Tsunami Emergency Response Preplanning with “Playbooks”
&
Enhanced Tsunami Height Calculation with “FASTER”

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RICK WILSON - California Geological Survey

National Tsunami Hazard Mitigation Program Meeting
August 21, 2013

Tsunami Playbook Work Group

Emergency Managers & First Responders in 5 California Counties:

- Humboldt
- Monterey
- Ventura
- Orange
- San Diego

CalOES, CGS, and NWS WFO/WCMs

- 3 Planning Conference Calls: April – May 2013
- 5 Workshops: June – July 2013
- Maps in production

Purpose of Workshops

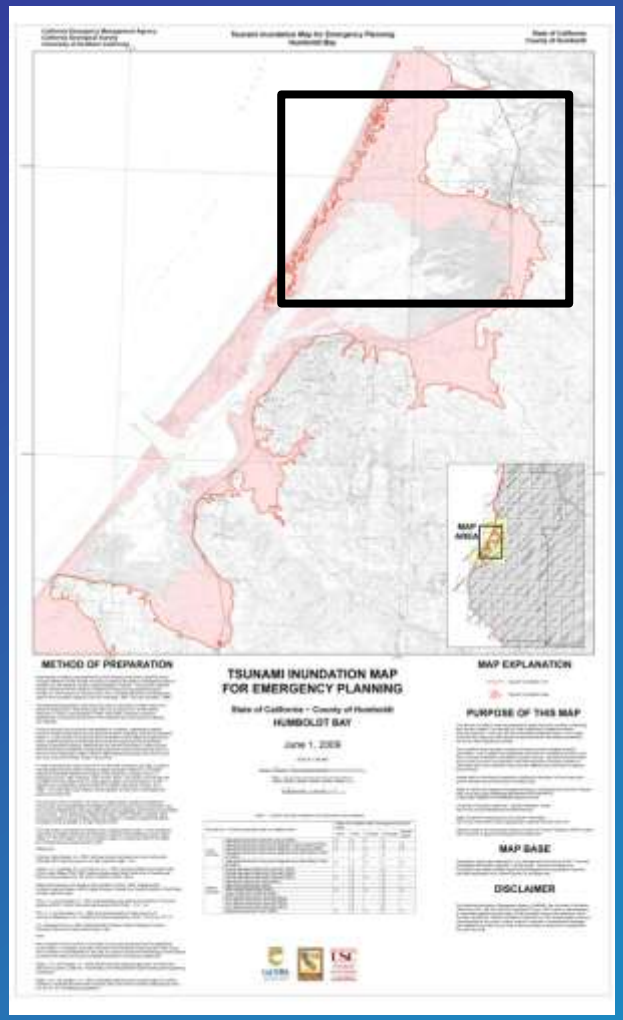
Introduce:

1. “Playbooks” of pre-modeled Tsunami scenarios, elevation & evacuation lines
2. FASTER approach – local conditions influencing incoming wave heights

Propose protocol for delivery of real-time data and information ahead of the next tsunami.

Goal: Draw tsunami playbook evacuation lines / zones on maps for each community.

CURRENT, EXISTING:
Evacuation Maps / Plans based on Maximum / Worst Case Scenarios



Inundation Map

Evacuation Map

NEW: Scenario "Playbooks" and "F.A.S.T.E.R." method

F.A.S.T.E.R.

March 11, 2011 Tsunami - "Warning" level locations in CA	Forecast Amplitude (meters)	Storm/ other conditions	Tidal conditions first 5 hours	potential Error in forecast modeling (FAx0.3)	potential site-specific Run-up (FAx0.2)	Total tsunami elevation or run-up	Recommended Playbook Evacuation Level
Crescent City	2.50	0.00	-1.00	0.75	0.50	**2.75**	3m
Humboldt Bay	1.33	0.00	-1.00	0.40	0.27	**1.00**	2m
Arena Cove	1.30	0.00	-1.00	0.39	0.26	**0.95**	none or 1m
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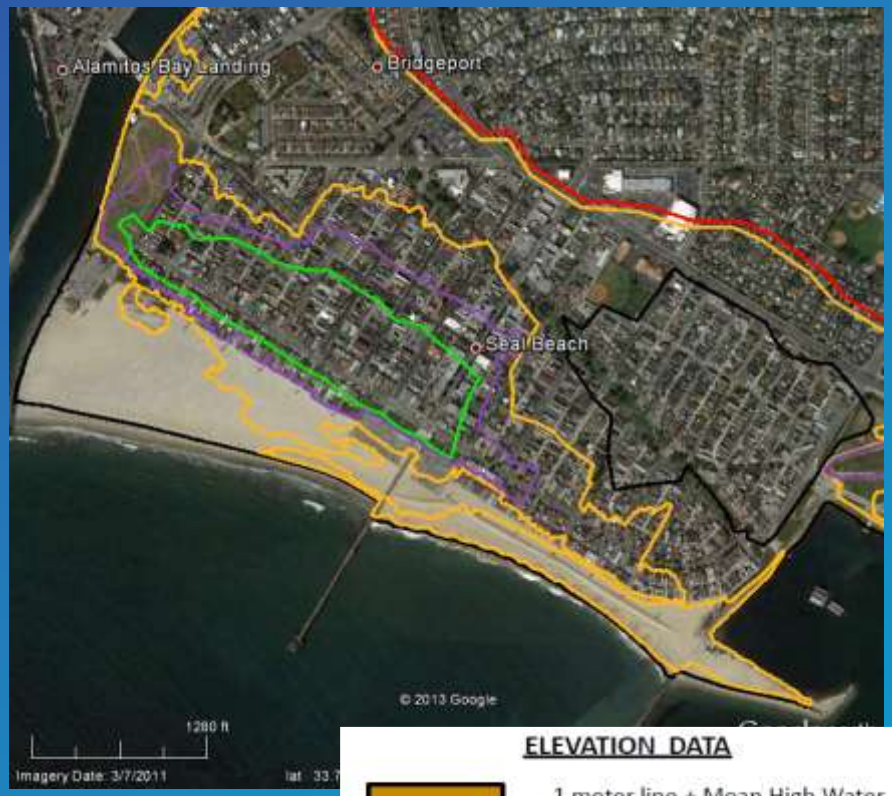
San Francisco	0.73	0.00	-1.00	0.22	0.15	**0.10**	none or 1m
Santa Cruz	1.01	0.00	-1.00	0.30	0.20	**0.52**	none or 1m
Monterey	0.52	0.00	-1.00	0.16	0.10	**-0.22**	none or 1m
Morro Bay	1.18	0.00	-1.00	0.35	0.24	**0.77**	none or 1m
Port San Luis	2.14	0.00	-1.00	0.64	0.43	**2.21**	3m

Playbook



ELEVATION DATA

- 1 meter line + Mean High Water Brown fill/brown line
- 2 meter line + Mean High Water Yellow fill/orange line
- 3 meter line + Mean High Water Pink fill/purple line
- 4 meter line + Mean High Water Aqua fill/green line
- State inundation line (all worst-case scenarios)

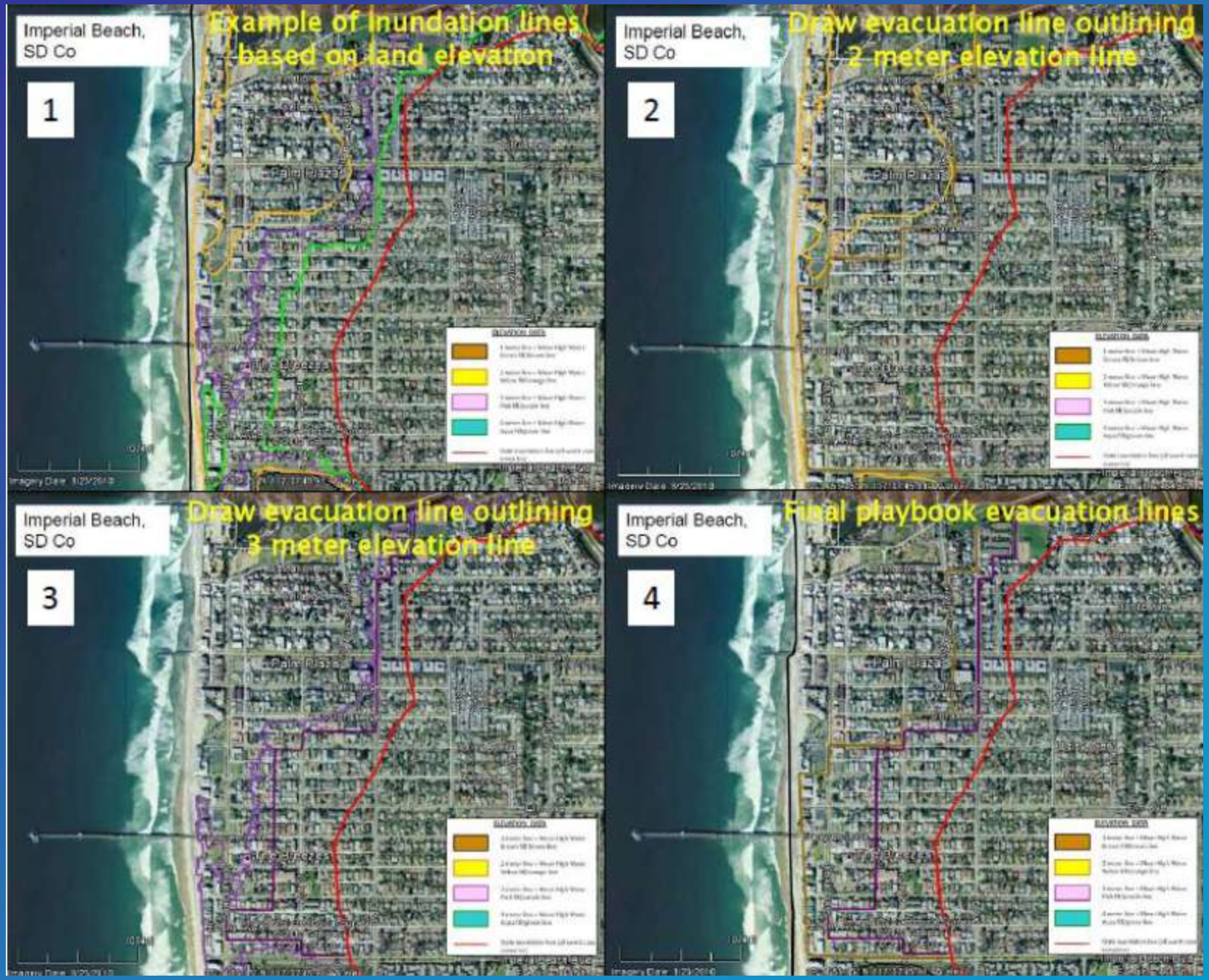
Spreadsheet

Number → Map

Potential Uses of Tsunami Playbooks
(Mapped Secondary Evacuation Zones)

- Real-time evacuations
- Evacuation planning
- Exercises & Drills
- Reverse 911-calling
- Staging critical response assets and locating response/evacuation centers
- Long term:
  - Land-use planning for critical facilities
  - Sea-level rise (50yr=1-1/2 feet; 100yr=4-5 feet)

Example of how playbook evacuation lines are produced from playbook inundation lines


Imperial Beach, SD Co
1
Example of Inundation lines based on land elevation
Imperial Beach, SD Co
2
Draw evacuation line outlining 2 meter elevation line
Imperial Beach, SD Co
3
Draw evacuation line outlining 3 meter elevation line
Imperial Beach, SD Co
4
Final playbook evacuation lines

- Windows Internet Explorer

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Sea Level Rise and Coastal Flooding Impacts

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Sea Level Rise | Confidence | Marsh | Vulnerability | Flood Frequency

Sea Level Rise

Current MHHW

Legend

- Water Depth
- Low-lying Areas
- Area Not Mapped
- Visualization Location

View Levees

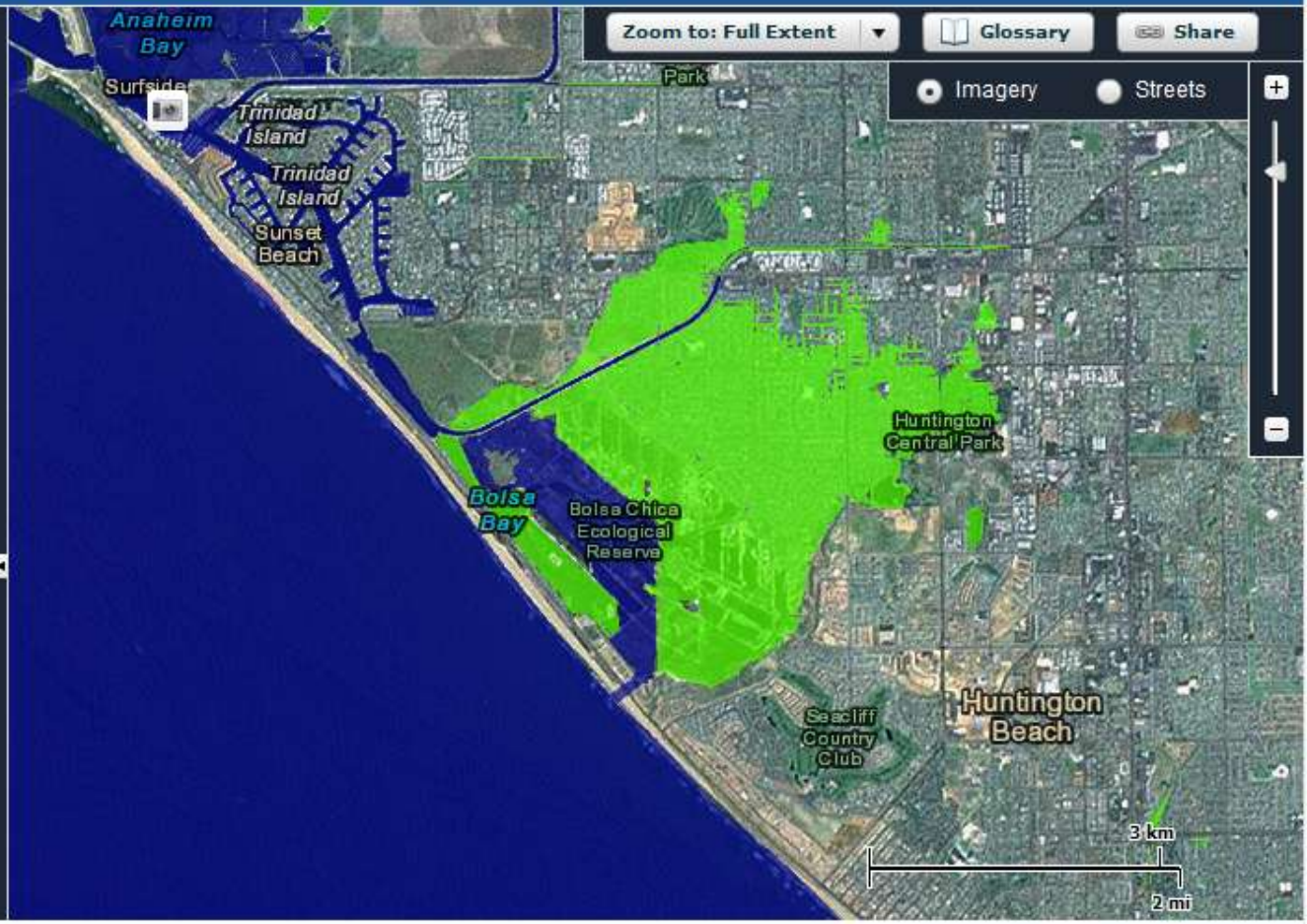
Overview

Use the slider bar above to see how various levels of sea level rise will impact this area.

Levels represent inundation at high tide. Areas that are hydrologically connected are shown in shades of blue (darker blue = greater depth).

Understanding the Map

Additional Information



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Sea Level Rise and Coastal Flooding Impacts

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Sea Level Rise

3 ft SLR

Legend

- Water Depth
- Low-lying Areas
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View Levees

Overview

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Understanding the Map

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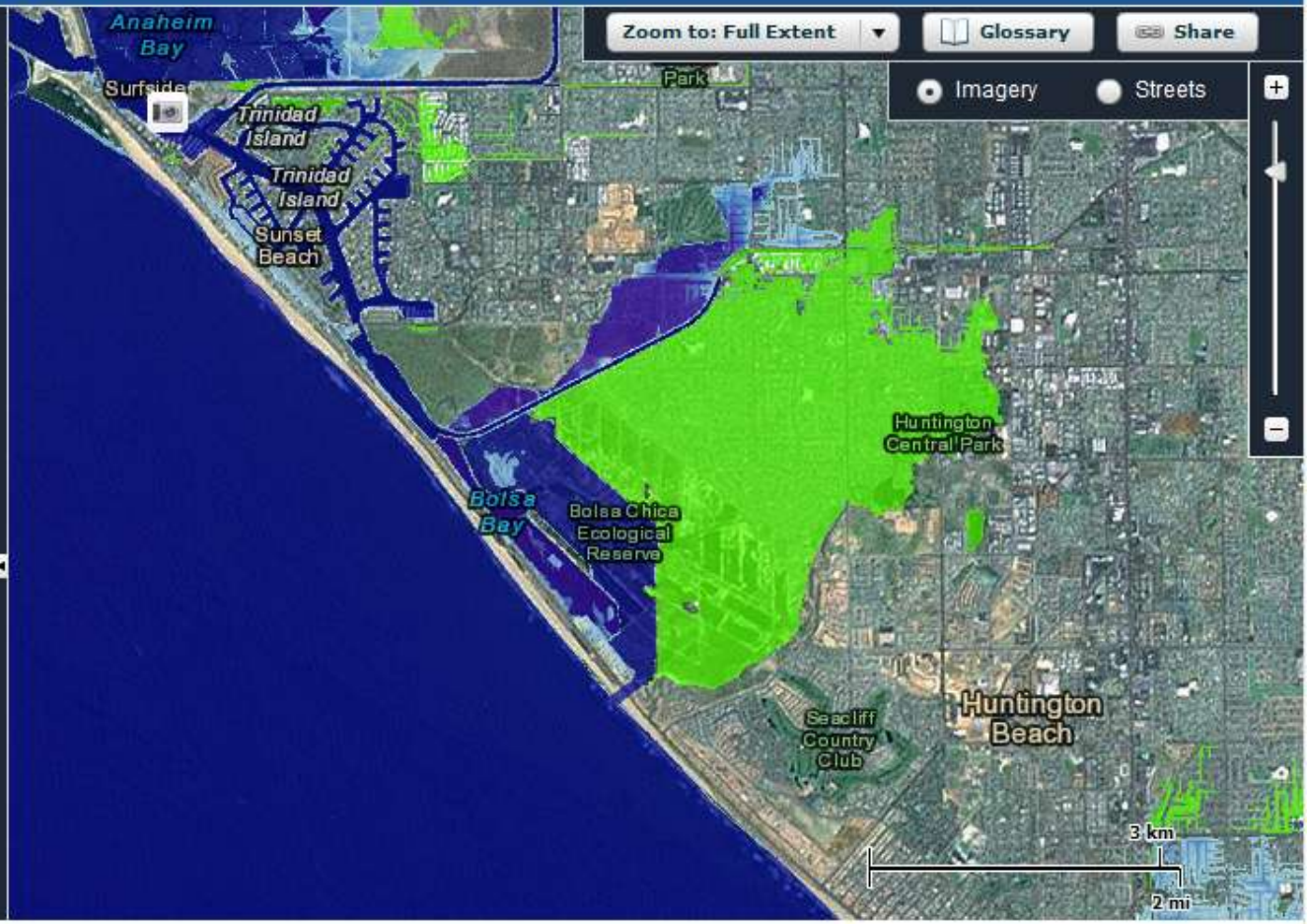

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Sea Level Rise and Coastal Flooding Impacts

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Sea Level Rise | Confidence | Marsh | Vulnerability | Flood Frequency

Sea Level Rise

6 ft SLR

Legend

- Water Depth
- Low-lying Areas
- Area Not Mapped
- Visualization Location

View Levees

Overview

Use the slider bar above to see how various levels of sea level rise will impact this area.

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Understanding the Map

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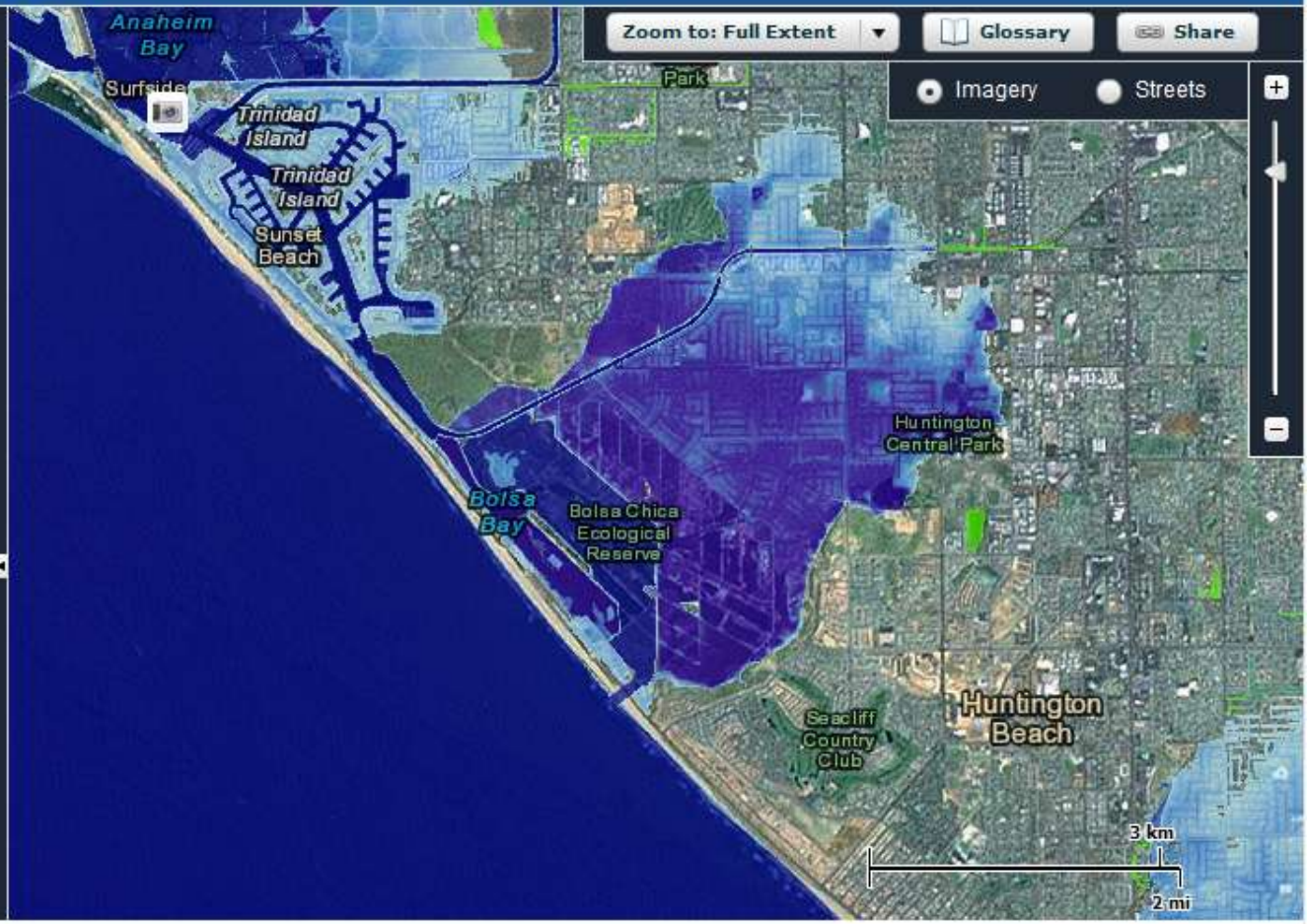

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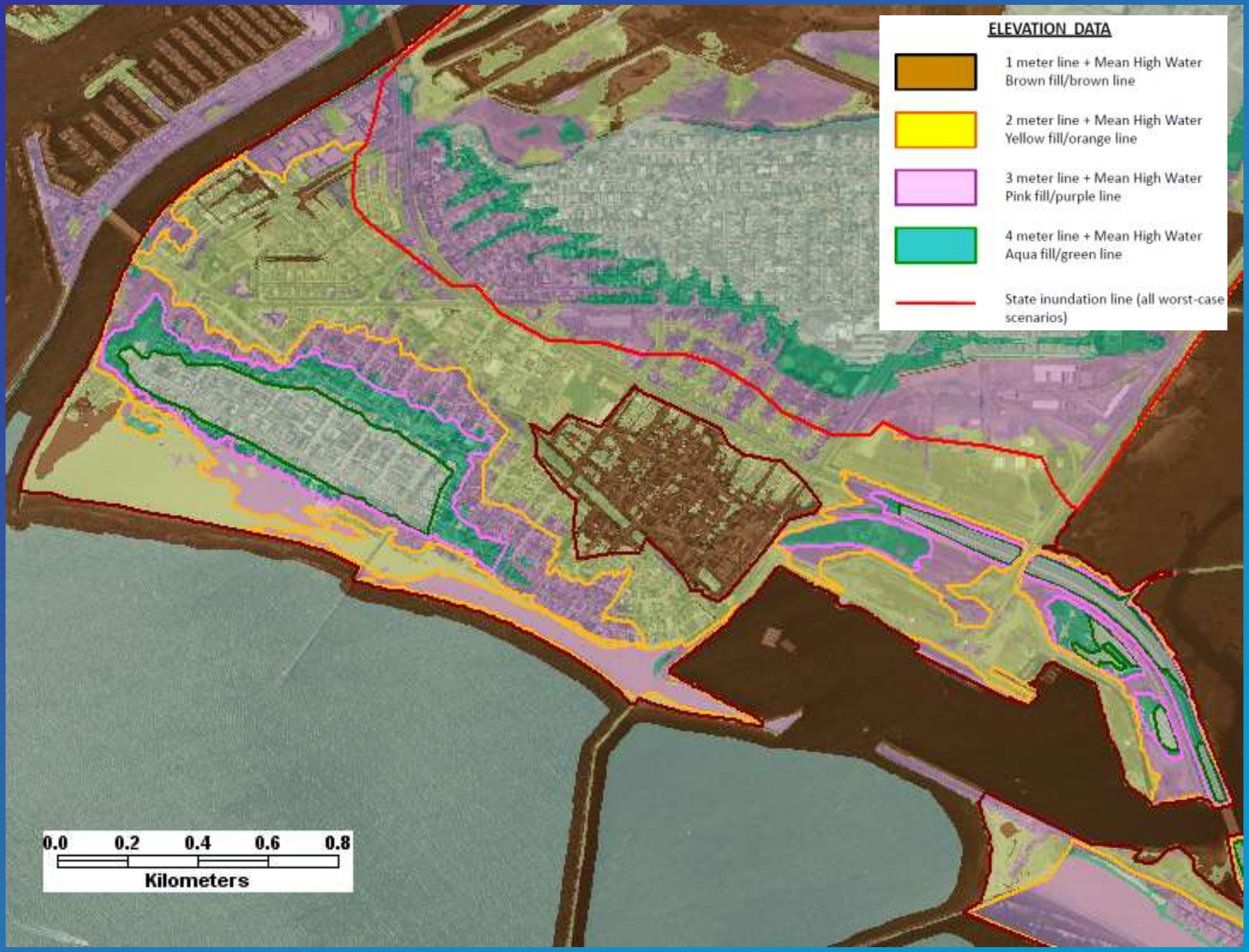
3 meter line + Mean High Water
Pink fill/purple line
4 meter line + Mean High Water
Aqua fill/green line
State inundation line (all worst-case scenarios)
0.0
0.2
0.4
0.6
0.8
Kilometers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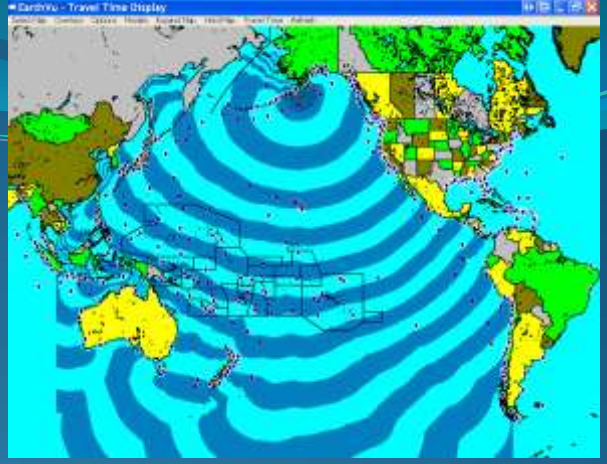
When to apply Playbooks?

Using Tsunami Scenarios and Elevation Lines
as enhanced information
to apply toward Realistic Advance Planning
of Evacuations

Use Playbook?



Are you in an Advisory or Warning Alert?
How long until “start of tsunami” for your section of the coast?

1. Is this a Warning-level **Alaska/Aleutians** event?
   If YES – Do not use Playbooks (full evacuation)
   If NO – Consider Playbooks (smaller evacuation)

2. Is this a DISTANT tsunami with time until first wave arrival **greater than 6 hours**?
   If YES - Consider Playbooks (smaller evacuation)
   If NO - Do not use Playbooks (full evacuation)

3. Is this a local or Warning-level **Cascadia** event (~2 hour travel time)?
   If YES – Do not use Playbooks (full evacuation)
   If NO – Consider Playbooks (smaller evacuation)

What is the F.A.S.T.E.R. Method?

F.A.S.T.E.R. Method
(enhanced estimates based on local conditions)

Working example: Formula for determining playbook evacuation line to use (FA-S-T-E-R):

FA: Forecasted Amplitude from Warning Center

+

S: Storm surge or existing ocean conditions

+

T: Maximum tidal height (first 5 hours of tsunami)

+

E: Forecast error potential (30%; analysis of 2010-11 events)

+

R: Site amplified run-up potential (from existing modeling, unique to each location; applied if inundation expected)

= Maximum tsunami run-up height

= Playbook elevation line

Working example for March 11, 2011 event at Crescent City:

FA + S + T + E + R = Height

2.5m+0m+(-1m)+0.75m+0.5m = 2.75m

3m elevation below purple line below

INITIAL WAVE HEIGHT NUMBER

Department of Commerce

National Oceanic and Atmospheric Administration's / National Weather Service

West Coast and Alaska Tsunami Warning Center

weather.gov

Location	Country	Lat	Lon	Obs Max Time (UTC)	Obs Height	Fcst. Height	Fcst. Arr Time (UTC)	TWC
Malibu , California	U.S./Canada	34 ° N	118.7 ° W	n/a		0.13 feet	n/a	WCATWC
Redondo Beach , California	U.S./Canada	33.9 ° N	118.4 ° W	n/a		0.23 feet	n/a	WCATWC
Middle Harbor , California	U.S./Canada	33.8 ° N	118.2 ° W	n/a		0.30 feet	n/a	WCATWC
San Pedro	United States	33.7 ° N	118.3 ° W	n/a		0.23 feet	10-28-2012 07:39:00	WCATWC
Alamitos Bay	United States	33.7 ° N	118.1 ° W	n/a			10-28-2012 07:54:00	WCATWC
Seal Beach , California	U.S./Canada	33.7 ° N	118.1 ° W	n/a		0.10 feet	n/a	WCATWC
Huntington Beach , California	U.S./Canada	33.7 ° N	118 ° W	n/a		0.20 feet	n/a	WCATWC
Newport Beach	United States	33.6 ° N	117.9 ° W	n/a			10-28-2012 07:46:00	WCATWC
Laguna Beach , California	U.S./Canada	33.5 ° N	117.8 ° W	n/a		0.20 feet	n/a	WCATWC
Oceanside 3 , California	U.S./Canada	33.2 ° N	117.4 ° W	n/a		0.16 feet	n/a	WCATWC

FASTER calculations for ELEVATION PLAYBOOK use: San Diego County Communities	Set to Receive Forecast Amplitude from WC/ATWC	Forecast Amplitude given (red) and projected (black; meters)	Storm/ ambient conditions first 5 hours, w/ errors	Tide conditions first 5 hours, w/ errors	Error in forecast amplitudes (from Wilson et al., 2012; 30%)	**Anticipated tsunami height first 5 hours (IN METERS)**	**Anticipated tsunami height first 5 hours (IN FEET)**	Runup potential factor per location, based on existing model results (applied if inudation expected)	Runup potential calculated per location (runup factor times forecast amplitude; meters)	**Anticipated tsunami height first 5 hours, if inundation expected (IN METERS)**	**Anticipated tsunami height first 5 hours, if inundation expected (IN FEET)**
San Onofre State Beach	Yes	1.3	0.0	-0.7	0.4	**1.0**	**3.2**	0.2	0.2	**1.2**	**3.9**
Oceanside	Yes	1.2	0.0	-0.7	0.4	**0.9**	**2.8**	0.2	0.2	**1.0**	**3.4**
Carlsbad		1.2	0.0	-0.7	0.4	**0.9**	**2.8**	0.2	0.2	**1.0**	**3.4**
Encinitas		1.2	0.0	-0.7	0.4	**0.9**	**2.8**	0.2	0.2	**1.0**	**3.4**
Del Mar		0.8	0.0	-0.7	0.2	**0.3**	**1.1**	0.2	0.1	**0.4**	**1.3**
La Jolla	Yes	0.8	0.0	-0.7	0.2	**0.3**	**1.1**	0.2	0.1	**0.4**	**1.3**
Mission Bay		0.8	0.0	-0.7	0.2	**0.3**	**1.1**	0.2	0.1	**0.4**	**1.3**
Shelter Isl/Ballast Pt	Yes	0.9	0.0	-0.7	0.3	**0.5**	**1.5**	0.1	0.0	**0.5**	**1.7**
San Diego/Nat. City	Yes	0.6	0.0	-0.7	0.2	**0.1**	**0.3**	0.1	0.0	**0.1**	**0.3**
Coronado		1.4	0.0	-0.7	0.4	**1.1**	**3.7**	0.2	0.2	**1.3**	**4.4**
Imperial Beach	Yes	1.4	0.0	-0.7	0.4	**1.1**	**3.7**	0.2	0.2	**1.3**	**4.4**

Red numbers = manually real-time input

Black numbers = set values

Example of use (FASTER approach)

Actual low tide conditions

March 11, 2011 Tsunami - "Warning" level locations in CA	Forecast Amplitude (meters)	Storm/ other conditions	Tidal conditions first 5 hours	potential Error in forecast modeling (FAx0.3)	potential site-specific Run-up (FAx0.2)	Total tsunami elevation or run-up	Recommended Playbook Evacuation Level
Crescent City	2.50	0.00	-1.00	0.75	0.50	**2.75**	**3m**
Humboldt Bay	1.33	0.00	-1.00	0.40	0.27	**1.00**	**2m**
Arena Cove	1.30	0.00	-1.00	0.39	0.26	**0.95**	**none or 1m**
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Monterey	0.52	0.00	-1.00	0.16	0.10	**-0.22**	**none or 1m**
Morro Bay	1.18	0.00	-1.00	0.35	0.24	**0.77**	**none or 1m**
Port San Luis	2.14	0.00	-1.00	0.64	0.43	**2.21**	**3m**

Evacuation Planning Playbooks
Example of use (FASTER approach)
Modified to high tide conditions

March 11, 2011 Tsunami - "Warning" level locations in CA - AT HIGH TIDE	Forecast Amplitude (meters)	Storm/ other conditions	Tidal conditions first 5 hours	potential Error in forecast modeling (FAx0.3)	potential site-specific Run-up (FAx0.2)	Total tsunami elevation or run-up	Recommended Playbook Evacuation Level
Crescent City	2.50	0.00	1.00	0.75	0.50	**4.75**	**All**
Humboldt Bay	1.33	0.00	1.00	0.40	0.27	**3.00**	**4m**
Arena Cove	1.30	0.00	1.00	0.39	0.26	**2.95**	**3m**
Bodega Bay	0.92	0.00	1.00	0.28	0.18	**2.38**	**3m**
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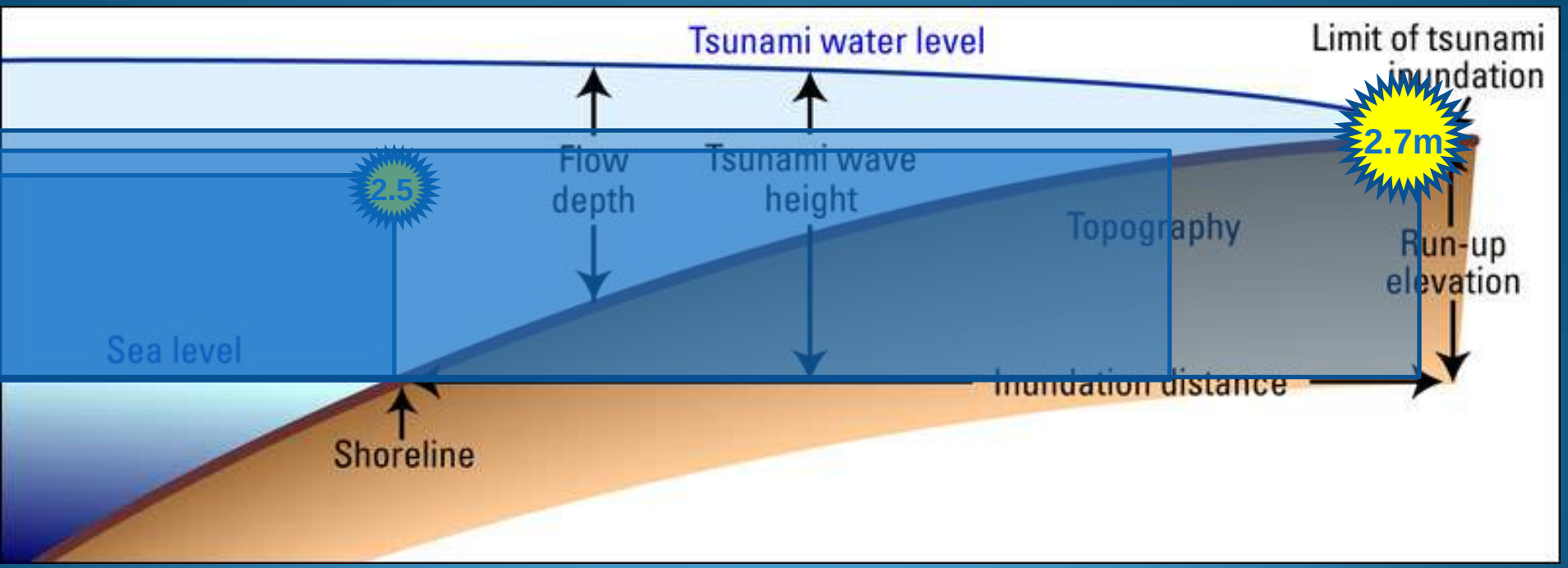
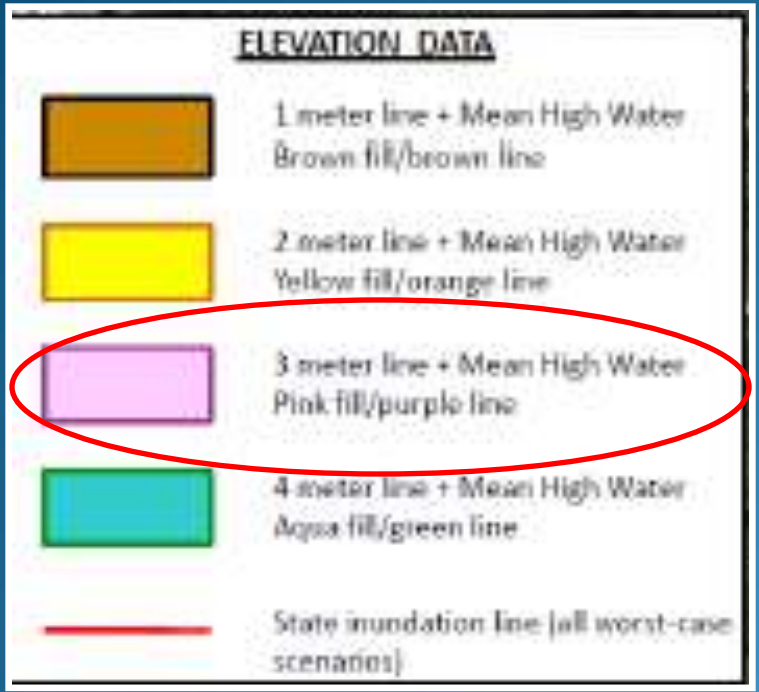
Morro Bay	1.18	0.00	1.00	0.35	0.24	**2.77**	**3m**
Port San Luis	2.14	0.00	1.00	0.64	0.43	**4.21**	**All**

How high will the water get?

Information for a "more informed" evacuation

Info Source:

FA	WCATWC	• Forecast Amplitude of Tsunami	2.5m
S	NWS Office	• Forecast Amplitude of Storm	
T	NOAA	• Tide at start of tsunami	
E	Already Known	• 30% Error margin from #'s in bulletin	
R	Inundation Modeling	• Run-Up at your location	2.7m


Tsunami water level
Limit of tsunami inundation
2.7m
2.5
Flow depth
Tsunami wave height
Topography
Run-up elevation
Sea level
Inundation distance
Shoreline

Which line gets used for evacuation?