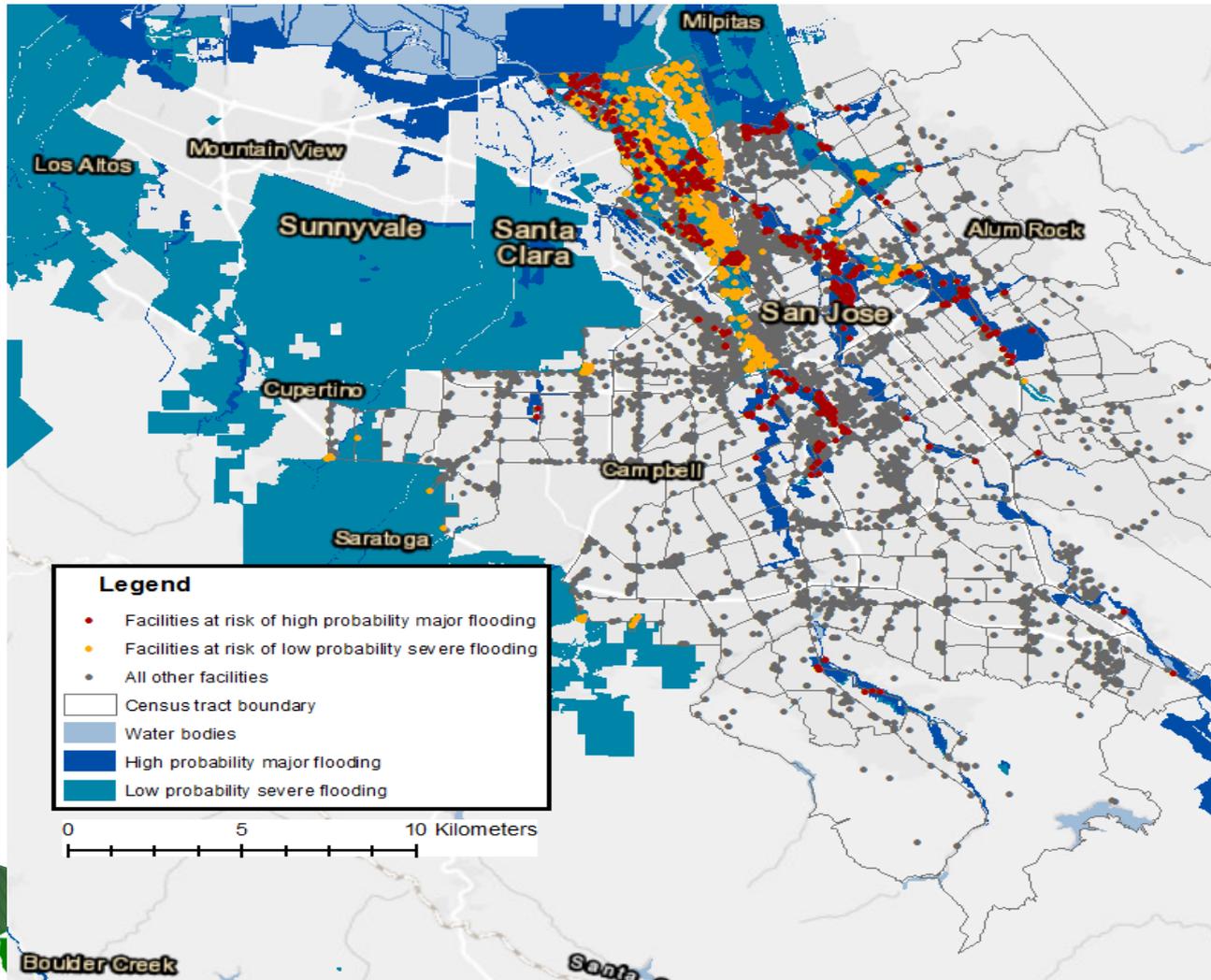
- 84 facilities at risk of **high probability major flooding**
- 309 in the **low probability severe flooding scenario**
- 23 facilities at risk of flooding had chemicals capable of causing acute health effects
- Majority of the chemicals classified as flammable and combustible liquids, as being corrosives, or as being either flammable or nonflammable gases under U.S. Department of Transportation (DOT) hazard classification

# Richmond: Sensitive Receptor Sites



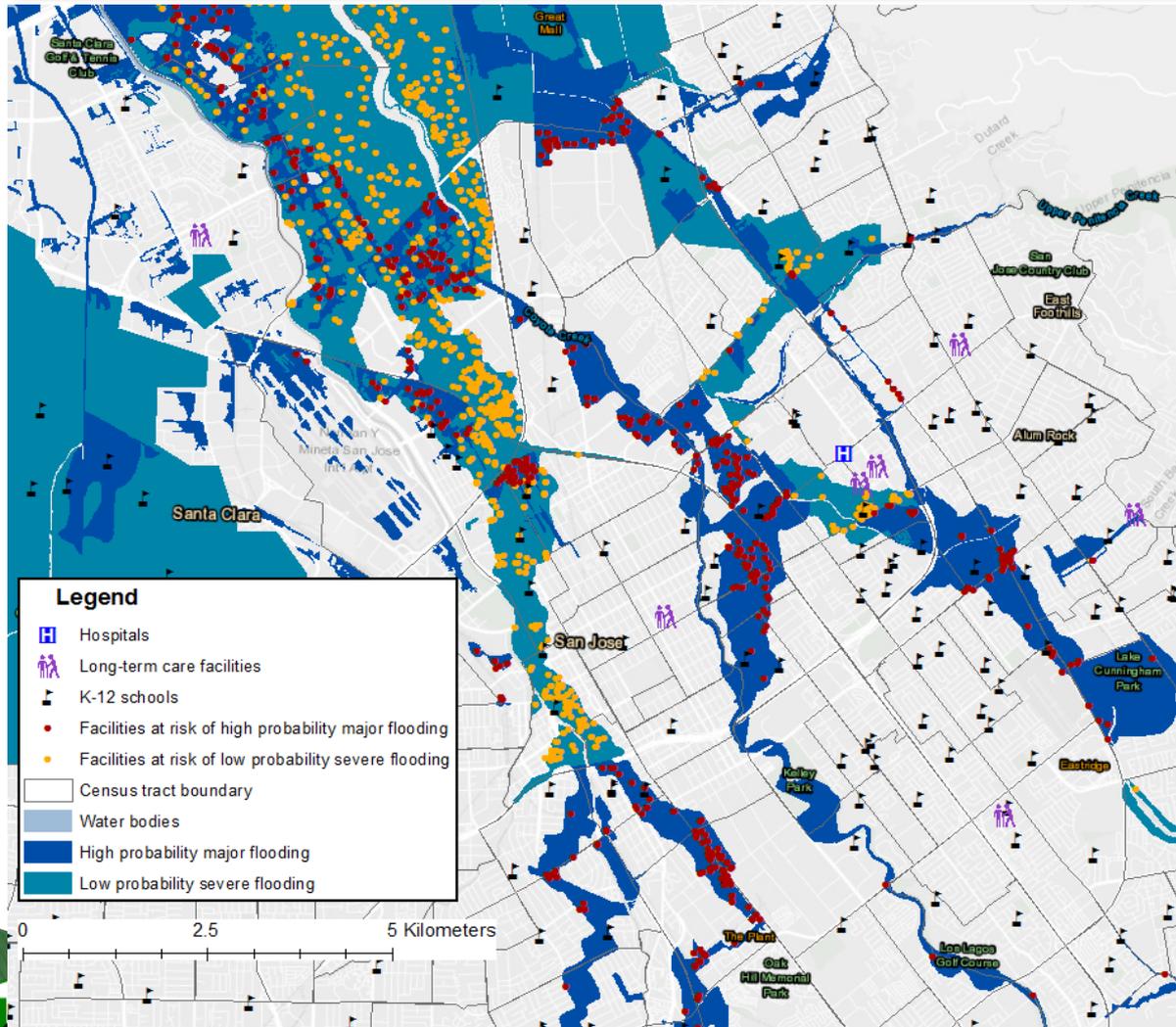
- Zero hospitals, one LTCF, and three schools in areas at risk of **low probability severe flooding**
- One hospital in the area is more than one kilometer away from any flood risk area or facility at risk of flooding

# San Jose: Industrial Facilities



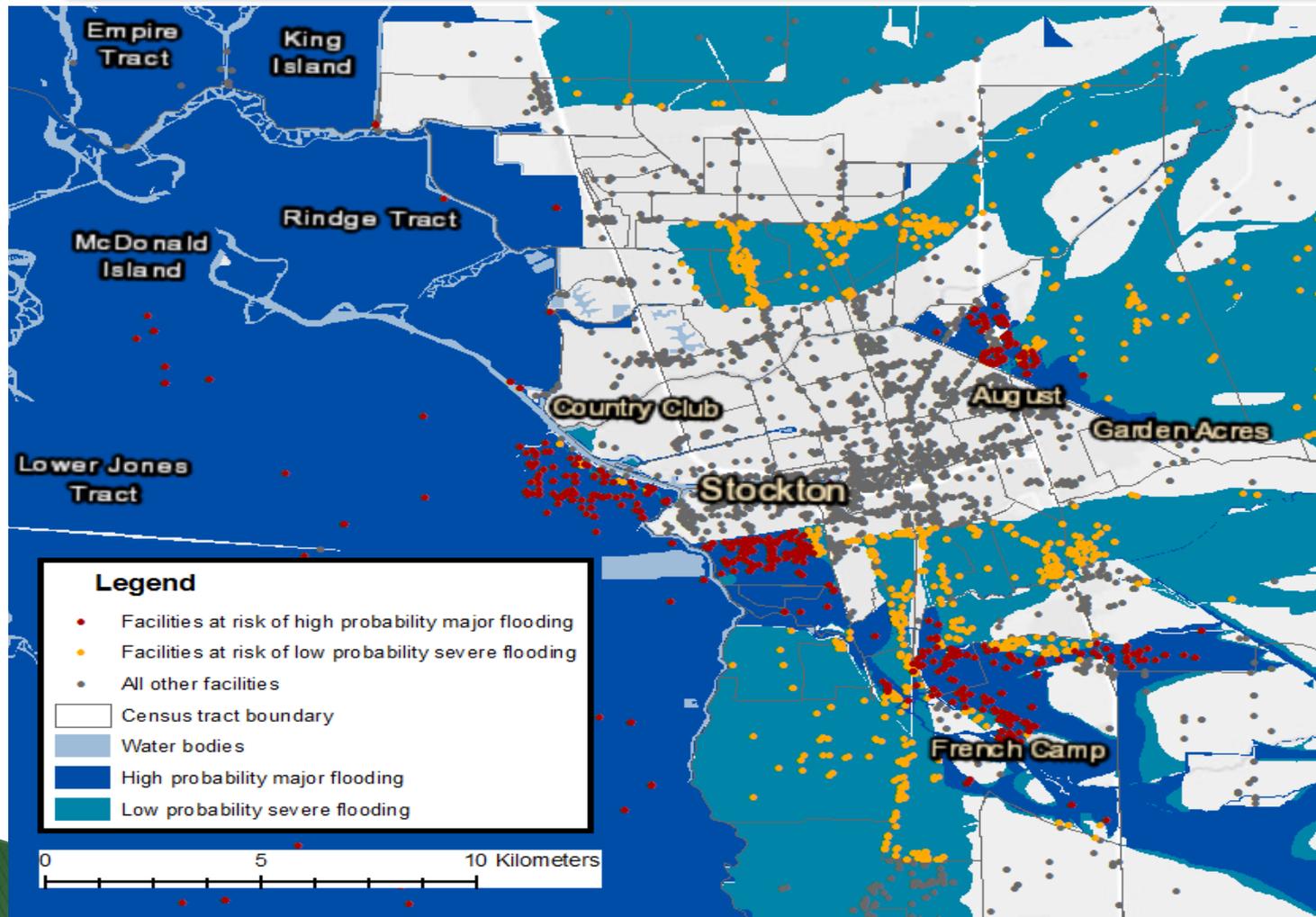
- 864 facilities in red are those at risk of high probability major flooding
- 1,990 facilities at risk in the low probability severe flooding scenario (additional facilities at risk in yellow)

# San Jose: Sensitive Receptor Sites



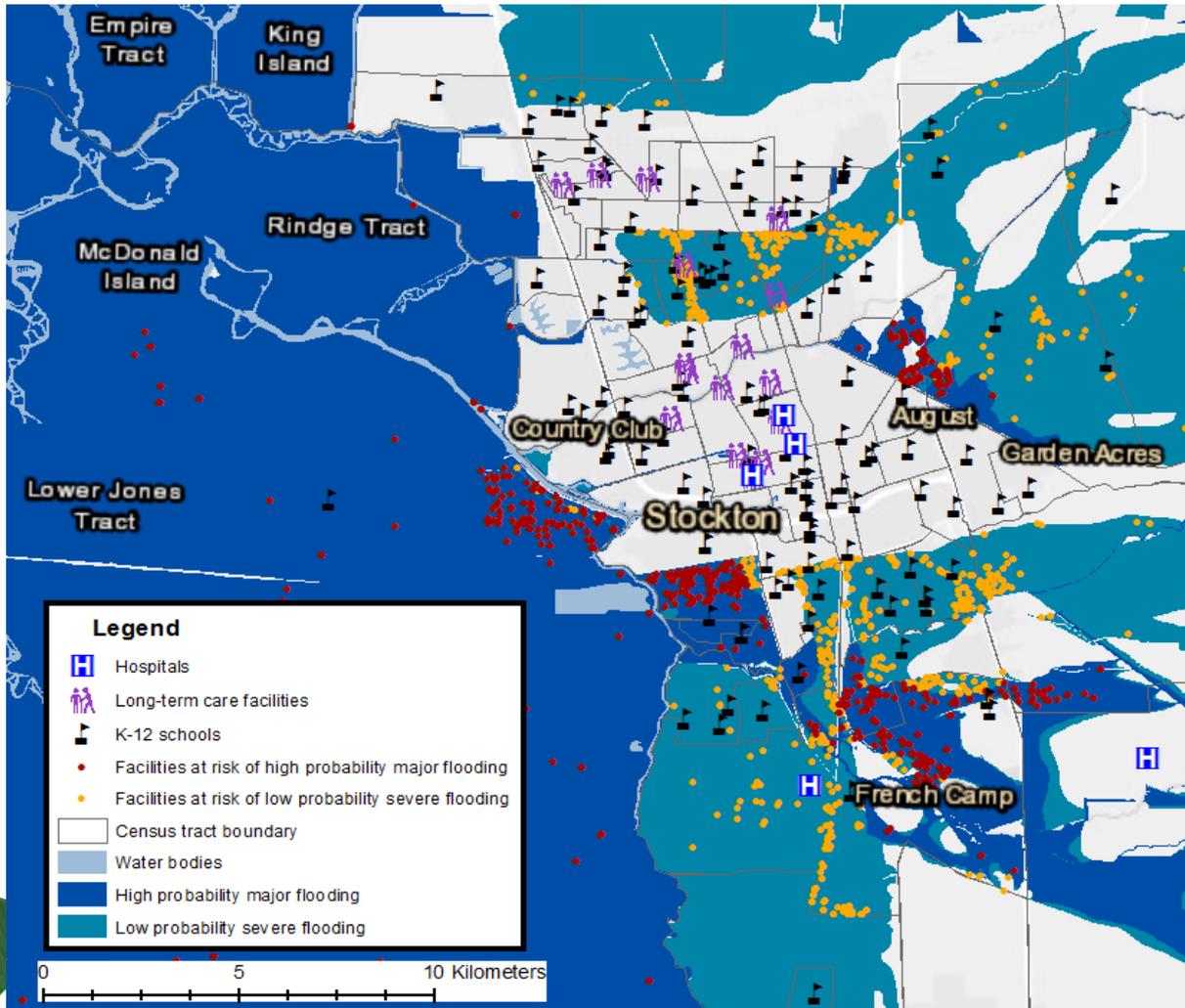
- Two hospitals, one LTCF, and 30 schools in areas at risk of low probability severe flooding

# Stockton: Industrial Facilities



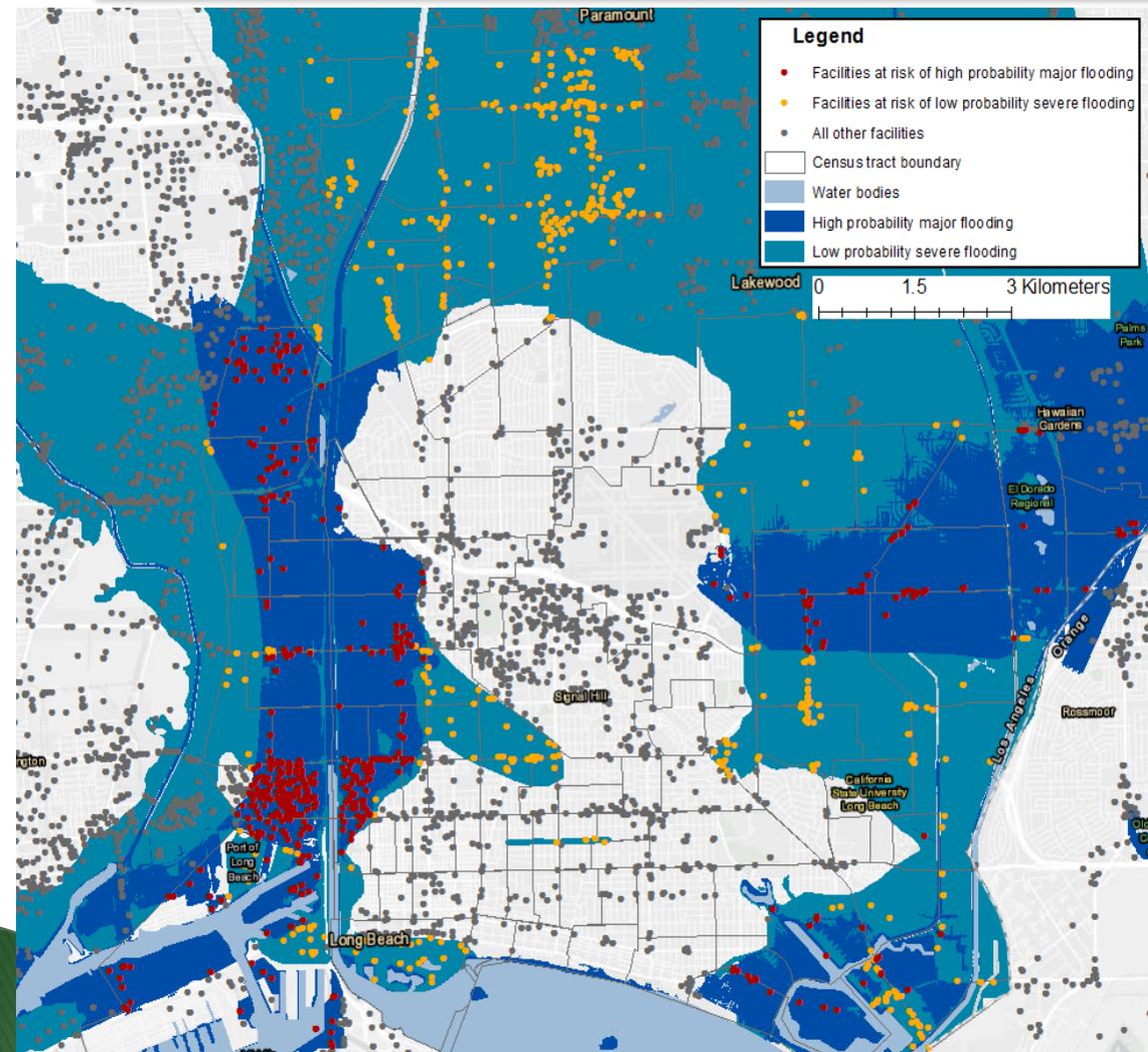
- 863 facilities in red are those at risk of high probability major flooding
- 1,932 facilities at risk in the low probability severe flooding scenario

# Stockton: Sensitive Receptor Sites



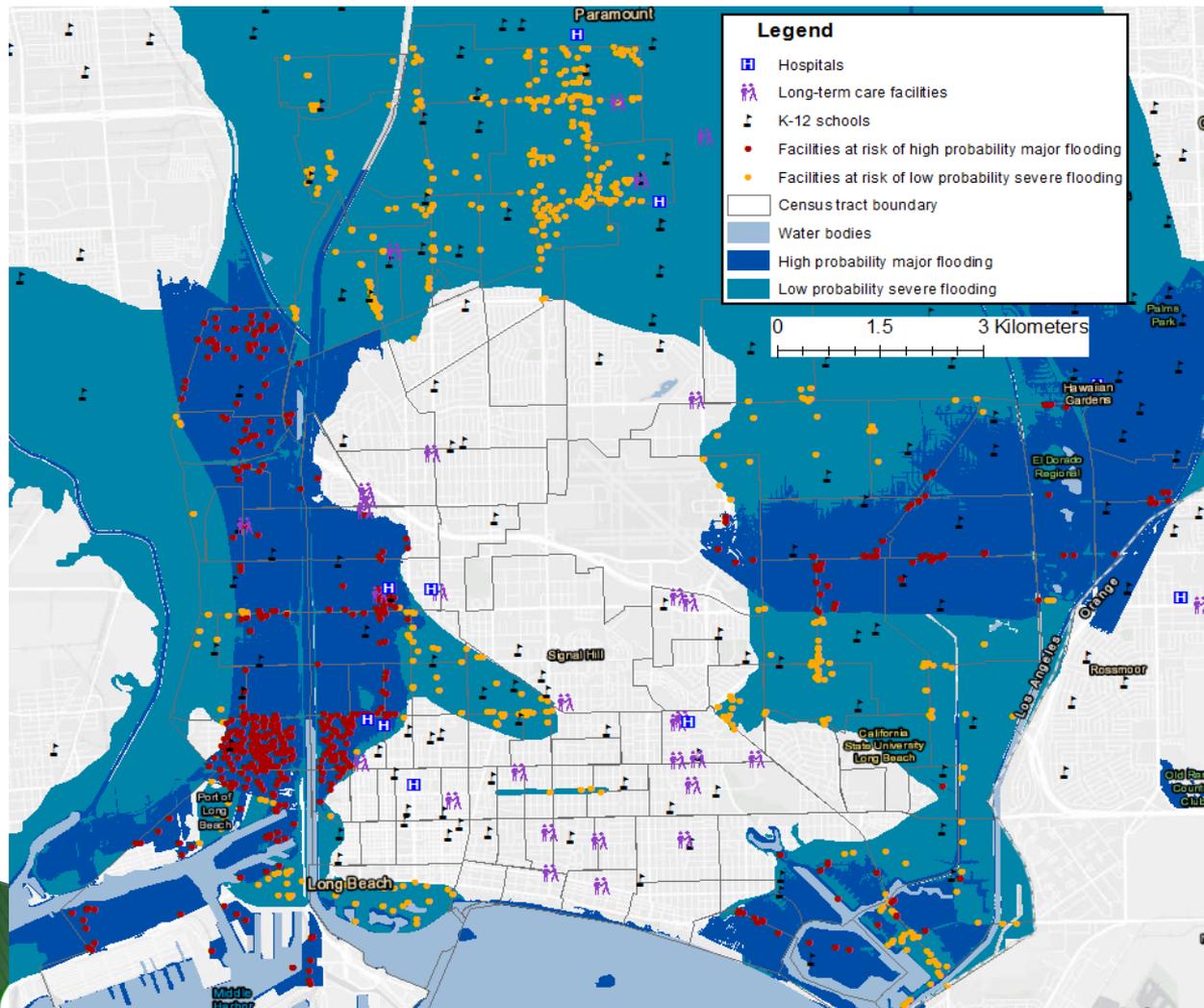
- One hospital, two LTCFs, and 38 schools in areas at risk of low probability severe flooding
- One hospital at risk is the San Joaquin General Hospital located in French Camp but it is only at risk in the low probability severe flooding scenario

# Long Beach: Industrial Facilities



- 829 facilities in red are those at risk of **high probability major flooding**
- 1,779 facilities at risk in the **low probability severe flooding** scenario

# Long Beach: Sensitive Receptor Sites



- Five hospitals, five LTCFs, and 55 schools in areas at risk of low probability severe flooding
- Five hospitals in the areas of high probability major flooding that are near at-risk facilities are primarily located in the southwest area

# Take Away Messages

---

- Flooding due to sea level rise, extreme storms, and inundation along the coastline and near creeks has potential to affect facilities with nearby populations totaling **more than 908,000 people** in studied areas
- Facilities projected to be at risk across the study regions investigated **increased** from 2,640 in the high probability major flooding scenario to 5,971 in the low probability severe flooding scenario
- **Eight hospitals, nine long-term care facilities (LTCF), and 126 schools** are located in flood risk areas near facilities at risk of flooding
- **644 of the 824 (78%)** unique locations with available chemical data **reported at least one chemical known to cause acute health effects**
- Census tracts with higher cumulative impact scores also had **some degree of projected flood risk and facilities at risk of flooding**

# Future Directions

---

- Incorporate quantities and identities of chemicals at each facility—as well as facility characteristics (e.g., age) that are associated with vulnerability to damage from flooding to improve characterization of hazards
- Application of hydrological models capable of characterizing the potential mobilization and transport of specific pollutants following flooding
- Use of mapping as a screening/planning tool for environmental justice communities, and not for site-specific decisions
- Potential development of a CalEnviroScreen indicator based in part on facilities coinciding with flood risk

**Project data and web maps available at:**

Data repository:

<https://github.com/alexysshi/Berkeley-FREE-data-repository>

Story Map:

<https://arcg.is/o1b4Cn>

## Acknowledgements

Ellen Dempsey



Karen Riveles

John Faust

Walker Wieland

Katy Fong



Justin Remais

Alex Shi

Sophie Kang

Winne Luo

Lucy Peritz

21<sup>st</sup> Annual California CUPA Training Conference  
February 2019

