Stakeholder Meeting #3 Minutes: Tuesday, April 21st, 2015
10:00am – 12:00pm
State Route 37 Integrated Traffic, Infrastructure and Sea Level Rise Analysis
Norman C. King South Vallejo Community Center
545 Magazine Street, Vallejo, CA 94590

Welcome and Introductions – Ina Gerhard, Caltrans District 4

- Ina Gerhard welcomed everyone and then all attendees gave their name and affiliation.

Brief summary of previous meetings – Fraser Shilling, UC Davis

(Slides 1-12).

Stakeholder Meeting #1 - 9/3/2014 (Slide2)

- Discussion revolved around speed of responding to needs along SR37, information needs to make good decisions, why not transit, private toll road, why constrained list of highway responses …

Stakeholder Meeting #2 - 1/29/2015 (Slide 3)

- Discussion revolved around sea level rise and potential inundation of highway and marshes, why certain future scenarios were chosen, and possible inaccuracies with sea level rise model.

Focused Meetings (Slide 4)

- Private toll road –what other structures are being considered.
- Local transportation agencies – how they would participate in this process and next steps for Hwy 37.
- Marsh restoration – what it means in the context of the hwy because of its physical connection to the highway,
- Transit/multi-modal – how we can fit them into the corridor.

Brief Study Overview (2014/15) – Fraser Shilling, UC Davis

Project Goals (Slide 5)

- Maintain and improve transportation corridor benefits and develop long-term solutions for the corridor.

- Determine how to support large-scale restoration of tidal and other marshes to benefit native species, ecological processes, and decrease the severity of storm and tidal action on coastal infrastructure.

Tasks (Slides 6-10) -- % indicates % of project effort

- Task 1: Inundation assessment of infrastructure and associated lands (18%)
- Task 2: Vulnerability assessment for existing transportation system (9%)
- Task 3: Design and cost estimates for resilient and sustainable transportation (26%)
- Task 4: Environmental and community benefits for different future scenarios (9%)
- Task 5: Stakeholder involvement to improve sustainability (19%)
- Task 6: Project management, presentations and reporting (19%)

Fraser Shilling, UCD added that Task 1 is complete and Task 2 is nearly complete.

Next Steps (Slide 11)

- Next stakeholder meeting in July OR September (August is not a good meeting month)
  - Presentation of draft adaptive structures design - what the concept designs would look like.
  - Presentation of draft benefits description – potentially draft cost estimates.
- Discussion of possible next project steps (grant opportunities and projects)

More Information (Slide 12)

http://hwy37.ucdavis.edu
fmshilling@ucdavis.edu

SLR: Potential Inundation and Risks – Justin Vandever and Kris May, AECOM

Mr. Vandever, AECOM, answered questions from the attendees as they arose.
(Slides 1-28).

Mr. Vandever reviewed the outline of his presentation (Slide 2)

- Review Mapping Methods
  - SLR Scenarios
  - Stakeholder Feedback
- Inundation Mapping Results
- HWY and Shoreline Overtopping
- Draft Vulnerability and Risk Assessment
- Next Steps and Stakeholder Feedback

Sea Level Rise Scenarios **(Slide 5)**
Q: So 15 years from now, the high end of the range is 12" above the current mean high tide?
A: Yes. The Baseline for these projections is relative to the year 2000.

Water Level Analysis **(Slide 7)**
Q: How much higher would a king tide be above the normal high tide?
A: A king tide adds about another foot to a typical high tide. It occurs at least twice a year.

Inundation Mapping Revisions **(Slide 8)**
Mr. Vandever explained that the revisions on this slide were a direct result from information gathered from attendees during past stakeholder meetings. They included some areas under construction or restoration, breached levees in the model and some areas had been shown as tidal but actually were not.

MHHW + 12" **(Slide 11)**
The blue is underwater – dark blue is deeper inundation and light blue is shallow inundation. The green areas in this scenario is around 7' and are actually lower elevation than that water level but there is no hydraulic connection for the water to get back to those areas. All 3 of the low-lying highway segments are in low lying depressions protected by features like levees. They are low and vulnerable to the water level in the bay. The green areas are also areas susceptible to increased groundwater levels, a secondary impact.

Slides (20 -27)
These depict overtopping scenarios of the highway with hot pink exceeding 5' of depth on the roadway. All this data is available for the vulnerability assessment to tabulate the degree of impacts for each scenario.

Hwy 37 Draft SLR Vulnerability and Risk Assessment **(Slides 29-54)**
Please see complete slide presentation at the end of these minutes.

Preliminary Vulnerability Assessment Reach A1 **(Slide 32)**
Bad news: shows scenarios very severe impact to the highway
Good news: the shoreline protection feature that is responsible for protecting it is only a very short segment.

Q: Did you compare the time that the water level was expected to be above those gaps/low points with the total volume that would be needed to create the inundation that you simulate?

A: No, this was a mapping exercise so there were no calculations done for volume of water through a low spot or the duration. For an extreme high tide, this is a very conservative estimate of the flood impacts.

Preliminary Vulnerability Assessment Reach A1 **(Slide 33)**
Protected by a complex set of levees.

Q: Are the levee calculations based on the current elevations?
A: Everything that was part of the 2010 LIDAR data set. Some of the new levees will be added in from the restoration projects. If vegetation interfered, it could underestimate the actual height of the levee.

Preliminary Vulnerability Assessment Reach A1 **(Slide 34)**
This is labeled incorrectly; actually this is the railroad and Hwy 121 is a little to the west of there. The railroad is showing impacts in this scenario.

Vulnerability Indicators **(Slide 44)**

Q: Did this study include other mitigation studies?
A: Yes, if those activities were likely to impact the highway.

Q: Looking at the long-term, is there any discussion about other mitigation projects that could help with the short-term solution?
A: Caltrans is always building up the road surface up because of settling but there has not been an emphasis on short term fixes for the highway itself.
Some of the data layers could feed into another assessment to look at the weak links – where is the low hanging fruit so you could make small improvements to the levee.

SLR Sensitivity Ratings **(Slide 47)**

Q: What does the Age refer to – infrastructure, roadway?
A: One of the reasons we have not completed this yet is because we are trying to figure out what is the appropriate definition of age. It's hard to tell because a lot of the roadway has been added to if it has settled. But the idea is some requisite indicator of the age and maybe the condition of the road. Age is less of an issue of a new structure but we are focused here on the existing – what is here today.

Q: What is the condition-based sensitivity?

A: It folds into a couple of things. We looked at information on which reaches that have historically have experienced the most settling as well as reaches that had documented historical flooding impacts and we folded them into either quantitative or anecdotal information on how Caltrans has had to maintain the highway historically.

Adaptive Capacity: Alternate Routes **(Slide 48)**
Q: Where or when does Hwy 29 get impacted?
A: Don't have that but we can certainly look at it and include it in the discussion.
C: When you talk about other routes, they definitely are not viable but I'm concerned from a policy perspective that we make sure we recognize that they are used when Hwy 37 is not functioning.

Next Steps **(Slide 54)**
Q: When do you want feedback?
A: The next two weeks.

Introduction to Conceptual Design of Adaptive Structures - Joy Villafranca, AECOM

Ms. Villafranca answered questions from attendees as they arose.
(Slides 1-20).

Presentation Outline (Slide 2)

- Study Areas
- Study Scenarios
- Design Considerations and Issues
- Cost Estimates
- Next Steps and Stakeholder Feedback

Engineering Design Scenarios **(Slide 7)**

Q: Did you look at only adding one lane or two?
A: Will discuss that later on.

Engineering Design Scenarios **(Slide 9)**
This map is the basis for raising the roadway.

Q: Is the elevation that you are adding based on the existing highway.

A: Yes, above the existing elevation.

Footprint of Scenario – Reach A: Levee **(Slide12)**
An example of a cross-section where Hwy 37 is in Reach A between Hwy 101 and Hwy 121 is a 4 lane road, 2 in each direction with a very wide median. We would maintain the same cross section of the roadway. When you raise it 13', you have about 40' of additional fill on each side of the toe.

Q: Where would the fill come from – locally or hauled in by truck?
A: Depends, the closer the source is the better. That is up to the contractor and where they can find the source.

Q: Could you eliminate the median?
A: There is a possibility but if it's narrower, you have to divide it with a concrete barrier and consider the safety aspect.

Footprint of Scenario – Reach A: Monopod **(Slide13)**
This show that the roadway is slightly narrower to minimize costs but still meet the Caltrans design requirements in terms of median width, road lane and shoulder width.

Q: How confident are you about a 70'depth for the pillar structure to get something to stand on?
A: It would probably be much wider and more elliptical compared to what this concept drawing looks like.

Q: Is there a bedrock study?
A: We haven't started that. That would be more of a consideration when we do the design. This is not the end but the beginning so that geologic studies are not done yet.

Footprint of Scenario – Reach A: Trellis **(Slide14)**
This is more of a "trestle". In this case the vertical supports for the whole width of the bridge but it will still be a narrower road width than the existing one.
Q: What is the consideration for the width of a shadow over protected habitat?
A: There are min/max requirements for lane, median and shoulder widths.

Q: But there are rules for how wide a shadow can be, maybe 70' – maybe it could be two separate roadways?
A: Yes and what might be entailed if you actually build one of these.

Footprint of Scenario – Reach B: Monopod **(Slide16)**
The roadway would be wider and cast a shadow but you could eliminate the roadway embankment with this scenario and open up the connection from one side to the other. That would mean a much taller column, increasing the cost.

Q: If you do that, then that will allow free flow and flooding of the properties much earlier.
A: That is one possibility. The current roadway pavement would be eliminated

Q: When you construct this, will the roadway close for construction?
A: When you build a new roadway like this, in general, you have to either build it to one side of the roadway or the other or, you close it altogether if you are trying to maintain the existing alignment. And what assumptions do we make regarding the intersections – does it also need to be raised or not. We would like feedback on that.

Q: If Sonoma Land Trust owns it, do you have an easement to build a parallel road and not encroach on their land?
A: It would require Right of Way (ROW)

Q: How much ROW do you have now?
A: Caltrans has a right of way along the highway alignment that varies in width.

Cost Estimates **(Slide19)**
Once we get the scenarios, then we look at costs.
Q: Shouldn't Environmental Mitigation be added to this slide?
A: Ok, yes.

Next Steps **(Slide 20)**
We will look at the scenarios and come up with 3D renderings.
Q: Since we don't know the final option in terms of transit, bike lanes, etc., how much of a range can you get that would allow for flexibility that accounts for inability to really determine this is what we really want?
A: There are contingencies involved but we have information on ROW, acquisition and different factors we can add on.

Additional Questions

Q: From the last round of Stakeholder meetings, I thought we were further down the road of eliminating the idea of rebuilding it on the existing roadway on top of a levee. Seems like we are seeing all the same options.
A: It is sort of like sending traffic through Hwy 12 – it's undesirable. If you keep it on the table you can see that undesirability and know we don't want the levee option. The set of alternatives as we get further down the road will be limited and set in concrete.
There is also a no-project requirement.

Q: Could you give a quick explanation of areas of moderate impacts in Reach 'C' aren't being proposed to be raised? Seems like it is just in Reaches A & B.
A: Where the freeway begins, a very small section of it would be impacted near White Slough

Q: Do you have a typical cost per mile of the 3 approaches?
A: Not yet. The structural costs more than the roadway costs.

Q: Seems like we have to get some parameters first for bike lane, etc. Are you doing that after you do the cost estimate?
A: No, we have to pin it down first.

Q: The bike lane has to be a Class 1 multi-facility – will it be?
A: Yes, we are working with Bay Trail

Q: Could you add one more bullet on Next Steps slide to show it swings back to review the concepts?
A: Yes, good idea.

Q: In earlier meetings, adding lanes, bike access, trains and light rail were discussed. At what point would those ideas be rolled into this process?
A: It's a moving target – if we have a structure that is 4 lanes wide, it doesn't mean it necessarily will have 4 lanes of single occupancy vehicles or if we had something that's 4 lanes plus ancillary structures like a bike lane. Narrowing that down is still a work in progress. What sits on top is more up to the collective mind.

Community and Environmental Benefits of Future Scenarios – Fraser Shilling, UC Davis

(Slides 1-10).

Summary

- What's it going to look like?
- How much is it going to cost?
- What do we get out of it?

Next Steps and Next Meeting – Fraser Shilling, UC Davis

Please email questions and or comments in the next week or two.

All general questions: Fraser Shilling at: fmshilling@ucdavis.edu

Vulnerability Assessment: Jason Vandever at: Justin.Vandever@aecom.com

Engineering Concept Design and Cost Estimates: Joy Villafranca at:Joy.Villafranca@aecom.com

http://hwy37.ucdavis.edu

State Route 37 Integrated Traffic, Infrastructure and Sea Level Rise Analysis

Ina Gerhard, Branch Chief
System Planning North/Peninsula
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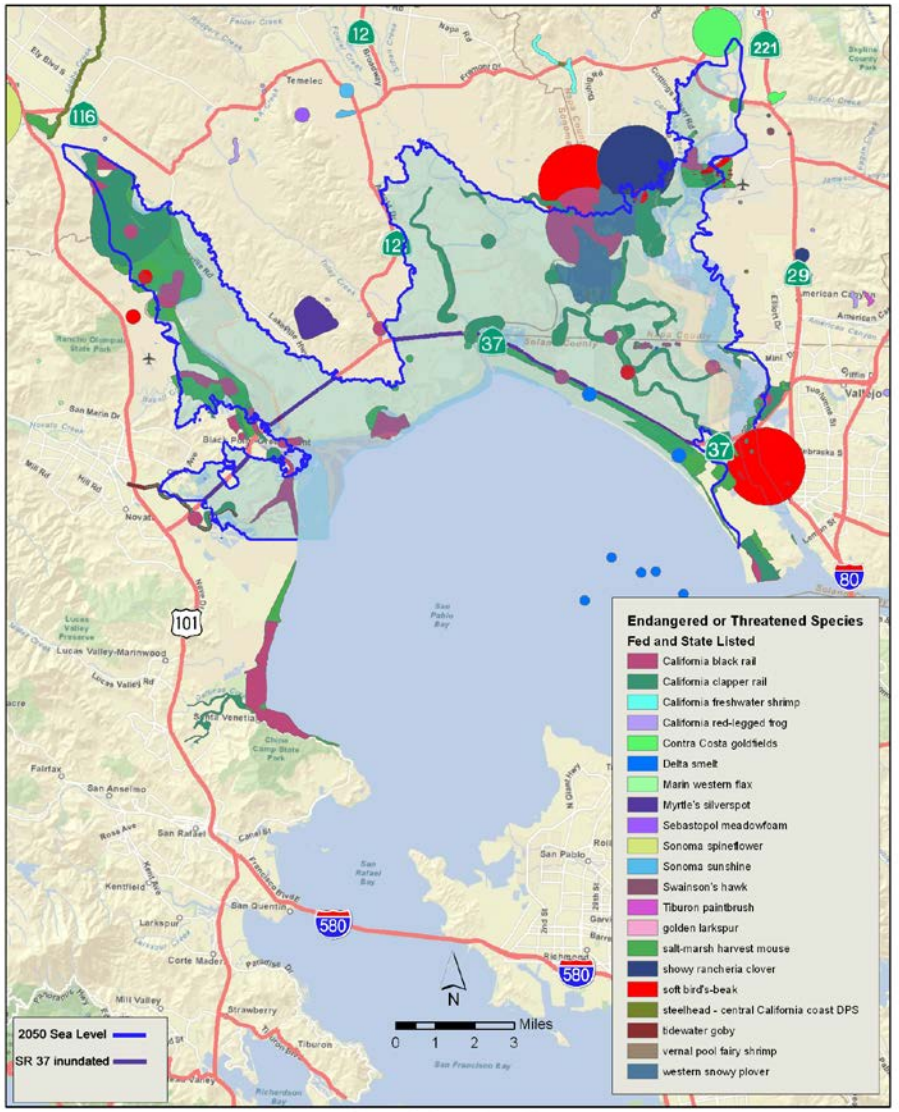
University of California, Davis



Listed Species Map

Stakeholder Meeting #1 (9/3/2014)

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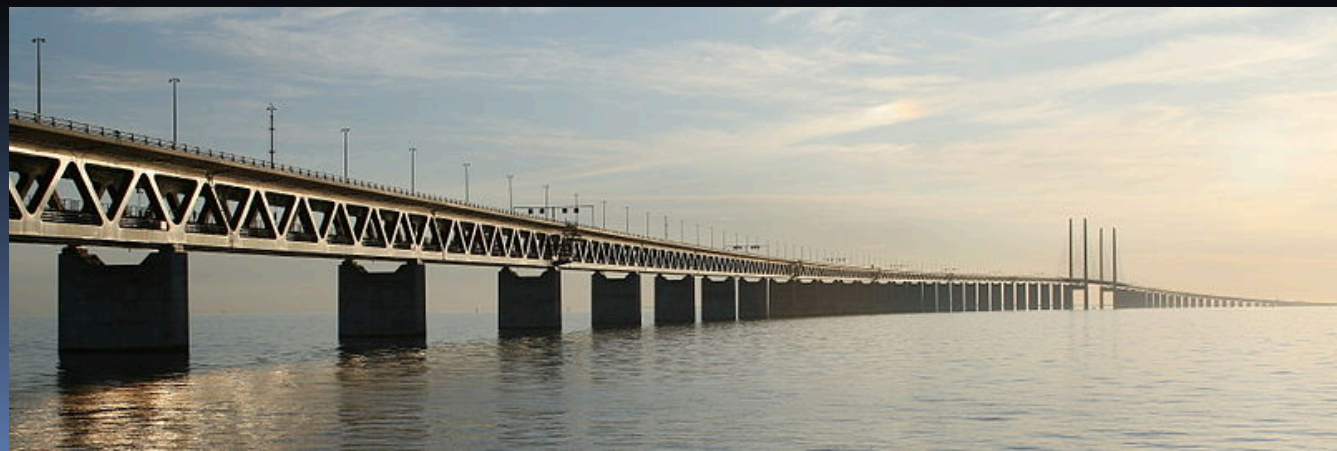

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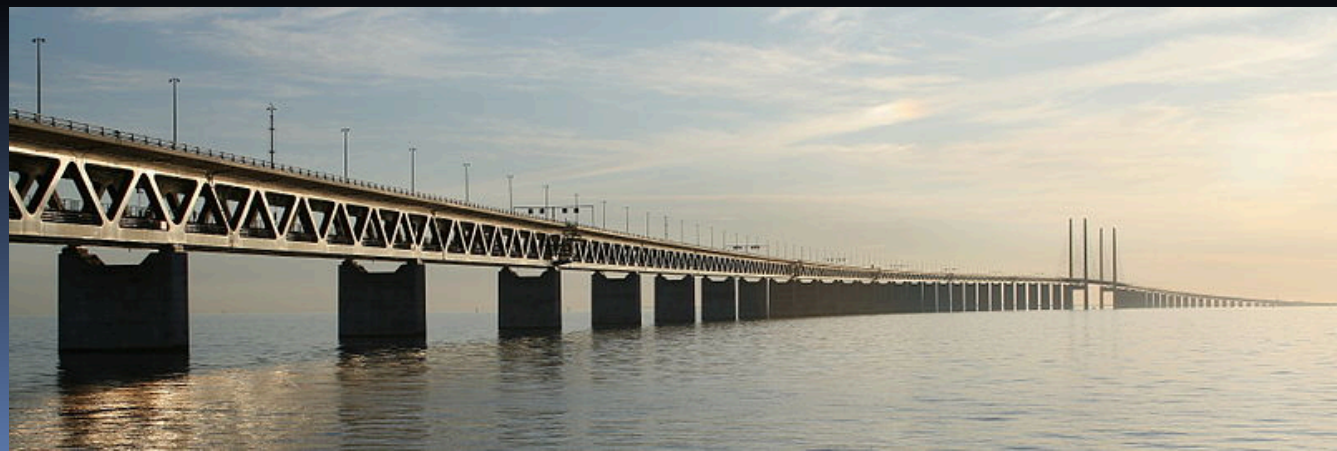
- Discussion revolved around sea level rise and potential inundation of highway and marshes, why certain future scenarios were chosen, and possible inaccuracies with sea levl rise model



Focused Meetings

- Private toll road
- Local transportation agencies
- Marsh restoration
- Transit/multi-modal

Project Goals

- Maintain and improve transportation corridor benefits and develop long-term solutions for the corridor
- Determine how to support large-scale restoration of tidal and other marshes to benefit native species, ecological processes, and decrease the severity of storm and tidal action on coastal infrastructure

Tasks

- Task 1: Inundation assessment of infrastructure and associated lands (18%)
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- Task 6: Project management, presentations and reporting (19%)

Task 1: Inundation Modeling/Mapping

- FINAL model of potential inundation under different future sea level conditions
- Used to inform risk/vulnerability assessment
- Presented today

Task 2: Vulnerability Assessment

- DRAFT model of vulnerability of highway and associated lands under different future sea level conditions
- Presented today
- Needs your input and local knowledge to finalize

Task 3: Design and cost estimates for future scenarios

- Approach presented today
- Certain structure types emphasized
- Needs your input and local knowledge to continue

Task 4: Environmental and community benefits from scenarios

- Approach presented today
- Benefits/disbenefits for community, environment and transportation
- Needs your input and local knowledge to continue

Next Steps

- Next stakeholder meeting in July OR September
  - Presentation of draft adaptive structures design
  - Presentation of draft benefits description
- Discussion of possible next project steps (grant opportunities and projects)

More Information

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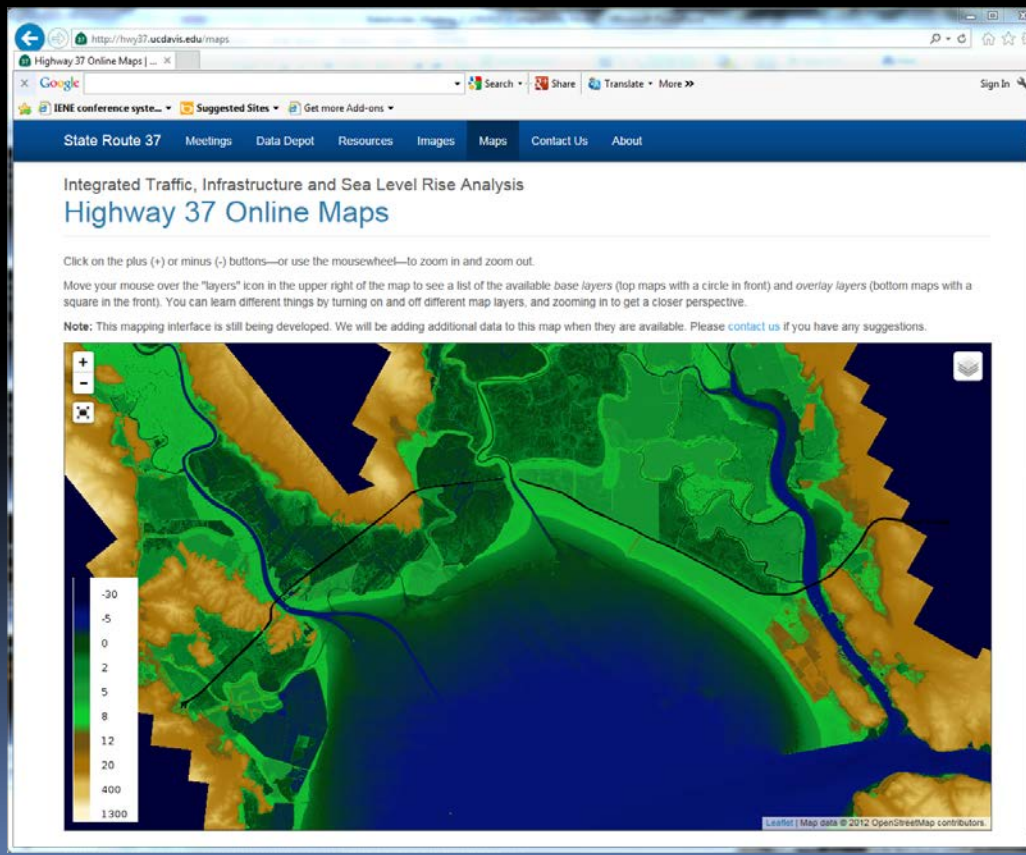

HWY 37 SLR Inundation Mapping

Justin Vandever, PE and Kris May, PhD, PE
AECOM – Oakland, CA
Justin.Vandever@aecom.com
Kris.May@aecom.com

Highway 37 Stewardship Study

Stakeholder Meeting – Vallejo, CA

April 21, 2015

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Presentation Outline

- Review Mapping Methods
  - SLR Scenarios
  - Stakeholder Feedback
- Inundation Mapping Results
- HWY and Shoreline Overtopping
- Draft Vulnerability and Risk Assessment
- Next Steps and Stakeholder Feedback

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SLR Inundation Mapping

Purpose and role of modeling and mapping in study:

- Informs the exposure component of the SLR vulnerability study (multiple SLR scenarios)
- Depth and extent of inundation
- Depth of roadway and shoreline overtopping
- Timing of inundation and adaptation options
- Design elevations for adaptation options

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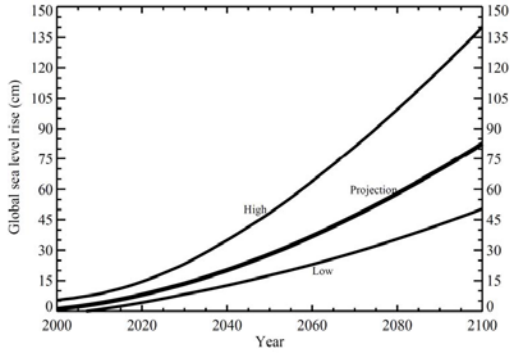
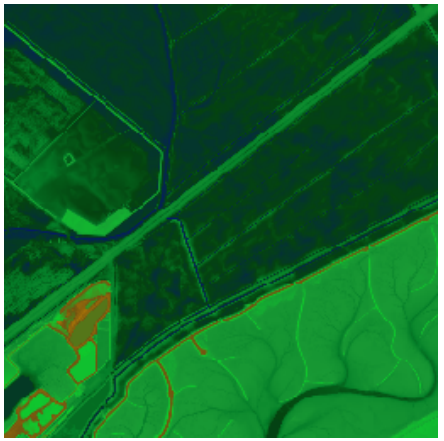
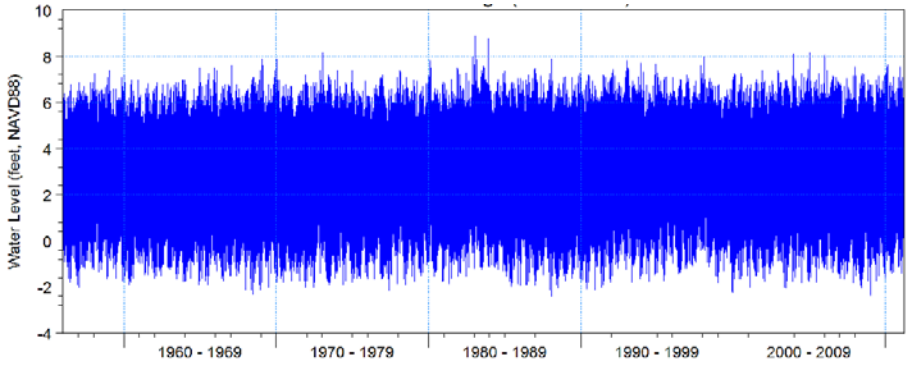
SLR Inundation Mapping Review

- Sea level rise scenarios – National Research Council (NRC 2012)
- Topography – 5-ft (1.5m) grid Digital Elevation Model (DEM) using 2010 CA Coastal LIDAR (NOAA). Vert. rms error ~9 cm.
- Water levels – daily and extreme tides from FEMA hydrodynamic model







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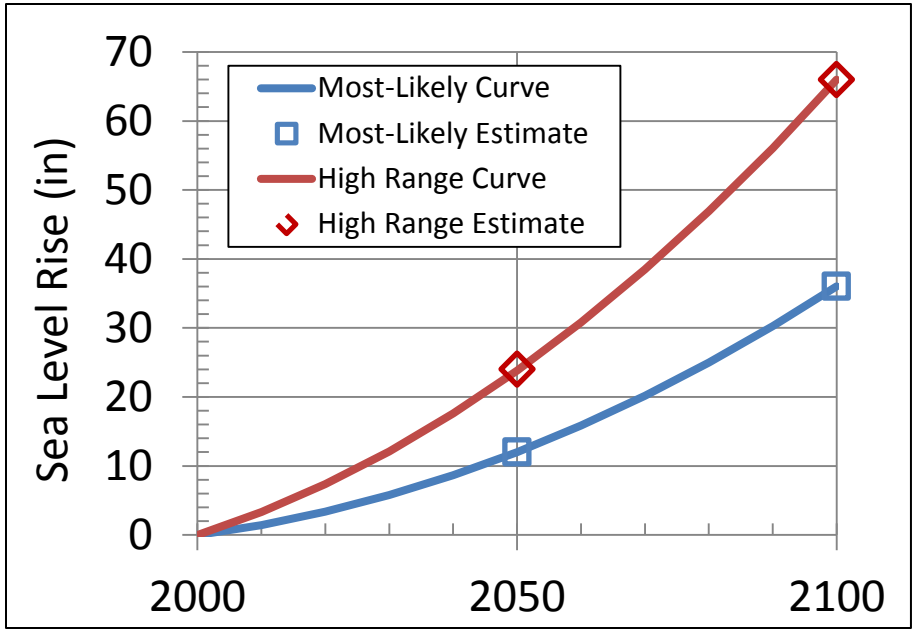
Sea Level Rise Scenarios

- Sea Level Rise Projections (NRC 2012)

Year	Projections	Ranges
2030	6 ± 2 in	2 to 12 in
2050	11 ± 4 in	5 to 24 in
2100	36 ± 10 in	17 to 66 in



- Selected Inundation Mapping Scenarios:
  - NRC “most likely”: 12 inch (2050) and 36 inch (2100)
  - NRC “high-end”: 24 inch (2050) and 66 inch (2100)

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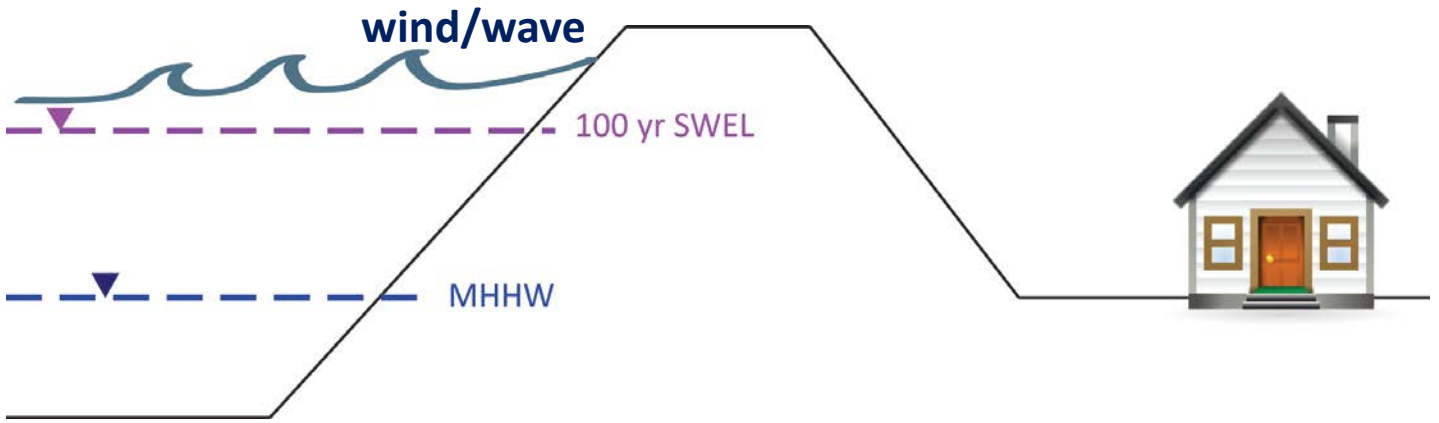
Water Level Analysis – Key Terms

- Mean Higher High Water (MHHW). Typical daily high tide. Permanent *inundation*.
- 100-yr Stillwater Elevation (SWEL) – Extreme high tide + storm surge. Very rare temporary *flooding* event.
- 100-yr SWEL + wind and wave effects. (Not evaluated)



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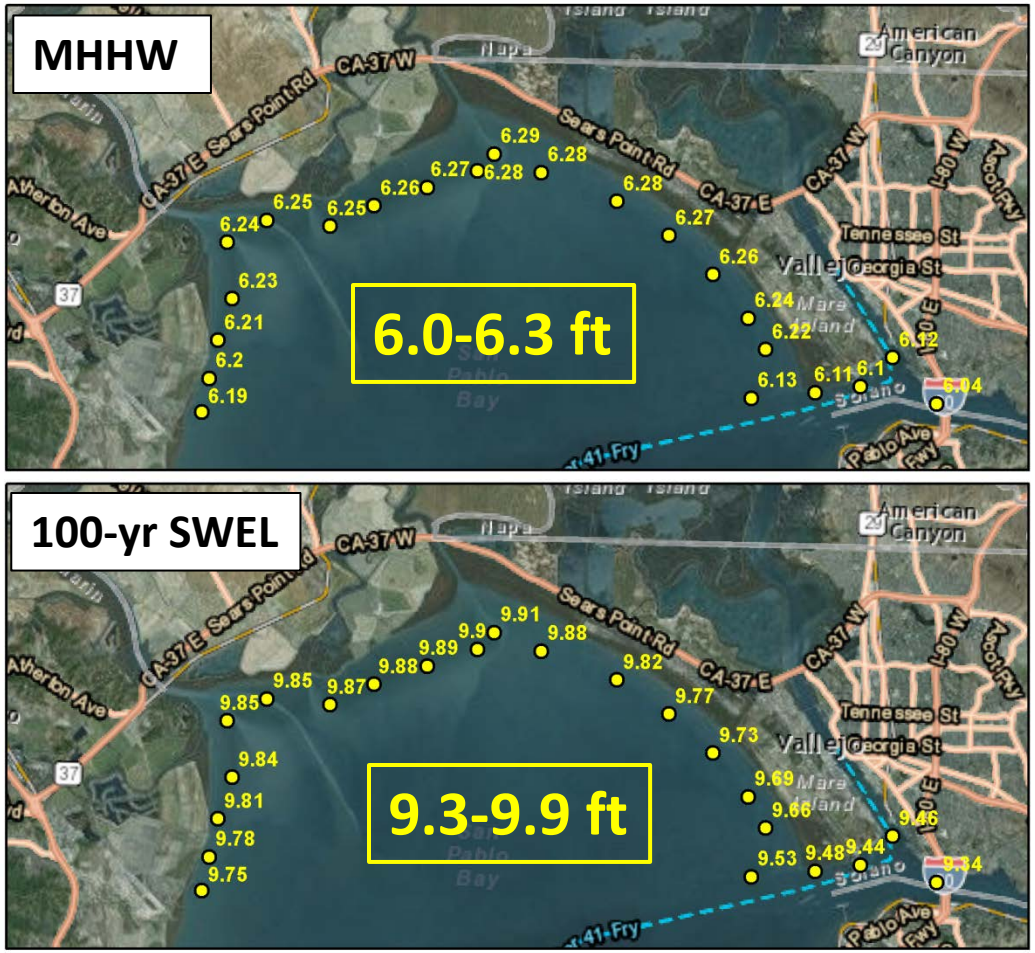
Water Level Analysis



- FEMA hydrodynamic modeling for existing conditions
- 32-year continuous simulation
- Analyzed data at 22 locations
- Daily and Extreme (storm surge) tides
- MHHW: 6.0-6.3 ft
- 100-yr SWEL: 9.3-9.9 ft
- Add SLR for mapping

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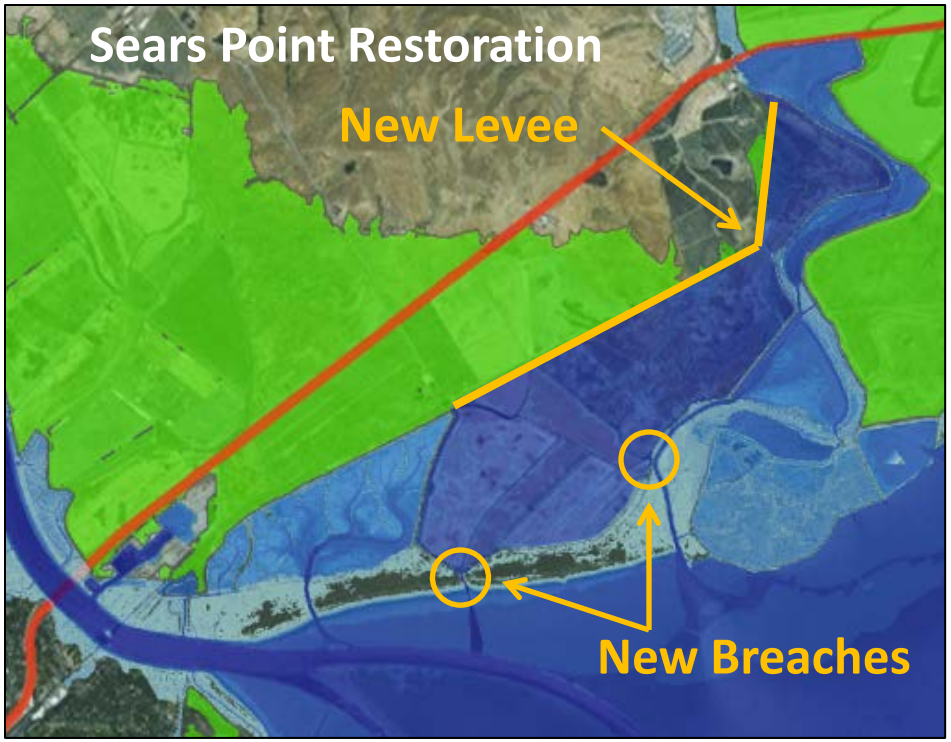
Inundation Mapping Revisions

- Newly restored areas (add breaches)
  - Cullinan Ranch
  - Sears Point
  - Hamilton Wetlands
  - Napa Plant Site
- Water control structures (add connection or structure)
  - West End
  - White Slough
- Managed areas
  - Camp 2
  - Bel Marin Keys
- New levees
  - Cullinan Ranch
  - Sears Point



Thanks to: Ducks Unlimited, Caltrans, ESA, and Coastal Conservancy for reviewing maps

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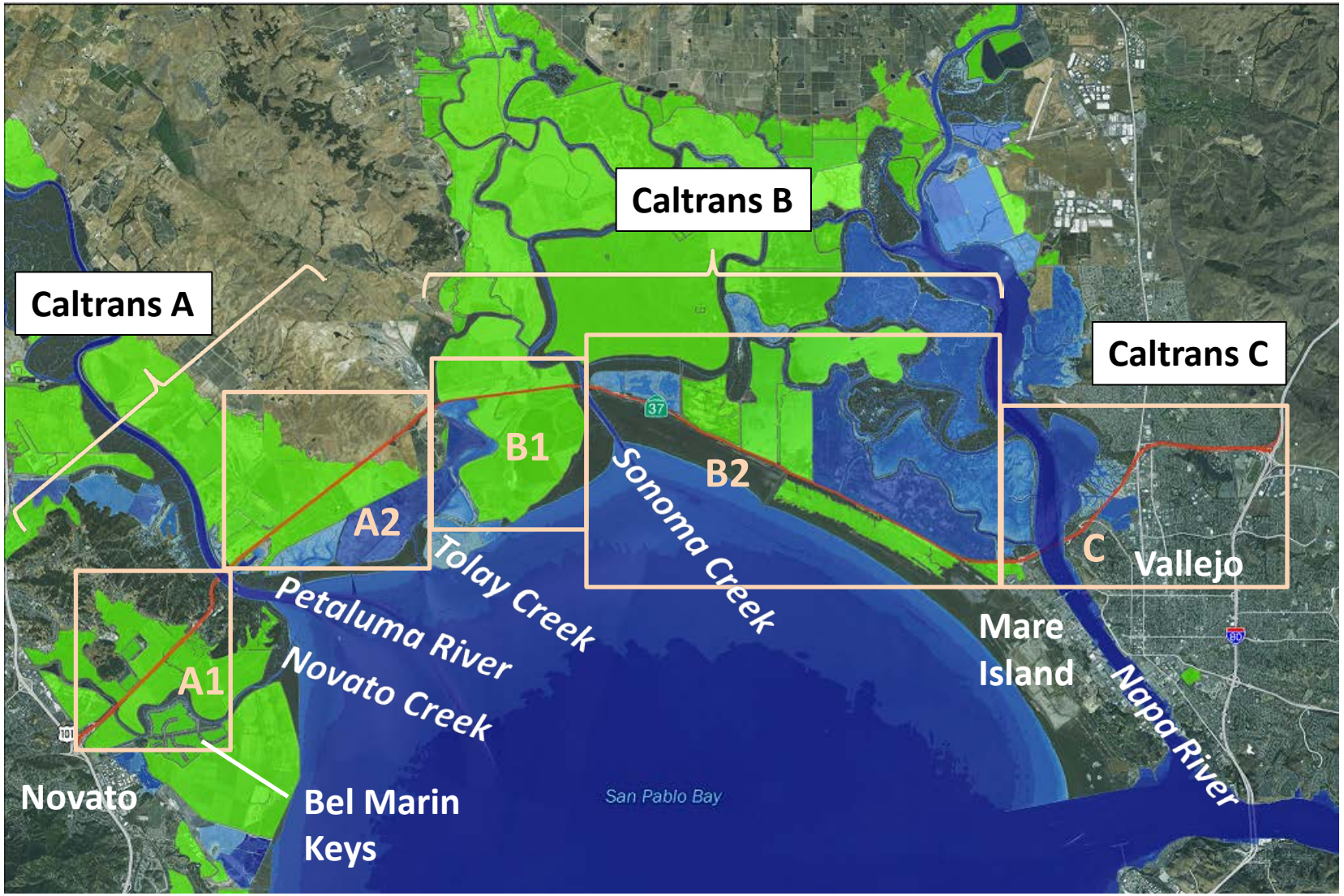
Preliminary Vulnerability Assessment: Reaches



SLR Mapping Results

- MHHW + 12” (2050 most-likely)
- MHHW + 24” (2050 high-end)
- MHHW + 36” (2100 most-likely)
- 100-yr SWEL (Existing)
- 100-yr SWEL + 12” (2050 most-likely)
- MHHW + 66” (2100 high-end)
- 100-yr SWEL + 36” (2100 most-likely)

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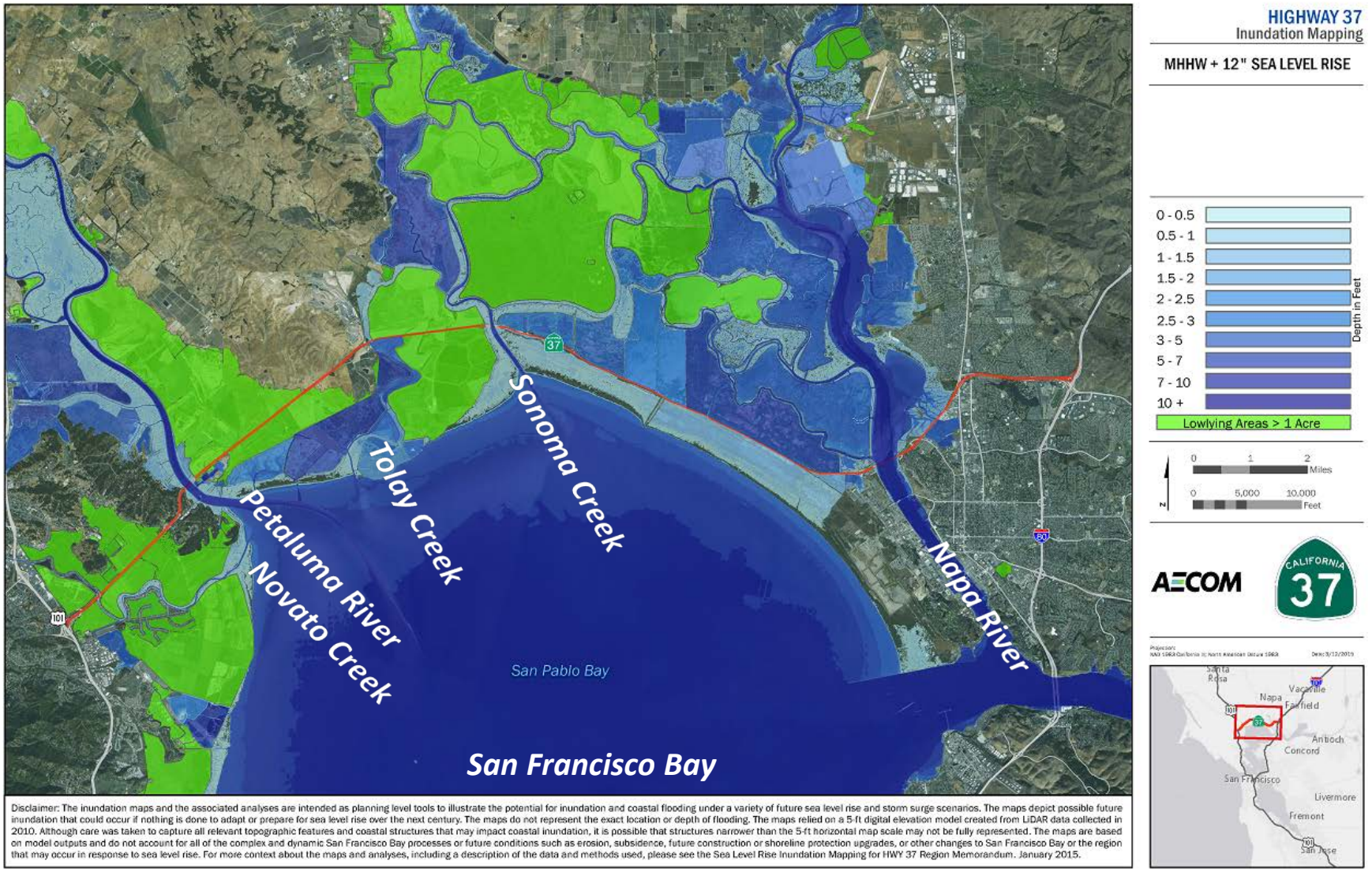
MHHW + 12”



Disclaimer: The inundation maps and the associated analyses are intended as planning level tools to illustrate the potential for inundation and coastal flooding under a variety of future sea level rise and storm surge scenarios. The maps depict possible future inundation that could occur if nothing is done to adapt or prepare for sea level rise over the next century. The maps do not represent the exact location or depth of flooding. The maps relied on a 5-ft digital elevation model created from LiDAR data collected in 2010. Although care was taken to capture all relevant topographic features and coastal structures that may impact coastal inundation, it is possible that structures narrower than the 5-ft horizontal map scale may not be fully represented. The maps are based on model outputs and do not account for all of the complex and dynamic San Francisco Bay processes or future conditions such as erosion, subsidence, future construction or shoreline protection upgrades, or other changes to San Francisco Bay or the region that may occur in response to sea level rise. For more context about the maps and analyses, including a description of the data and methods used, please see the Sea Level Rise Inundation Mapping for HWY 37 Region Memorandum. January 2015.

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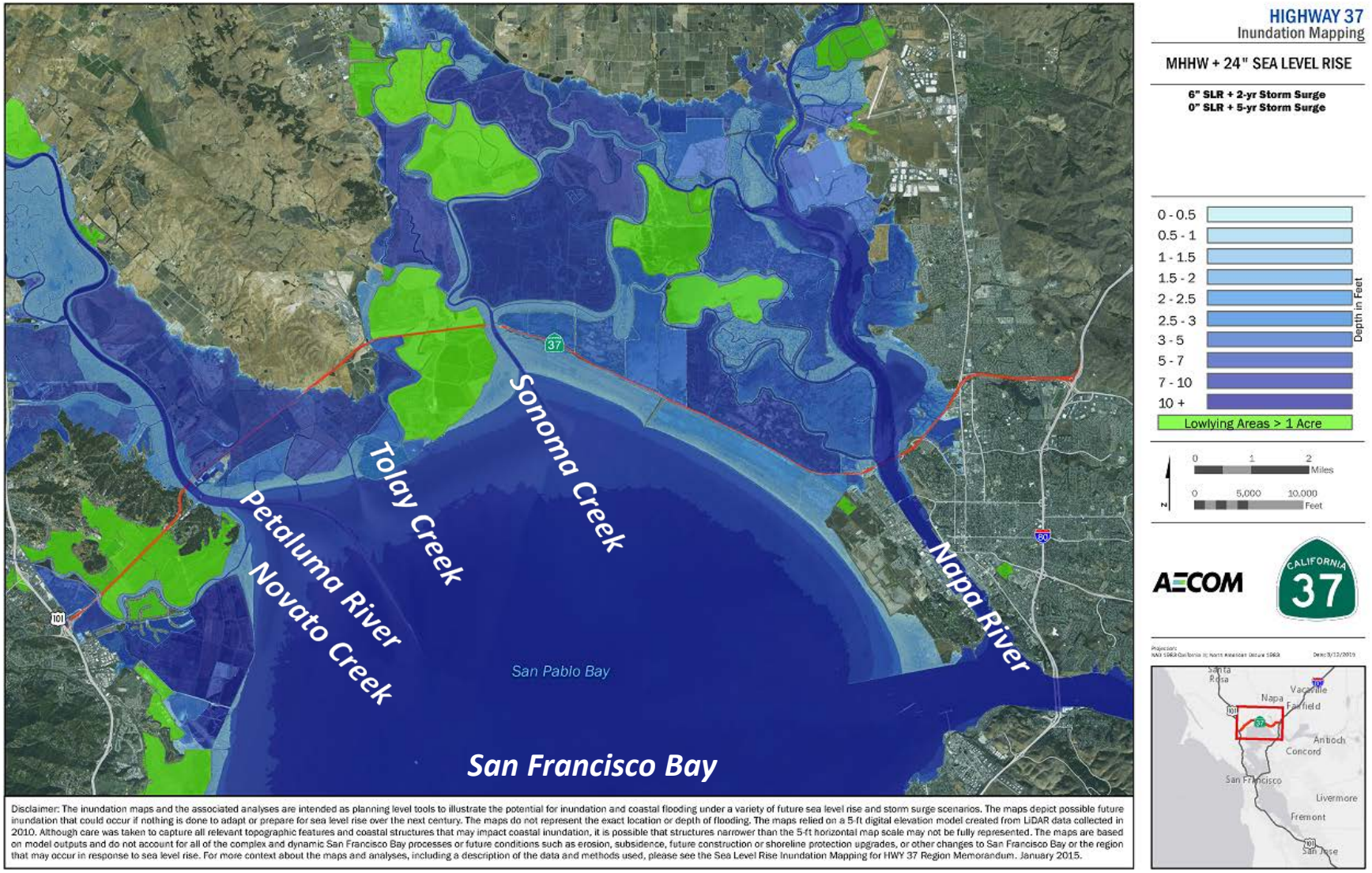
MHHW + 24”



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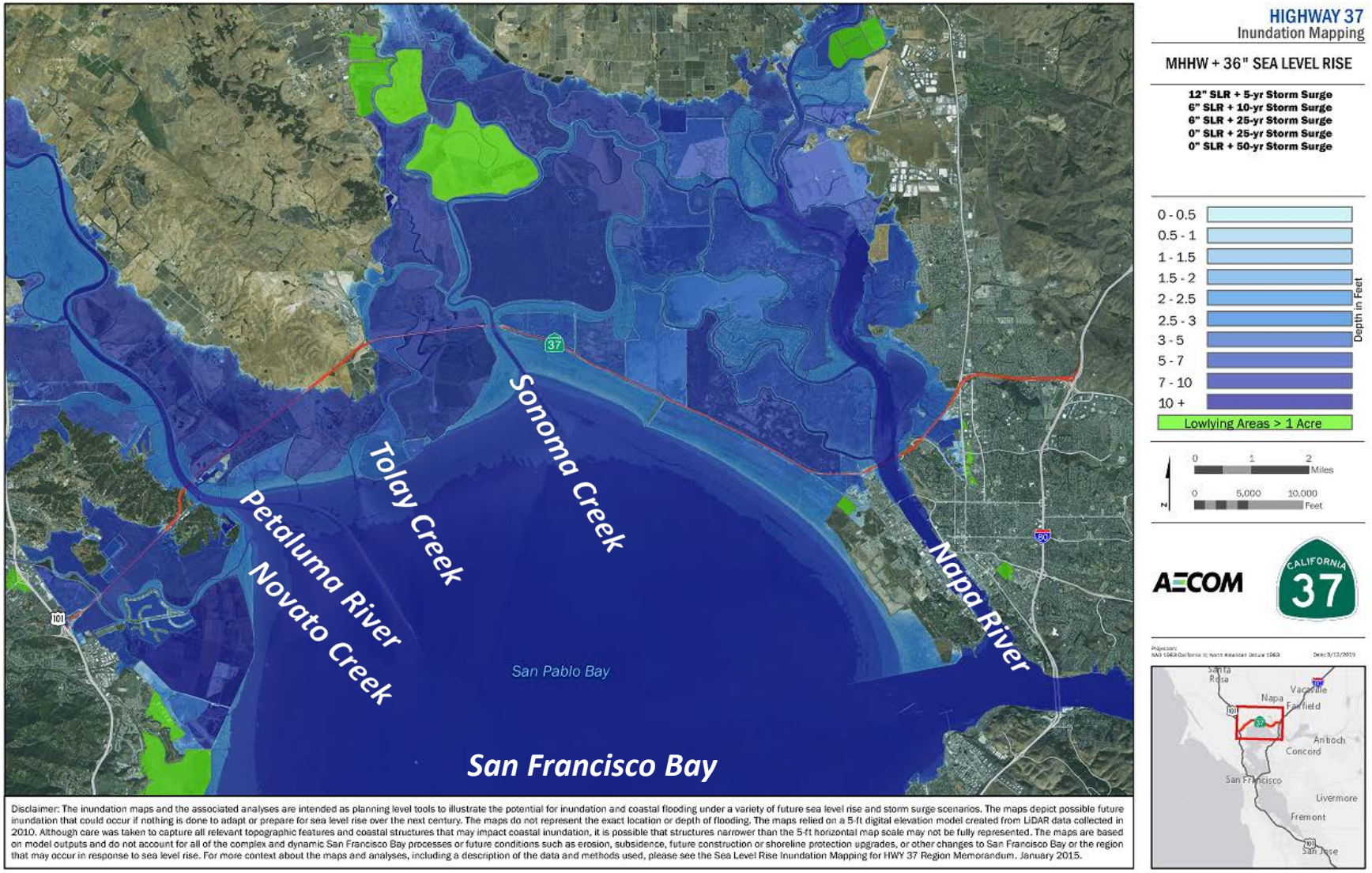
MHHW + 36”



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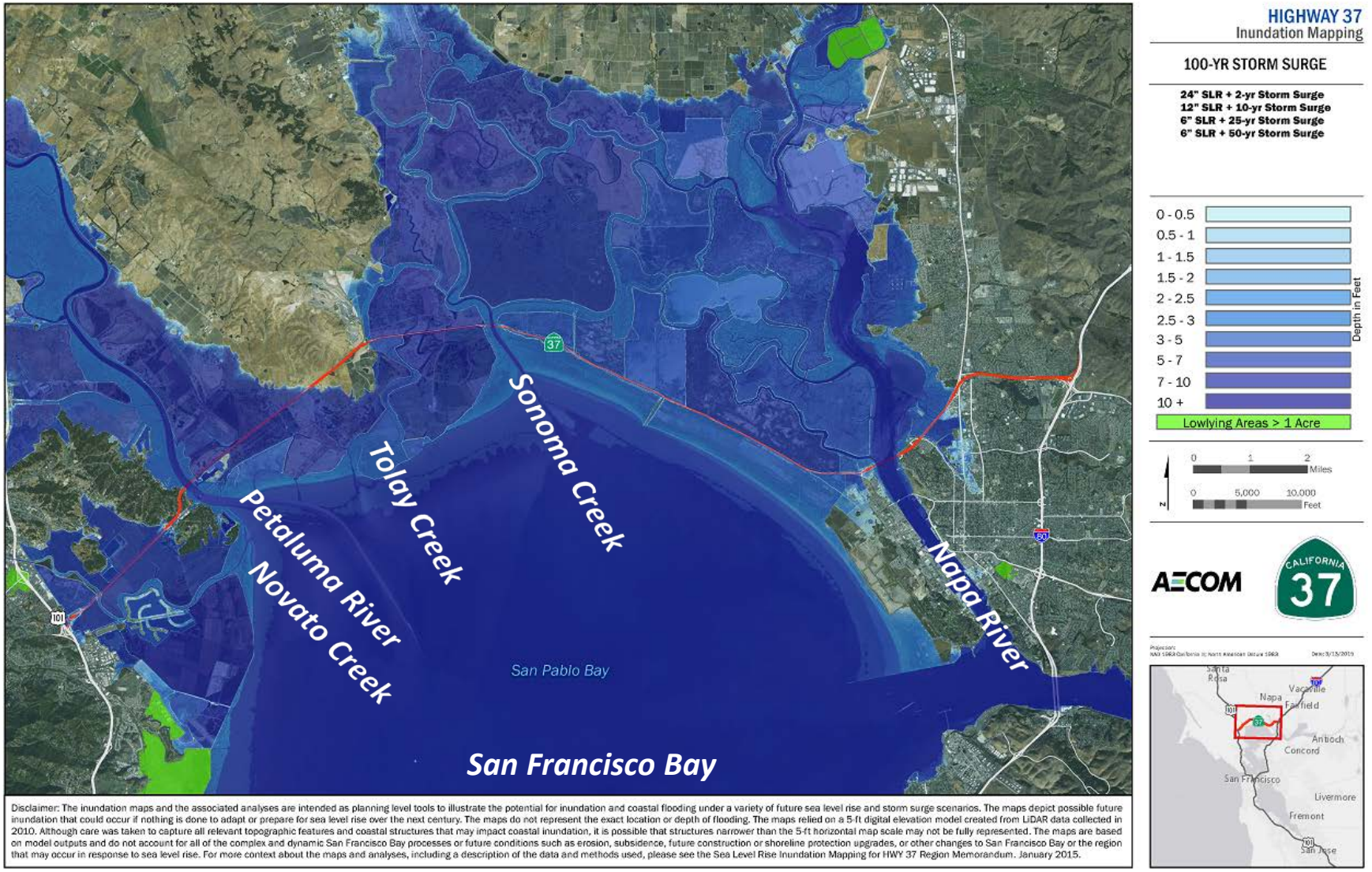
100-yr Storm Surge



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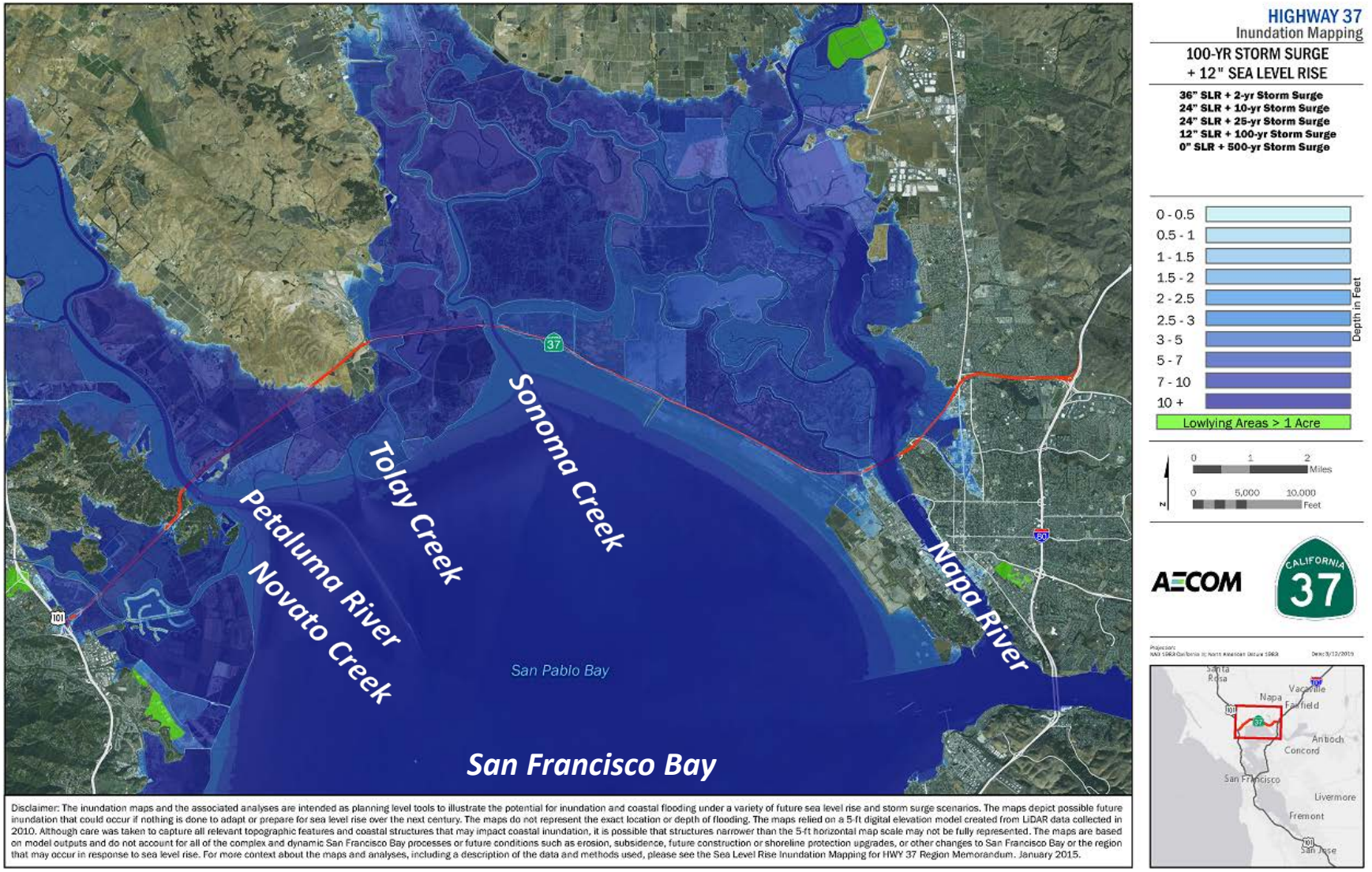
100-yr SWEL + 12”



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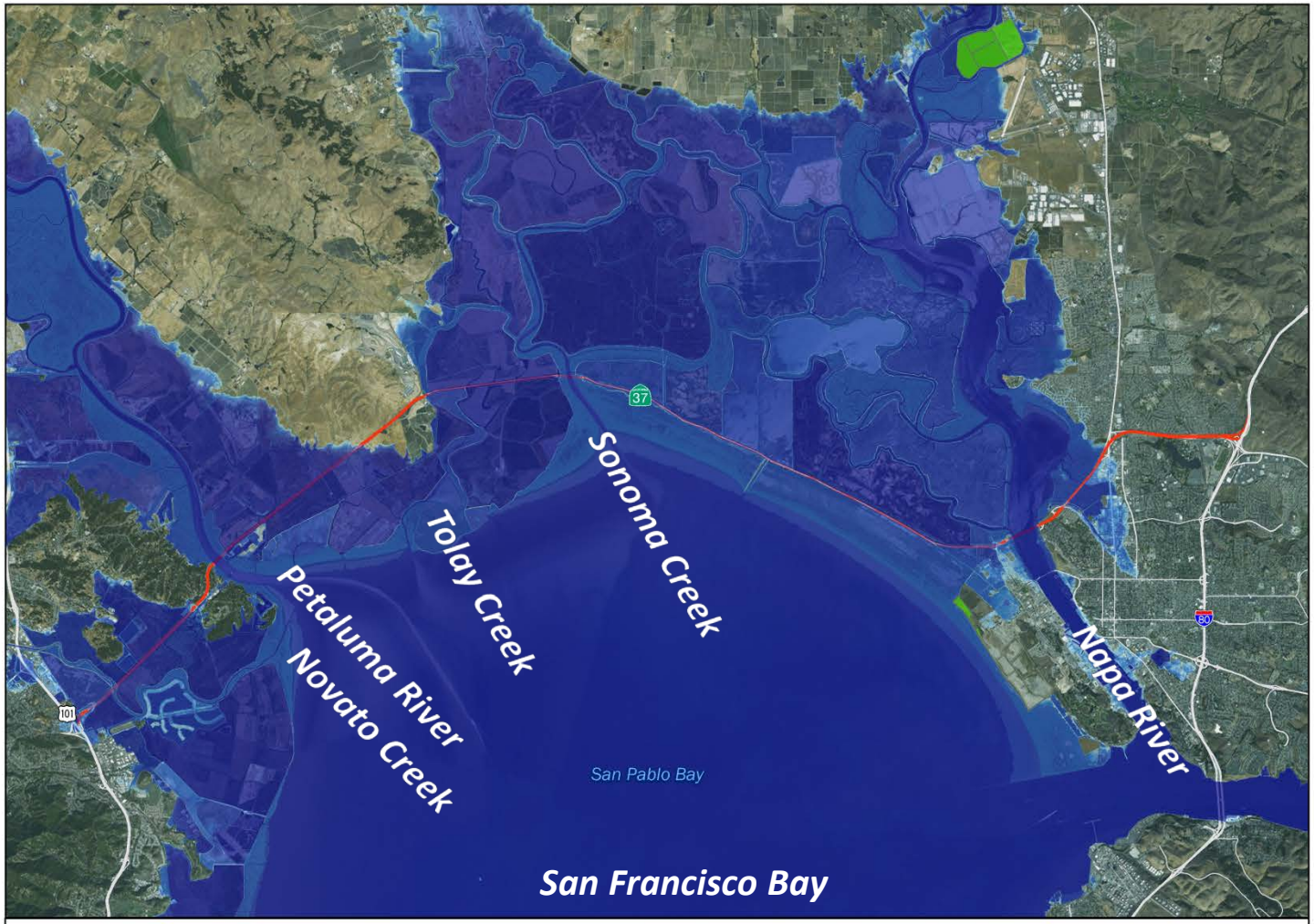
MHHW + 66”



HIGHWAY 37
Inundation Mapping

MHHW + 66" SEA LEVEL RISE

48” SLR + 2-yr Storm Surge
42” SLR + 5-yr Storm Surge
36” SLR + 10-yr Storm Surge
36” SLR + 25-yr Storm Surge
24” SLR + 100-yr Storm Surge
12” SLR + 500-yr Storm Surge

Depth in Feet
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

CALIFORNIA 37

Projection: NAD 1983 California (2) North American Datum 1983 Date: 3/12/2015

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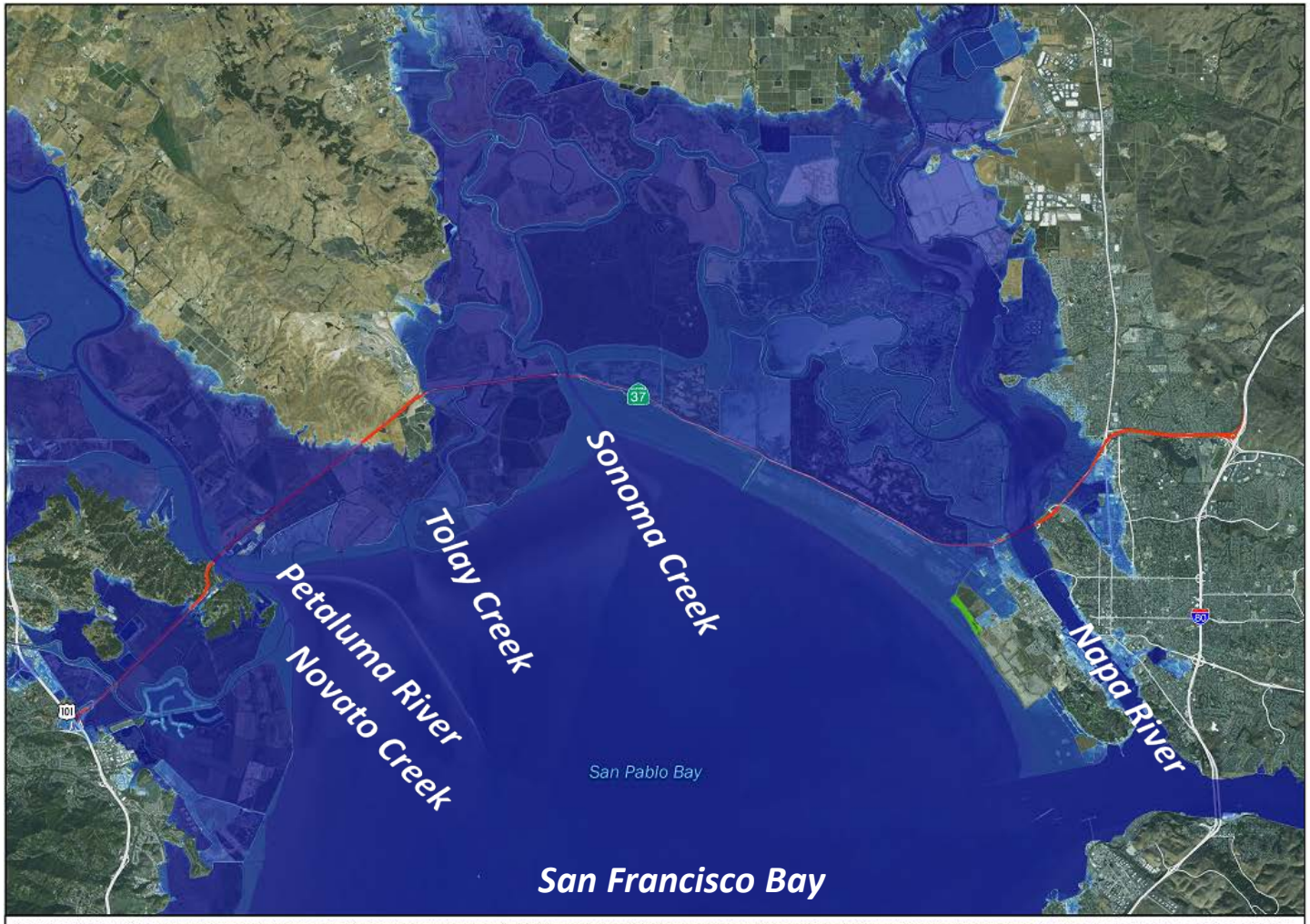
100-yr SWEL + 36”



HIGHWAY 37
Inundation Mapping

100-YR STORM SURGE + 36" SEA LEVEL RISE

60" SLR + 2-yr Storm Surge
54" SLR + 5-yr Storm Surge
48" SLR + 10-yr Storm Surge
48" SLR + 25-yr Storm Surge
42" SLR + 25-yr Storm Surge
42" SLR + 50-yr Storm Surge
36" SLR + 100-yr Storm Surge
24" SLR + 500-yr Storm Surge

Depth in Feet
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet
N

AECOM

CALIFORNIA 37

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SLR Inundation Maps

- Provide high level depiction of inundation patterns and timing of inundation
- Indicate when large-scale low-lying basins are inundated
- Difficult to see extent of impacts to roadway and source of inundation
- Overtopping assessment can provide more detailed information

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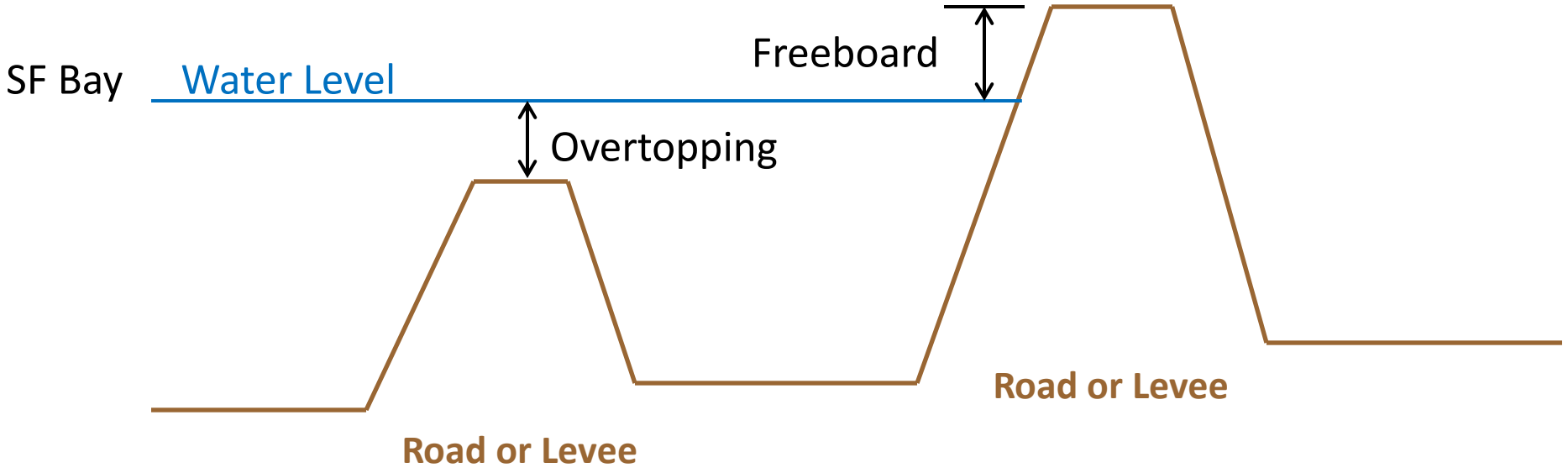
Overtopping and Freeboard

- Overtopping: Water level (MHHW or SWEL) exceeds elevation of roadway. “Depth of overtopping”.
- Freeboard: Elevation of roadway exceeds water level (MHHW or SWEL). Freeboard = the height of the roadway above the adjacent water surface.



Overtopping Delineation: Edge of Lanes

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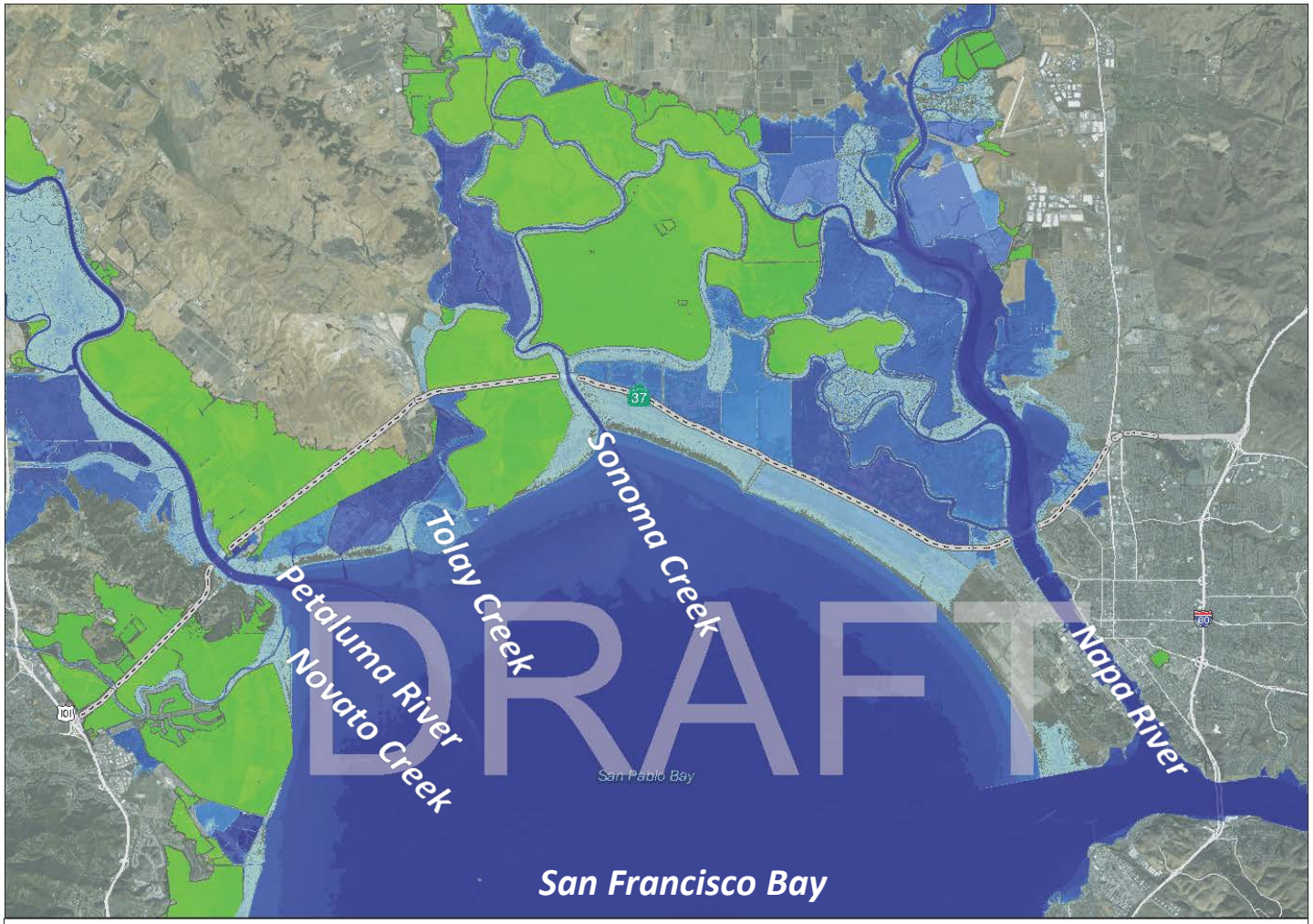
MHHW + 12” (Eastbound)



HIGHWAY 37
Inundation Mapping

MHHW + 12" SEA LEVEL RISE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet
No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

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Note: Bridges not included in overtopping assessment

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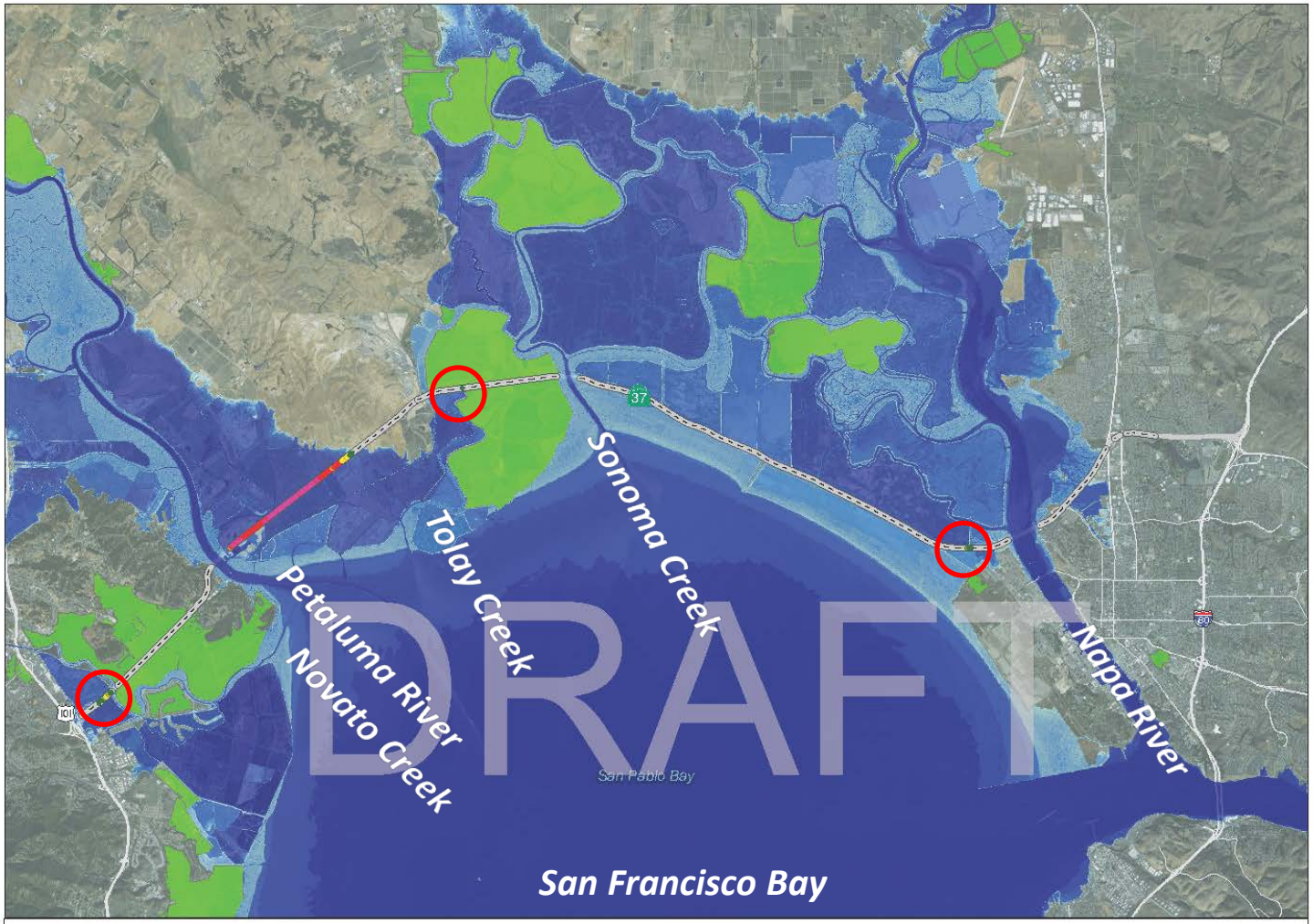
MHHW + 24” (Eastbound)



HIGHWAY 37
Inundation Mapping

MHHW + 24" SEA LEVEL RISE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37
6" SLR + 2-yr Storm Surge
0" SLR + 5-yr Storm Surge

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet
No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

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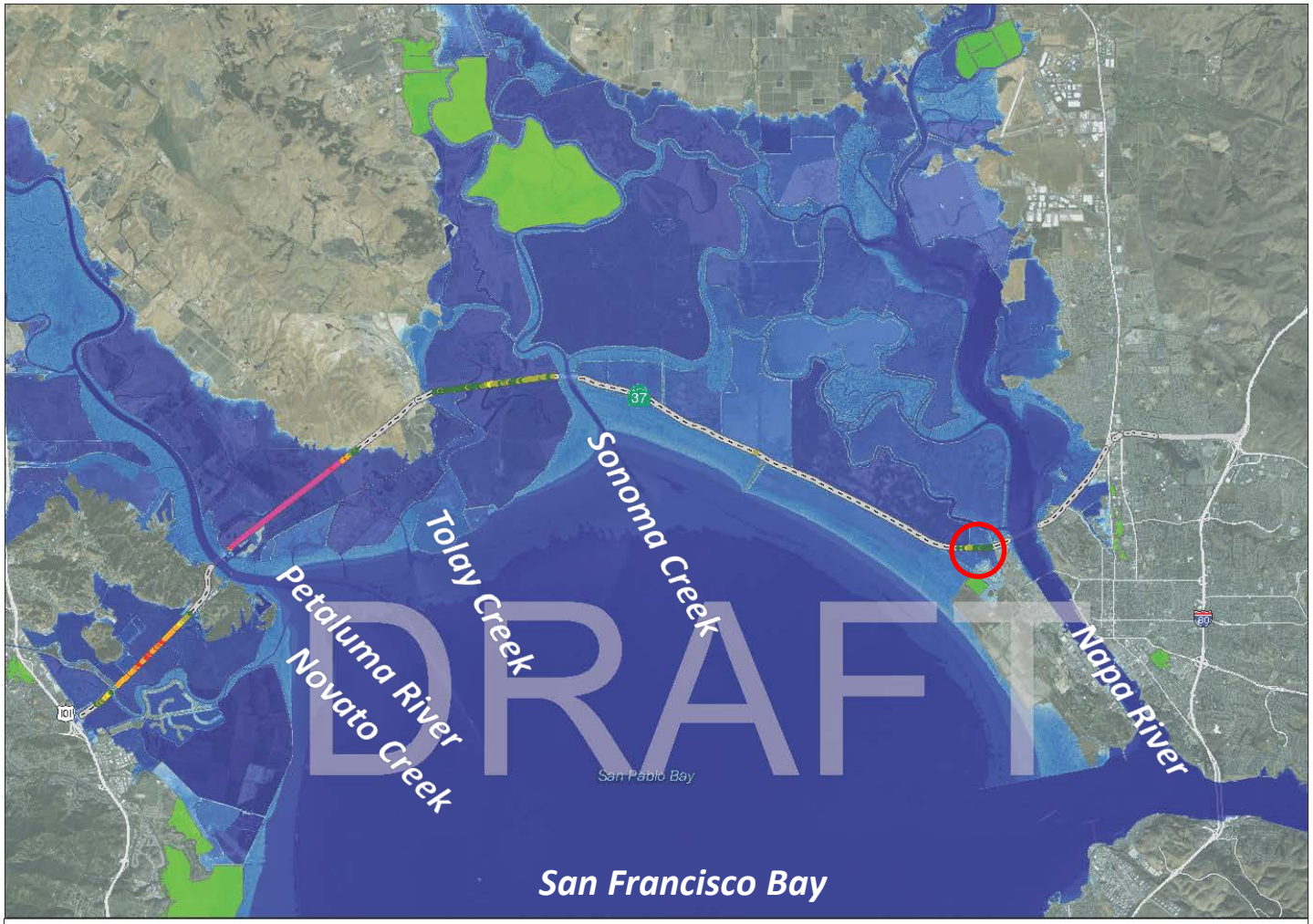
MHHW + 36” (Eastbound)



HIGHWAY 37
Inundation Mapping

MHHW + 36" SEA LEVEL RISE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37
12" SLR + 5-yr Storm Surge
6" SLR + 10-yr Storm Surge
6" SLR + 25-yr Storm Surge
0" SLR + 25-yr Storm Surge
0" SLR + 50-yr Storm Surge

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet
No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

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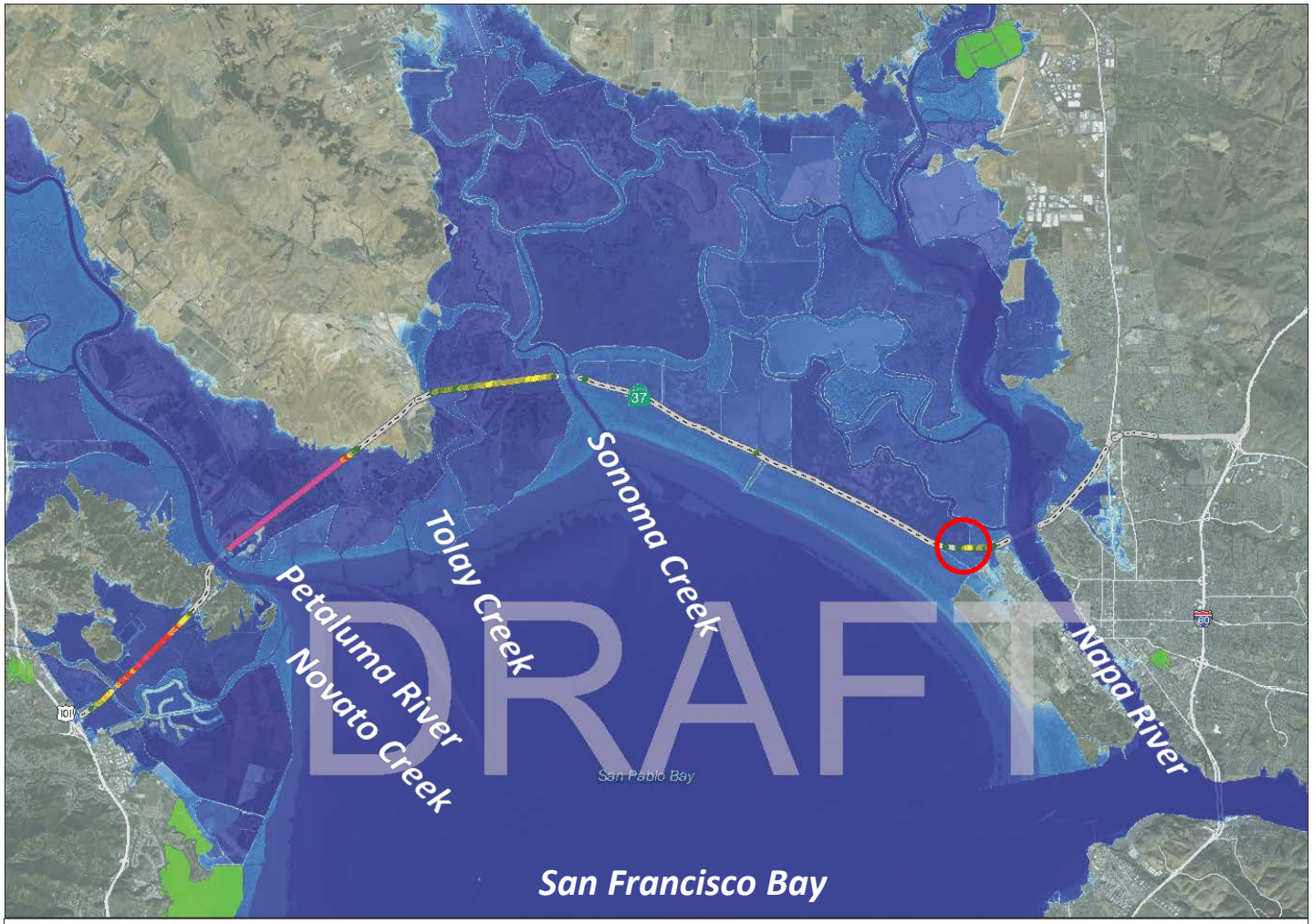
100-yr Storm Surge (Eastbound)



HIGHWAY 37
Inundation Mapping

100 YR STORM SURGE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet

No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet

Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

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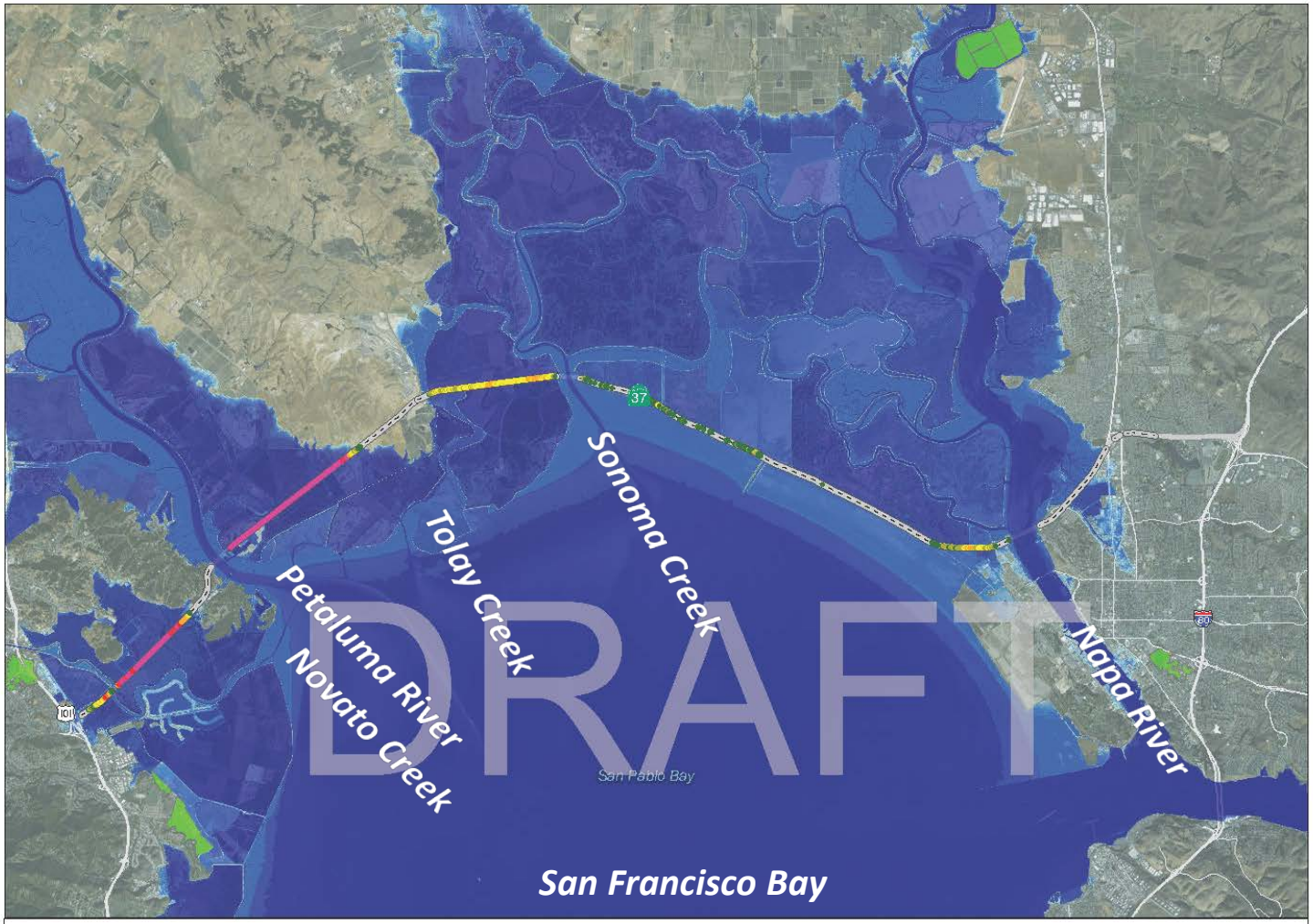
100-yr SWEL + 12” (Eastbound)



HIGHWAY 37
Inundation Mapping

100 YR STORM SURGE + 12" SEA LEVEL RISE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37
36" SLR + 2-yr Storm Surge
24" SLR + 10-yr Storm Surge
24" SLR + 25-yr Storm Surge
12" SLR + 100-yr Storm Surge
0" SLR + 500-yr Storm Surge

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet
No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

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MHHW + 66” (Eastbound)

HIGHWAY 37
Inundation Mapping

MHHW + 66" SEA LEVEL RISE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37
48" SLR + 2-yr Storm Surge
42" SLR + 5-yr Storm Surge
36" SLR + 10-yr Storm Surge
36" SLR + 25-yr Storm Surge
24" SLR + 100-yr Storm Surge
12" SLR + 500-yr Storm Surge

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet
No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

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100-yr SWEL + 36” (Eastbound)

HIGHWAY 37
Inundation Mapping

100 YR STORM SURGE + 36" SEA LEVEL RISE
OVERTOPPING POTENTIAL - EAST BOUND HWY 37

- 60" SLR + 2-yr Storm Surge
- 54" SLR + 5-yr Storm Surge
- 48" SLR + 10-yr Storm Surge
- 48" SLR + 25-yr Storm Surge
- 42" SLR + 25-yr Storm Surge
- 42" SLR + 50-yr Storm Surge
- 36" SLR + 100-yr Storm Surge
- 24" SLR + 500-yr Storm Surge

Overtopping
.5 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
Depth in Feet
No Overtopping

Inundation
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Depth in Feet
Lowlying Areas > 1 Acre

0 1 2 Miles
0 5,000 10,000 Feet

AECOM

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Inundation Mapping Summary

- Adopted NRC (2012) SLR scenarios: 12”, 24”, 36” and 66”
- Completed SLR inundation modeling and mapping for daily (MHHW) and extreme (100-yr SWEL) tide
- Extracted overtopped length and depth along HWY alignment
- Maps show large-scale patterns of SLR impact; overtopping shows localized impacts
- Mapping results feed into vulnerability assessment as indicator of exposure

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HWY 37 Draft SLR Vulnerability and Risk Assessment

Justin Vandever, PE and Kris May, PhD, PE
AECOM – Oakland, CA
Justin.Vandever@aecom.com
Kris.May@aecom.com

Highway 37 Stewardship Study

Stakeholder Meeting – Vallejo, CA

April 21, 2015

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Preliminary Vulnerability Assessment

- HWY 37 is protected by a complex system of interconnected levees
- Divide study area into five reaches (west to east). Each reach is a system of flood protection:
  - Reach A1: HWY 101 to Petaluma River
  - Reach A2: Petaluma River to HWY 121
  - Reach B1: HWY 121 to Sonoma Creek
  - Reach B2: Sonoma Creek to Mare Island
  - Reach C: Mare Island to I-80
- What are the sources of inundation/flooding within each reach (e.g., levee overtopping, direct inundation)?
- What is timing of inundation/flooding within each reach?

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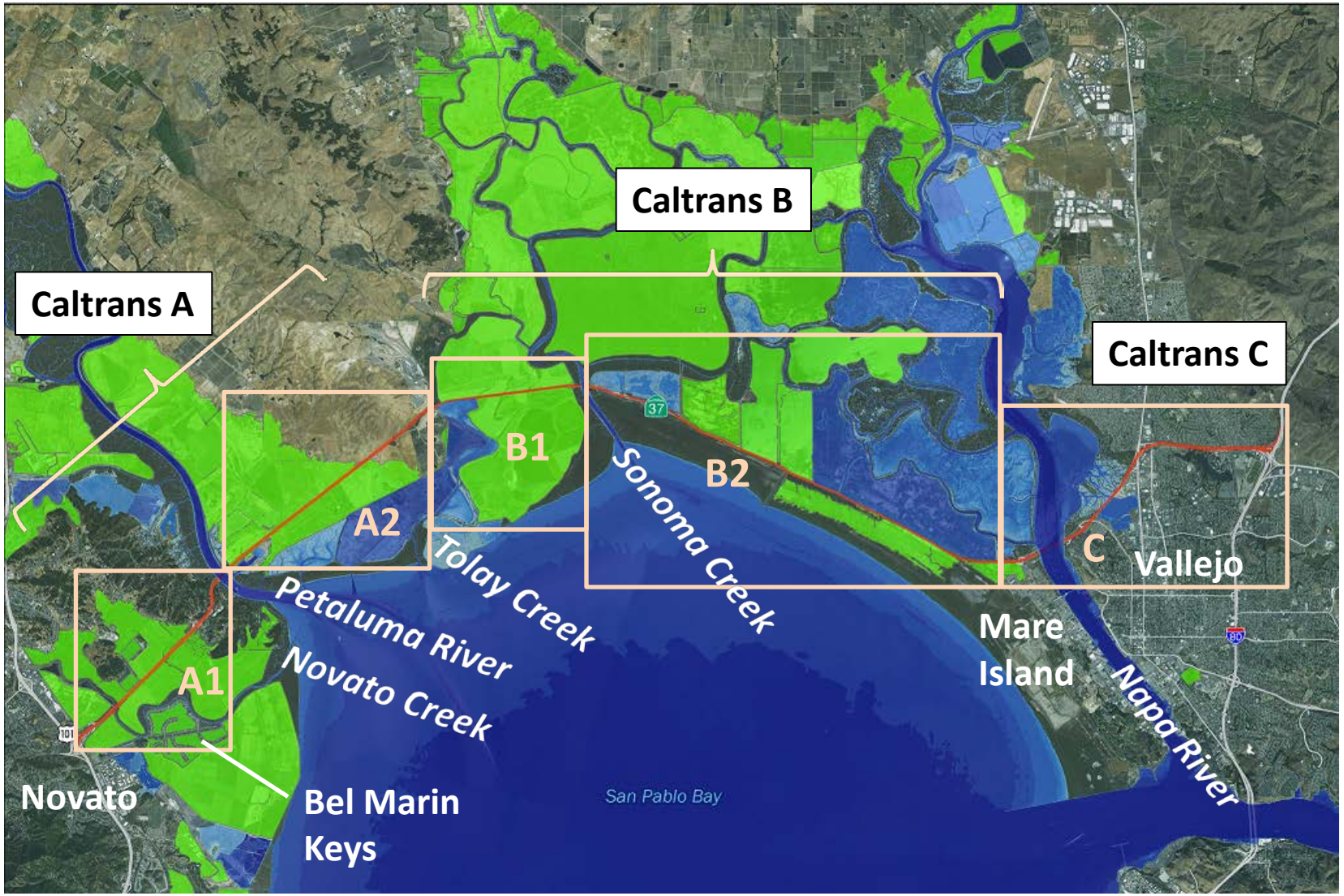
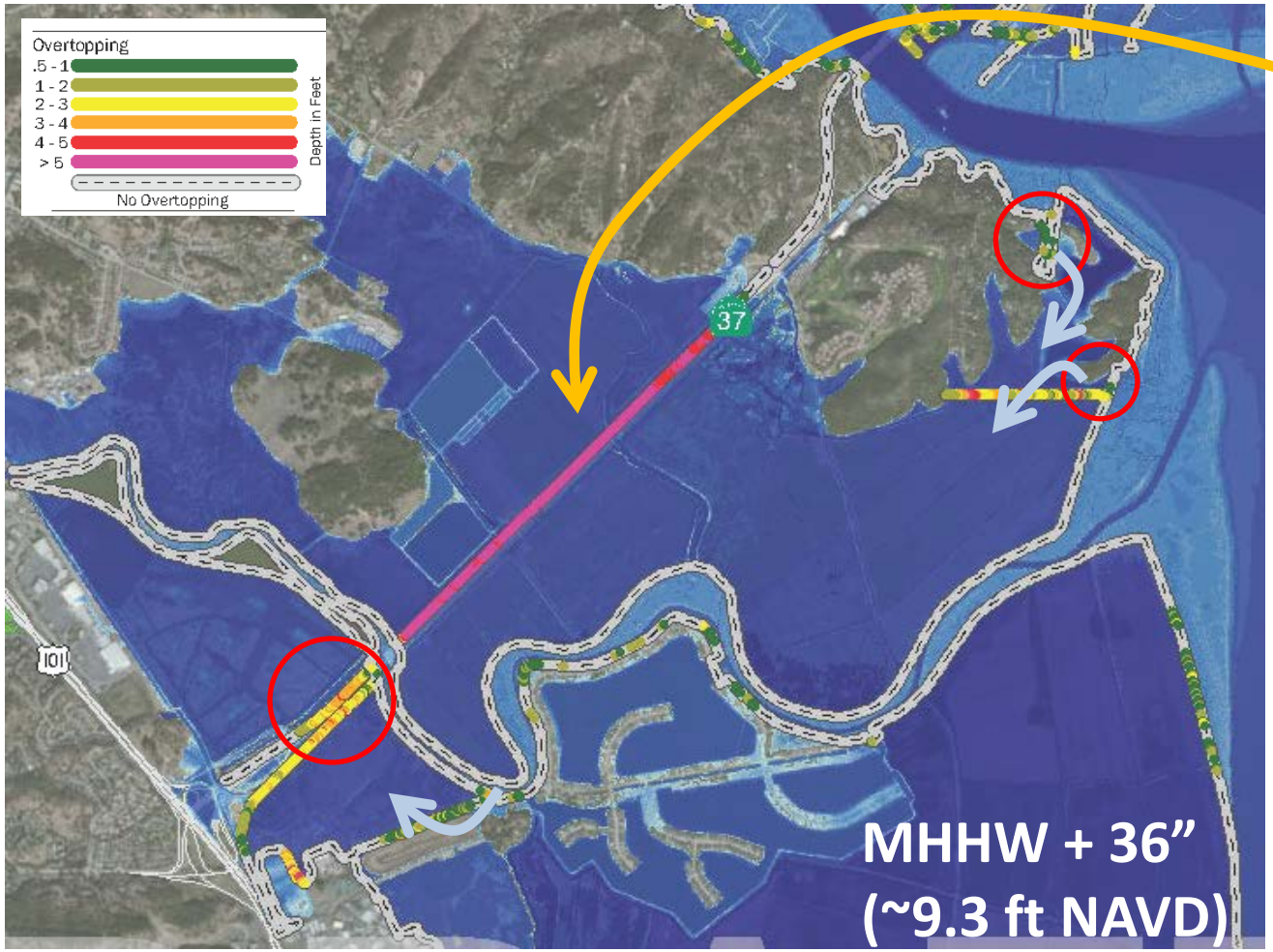
Preliminary Vulnerability Assessment: Reaches



Preliminary Vulnerability Assessment:

Reach A1 – HWY 101 to Petaluma River



- HWY low-lying (4-6 ft NAVD)
- Protected by Novato Creek levees (10-13 ft NAVD)
- Sources of flooding: overland flooding at Black Point-Green Point and levee overtopping at Novato Creek Mouth

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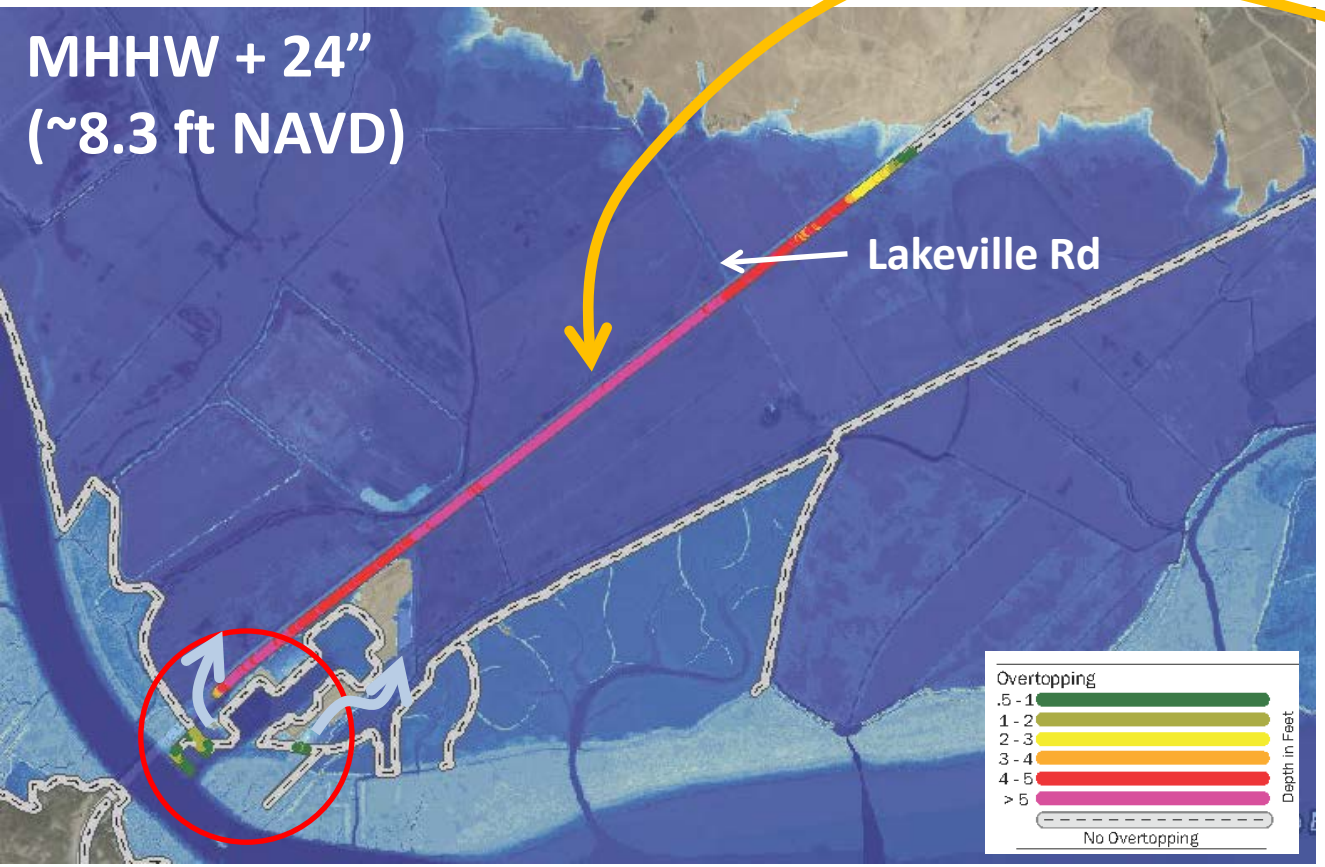
Preliminary Vulnerability Assessment:
Reach A2 – Petaluma River to HWY 121



- Western segment of HWY low-lying (2-4 ft NAVD)
- Protected by Petaluma River levees, Sonoma Baylands, Sears Point, Tolay Creek levees
- Sources of flooding: Port Sonoma marina

Realistic permanent inundation but conservative temporary flooding extent and depth.

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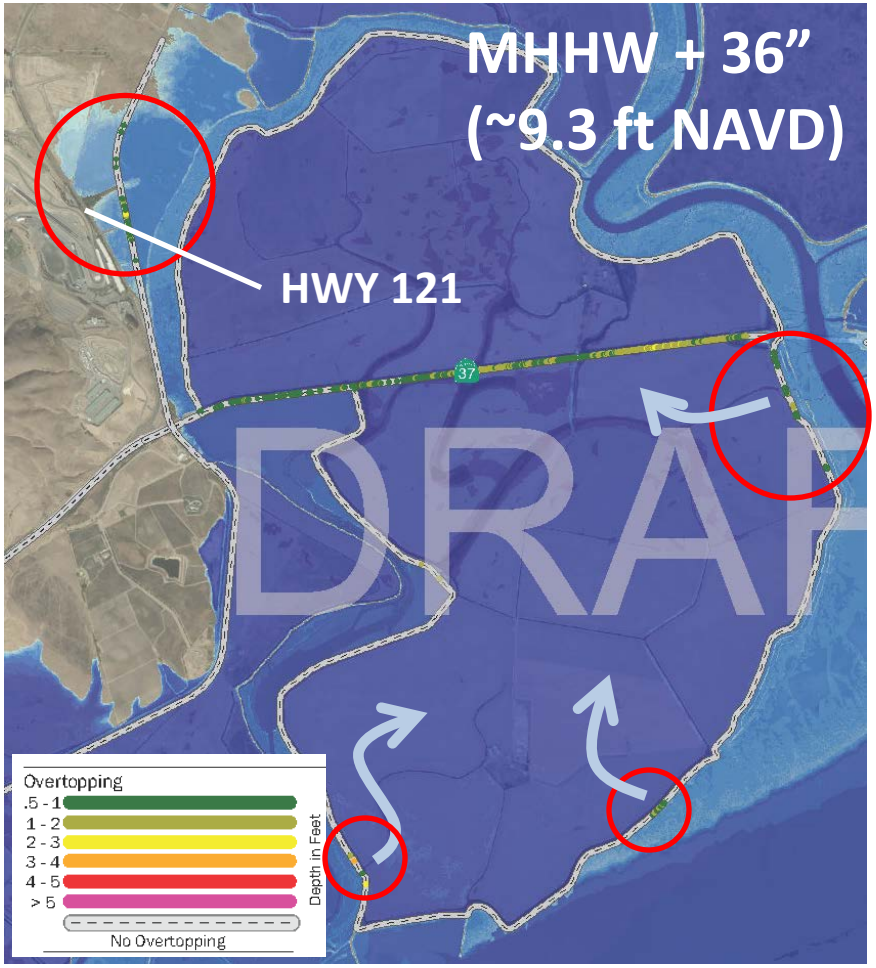
Preliminary Vulnerability Assessment:
Reach B1 – HWY 121 to Sonoma Creek

- Road is 8-9 ft NAVD elevation
- Protected by Tolay Creek and Sonoma Creek levees
- Sources of flooding: Tolay Creek, Sonoma Creek, SF Bay



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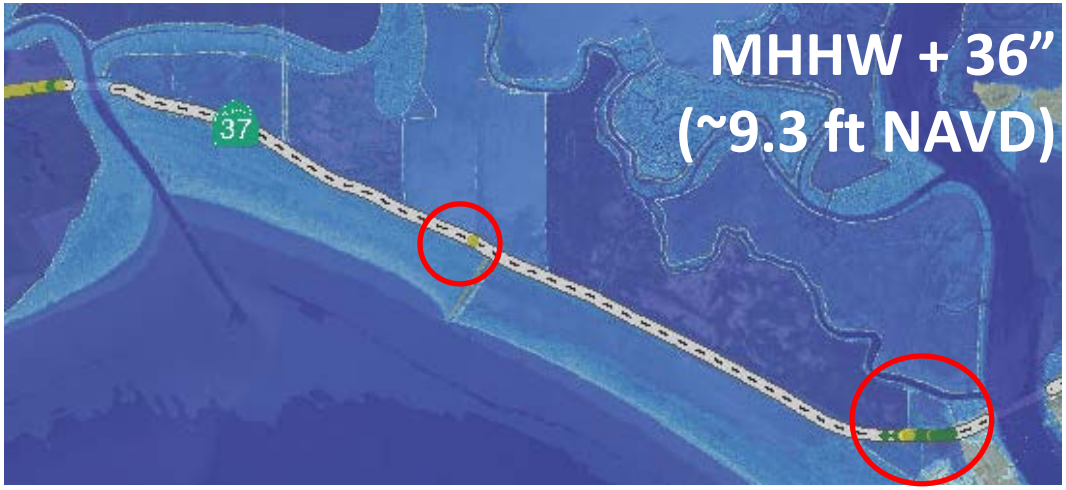
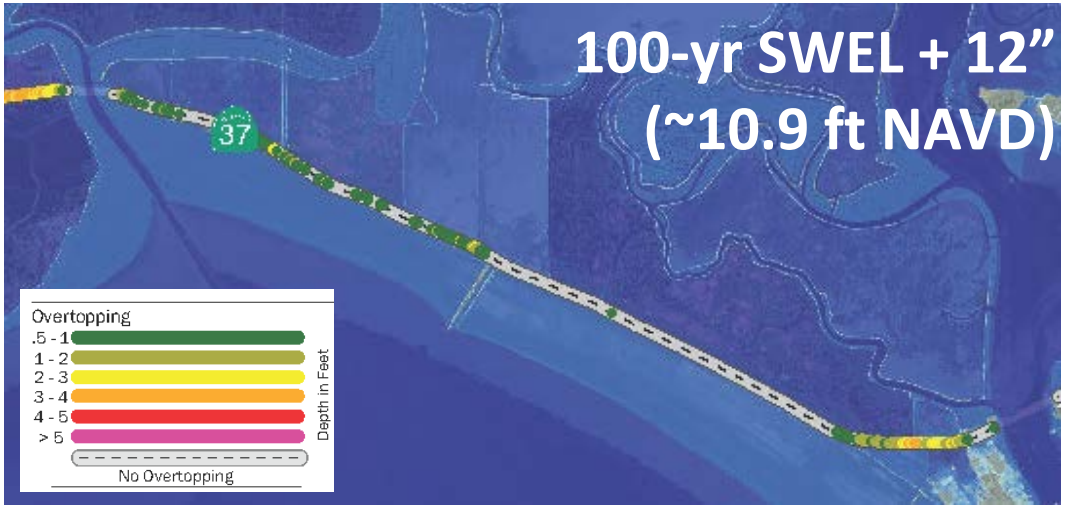
Preliminary Vulnerability Assessment:
Reach B2 – Sonoma Creek to Mare Island

- Road is ~11 ft NAVD elevation; low spots flood
- No bayfront levee on this reach
- Sources of flooding: Direct flooding from SF Bay





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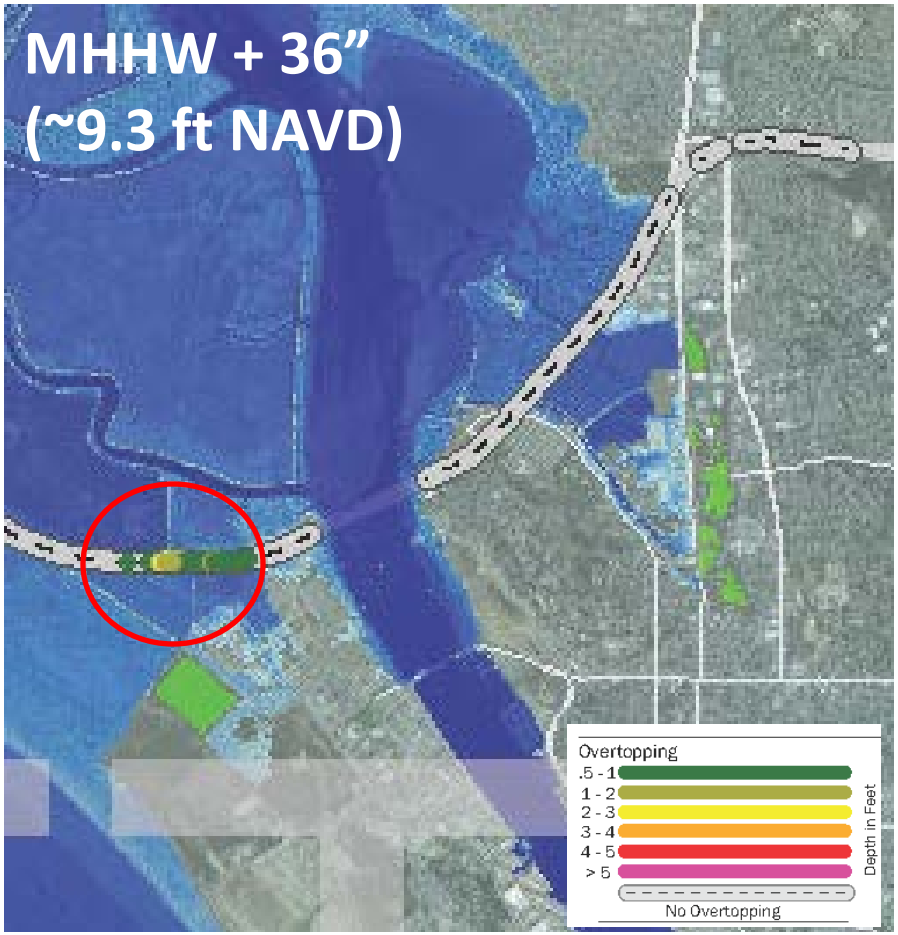
Preliminary Vulnerability Assessment:
Reach C – Mare Island to I-80

- Road is 13-15 ft NAVD elevation; low-lying Mare Island is 7-8 ft NAVD
- No bayfront levee on this reach
- Sources of flooding: Direct flooding from SF Bay



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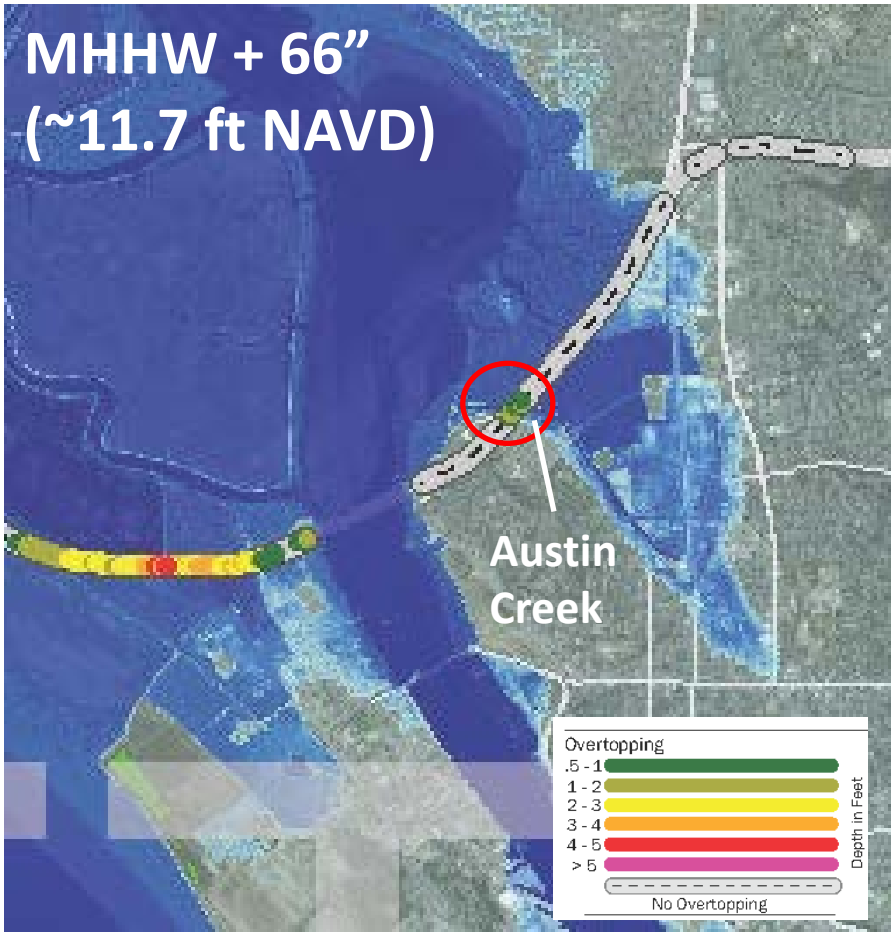
Preliminary Vulnerability Assessment:
Reach 5 – Mare Island to I-80

- Road is 13-15 ft NAVD elevation; low-lying Mare Island is 7-8 ft NAVD
- No bayfront levee on this reach
- Sources of flooding: Direct flooding from SF Bay



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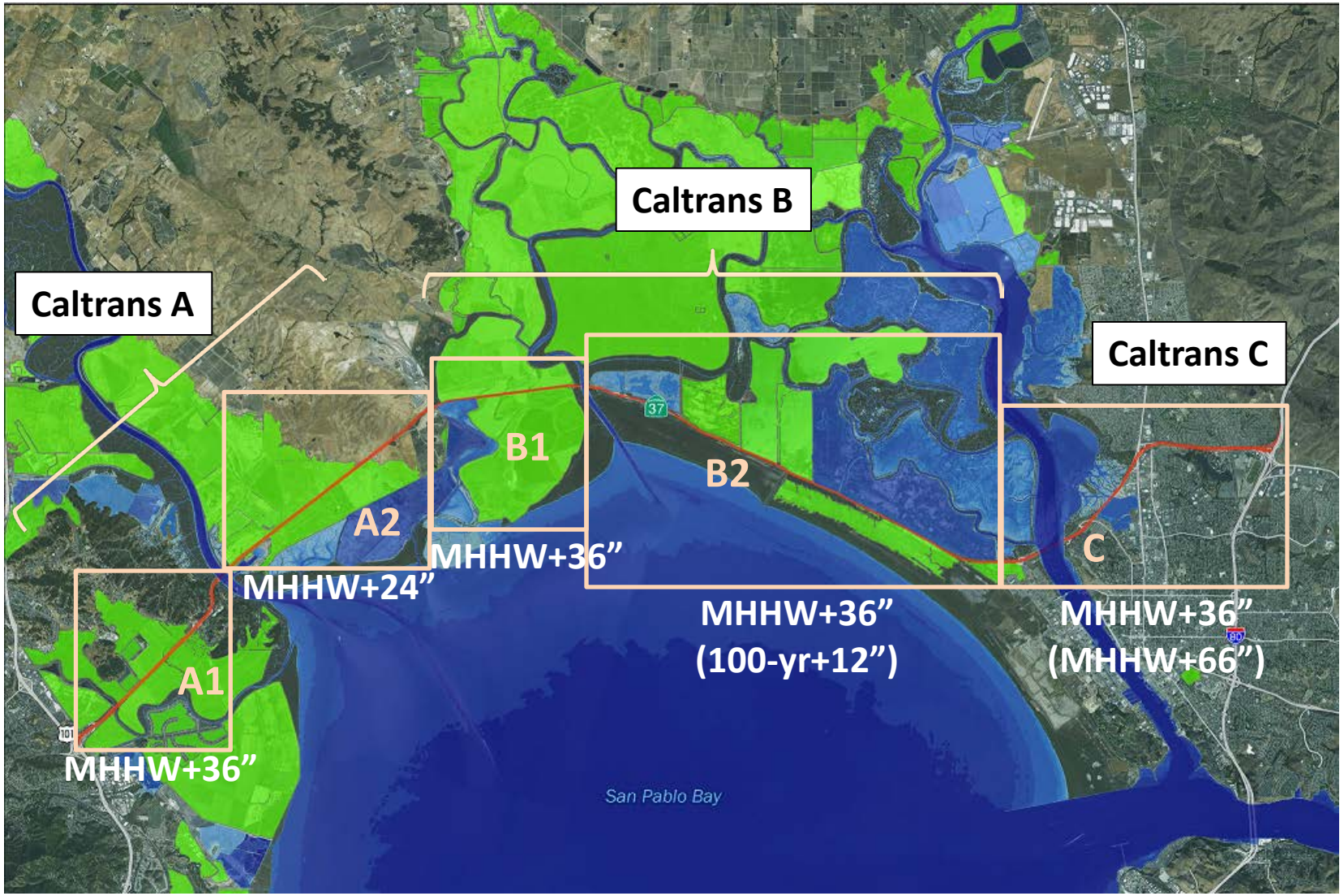
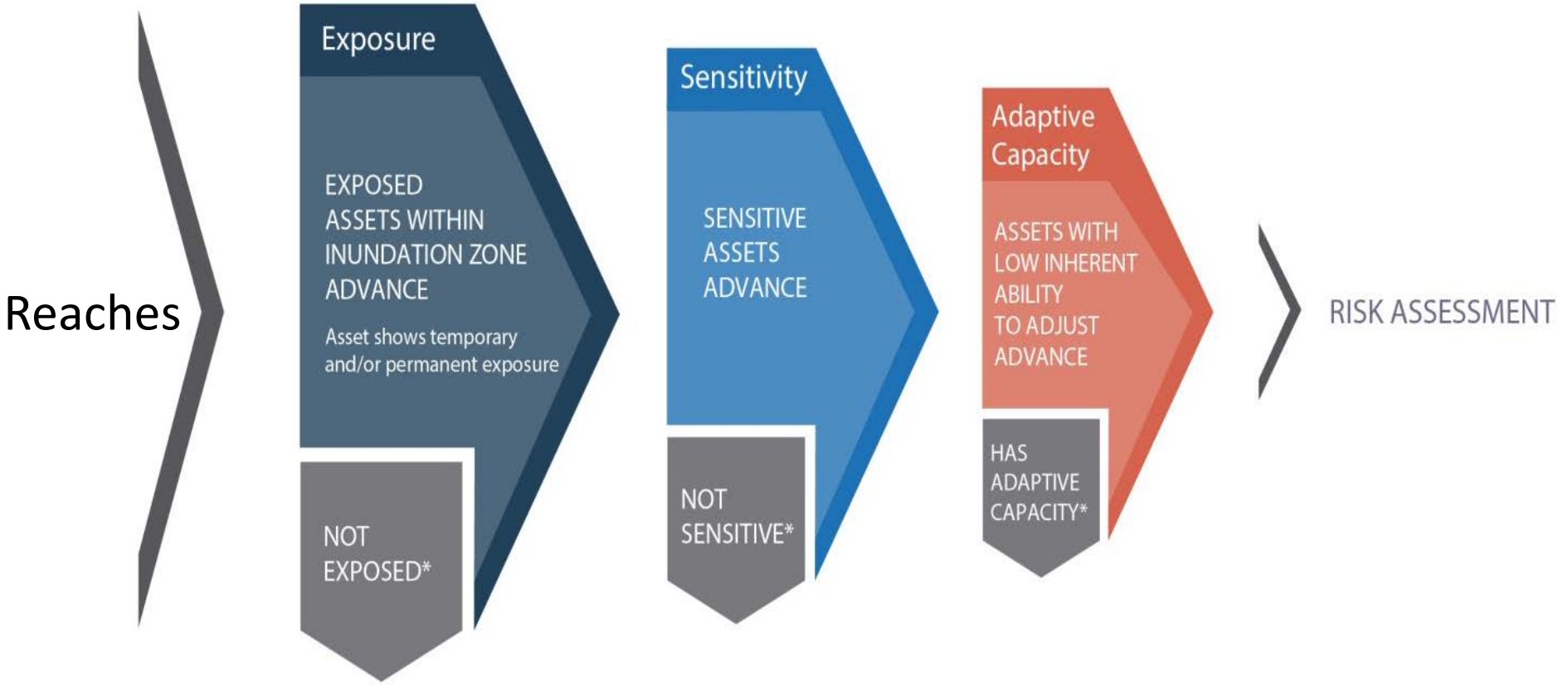
Preliminary Vulnerability Assessment: Timing of SLR Impacts



Vulnerability Assessment Framework
(adapted from FHWA framework)



Vulnerability Assessment considers exposure, sensitivity, and adaptive capacity

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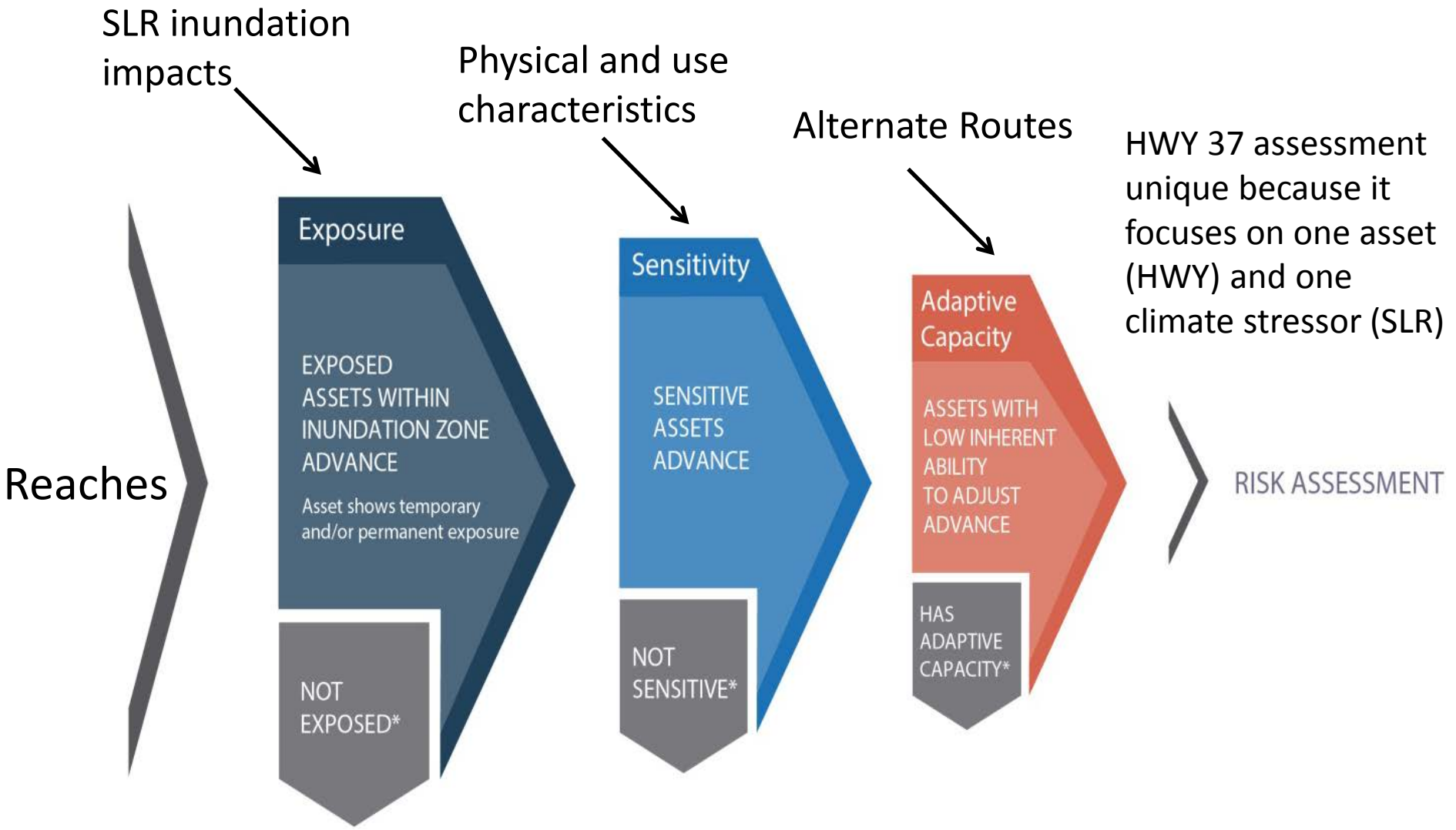
Vulnerability Assessment Framework



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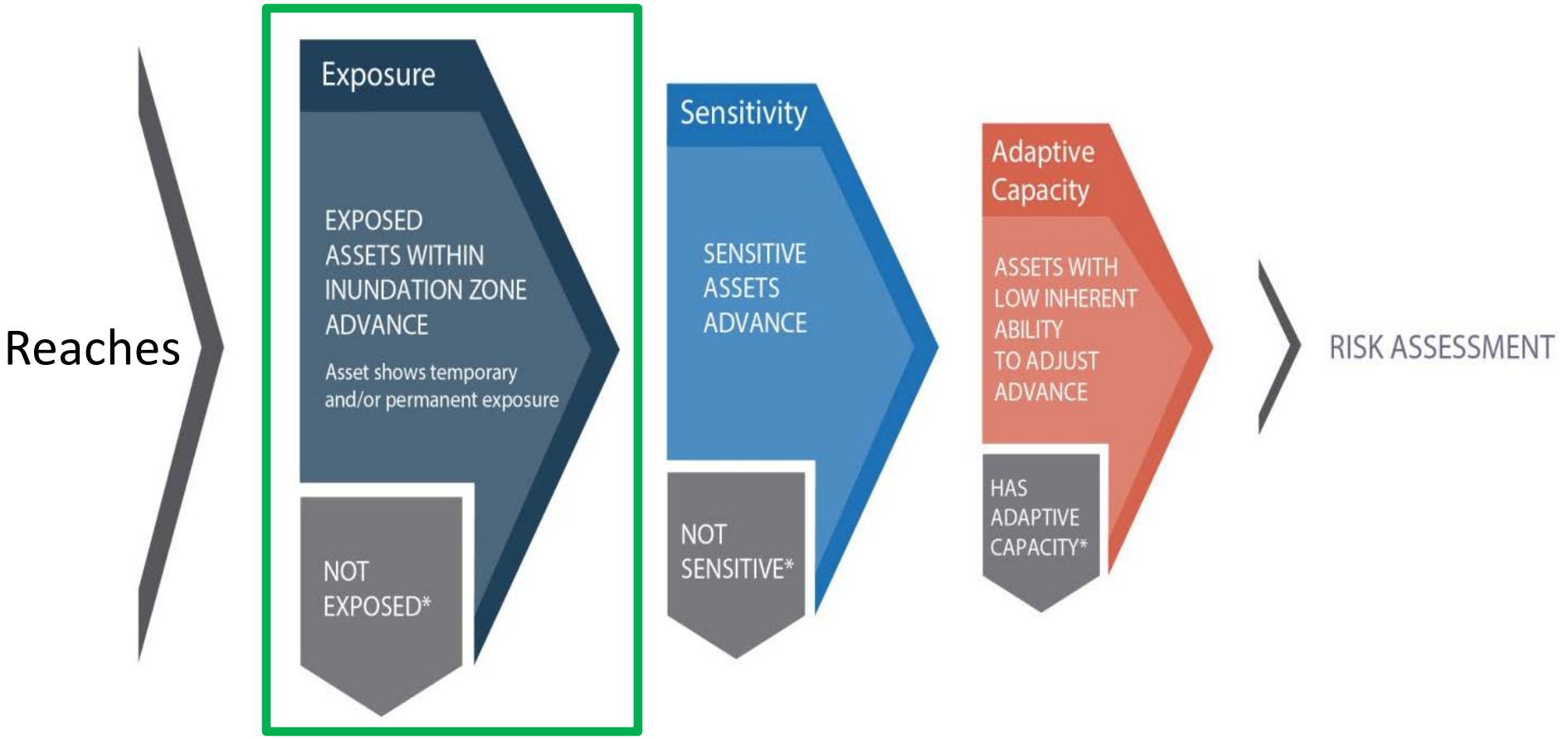
Vulnerability Assessment: **Exposure**



Exposure: Is the reach impacted by SLR? When and by how much? Does reach rely on levees for protection?

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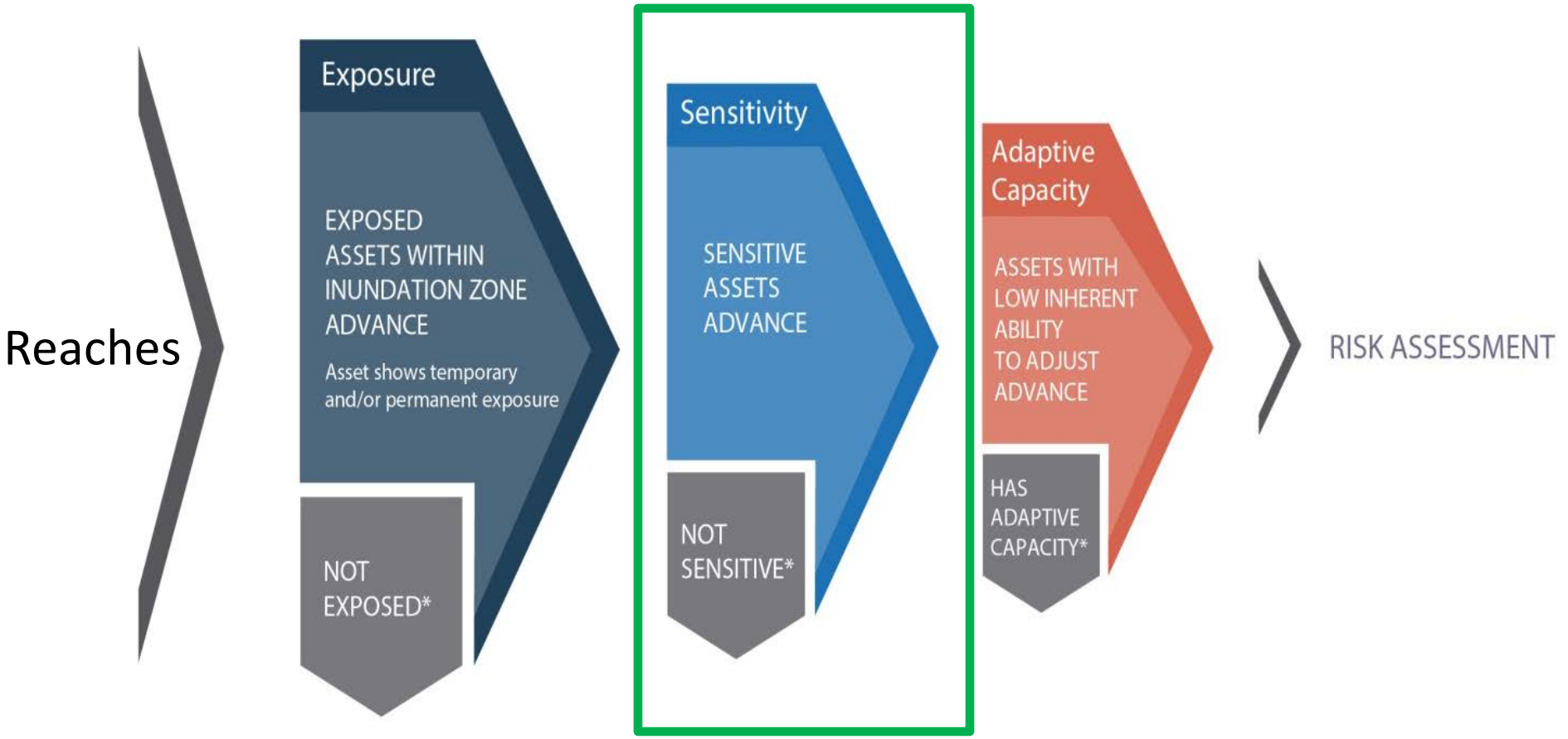
Vulnerability Assessment: **Sensitivity**



Sensitivity: Is the asset sensitive to SLR impacts? What physical and use attributes of the reach might make it more susceptible to impact?

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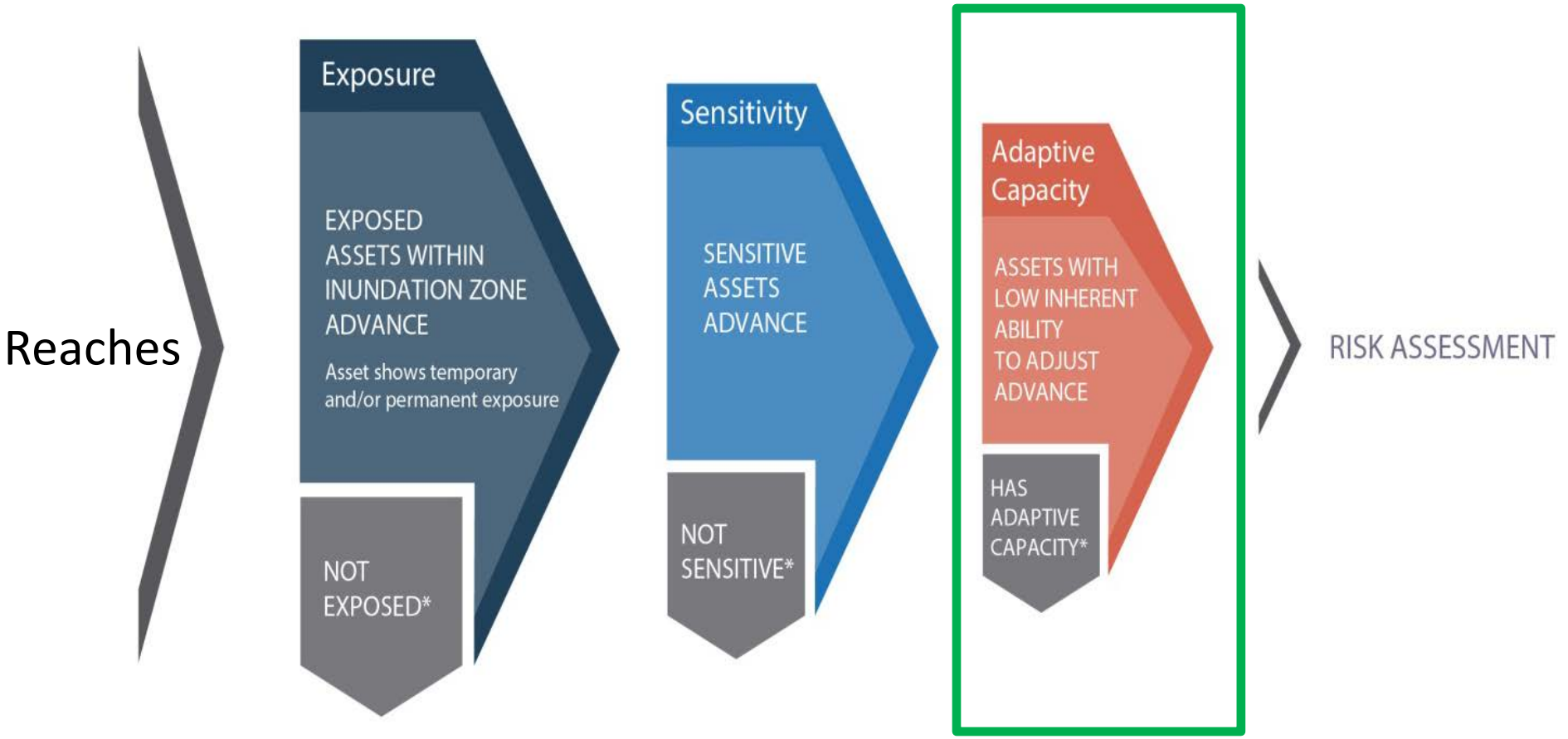
Vulnerability Assessment: **Adaptive Capacity**



Adaptive Capacity: How viable are alternate routes? Are they also vulnerable to SLR? Can they handle additional capacity?

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Vulnerability Indicators

Exposure

- Timing of SLR impact
- Overtopped length and depth
- Shoreline protection features

Sensitivity

- Age
- Level of vehicle use (AADT)
- Level of truck use (AADTT)
- Condition
- O&M Costs
- Seismic Sensitivity (bridges)
- Liquefaction Susceptibility

Adaptive Capacity

- Availability of alternate routes
- Capacity to upgrade*
- Vulnerability of alternate routes*
- Capacity of alternate routes*

*Not yet considered in present study

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SLR Exposure Ratings

Table 4. Summary of Composite Exposure Ratings and Values for HWY 37

Reach	A1	A2	B1	B2	C
Timing of SLR Impact	Moderate 2	High 3	Moderate 2	Moderate 2	Moderate 2
Overtopped Length and Depth	High 3	High 3	High 3	Moderate 2	Moderate 2
Shoreline Protection Features	High 3	High 3	High 3	Low 1	Low 1
Composite Exposure Value	**2.7**	**3.0**	**2.7**	**1.7**	**1.7**
Composite Exposure Rating	**High**	**High**	**High**	**Moderate**	**Moderate**

Note: Composite exposure ratings were assigned as follows: 1.0-1.4 (Low), 1.5-2.4 (Moderate), and 2.5-3.0 (High). Exposure values assigned as follows: high=3, moderate=2, low=1.

- Reach A2 Example: Impacted at MHHW+24”; low-lying elevation; extensive HWY overtopping length and depth; relies on levee shoreline protection

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SLR Sensitivity Ratings

Table 7. Sensitivity Indicators Evaluated for HWY 37 Vulnerability

Reach	A1	A2	B1	B2	C
Age			(Not available)	(in progress)	
Level of use (AADT) [1]	High	High	High	High	High
Level of use (AADTT) [1]	Low	Low	High	High	Low
Condition-based Sensitivity	High	High	High	High	Low
O&M Costs			(Not available)	(in progress)	
Seismic Sensitivity	Low	Low	Low	Low	Low
Liquefaction Susceptibility[2]	High	Moderate	Moderate	Moderate	Moderate

Sources: [1]Caltrans (2013), [2]U.S. Geological Survey (2006)

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SLR Sensitivity Ratings

Table 8. Summary of Composite Sensitivity Ratings for HWY 37

Reach	A1	A2	B1	B2	C
Age	(Not available)				(in progress)
Level of use (AADT)	3	3	3	3	3
Level of use (AADTT)	1	1	3	3	1
Condition-based Sensitivity	3	3	3	3	1
O&M Costs	(Not available)				(in progress)
Seismic Sensitivity	1	1	1	1	1
Liquefaction Susceptibility	3	2	2	2	2
Composite Sensitivity Value	**2.2**	**2.0**	**2.4**	**2.4**	**1.6**
Composite Sensitivity Rating	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Note: Composite sensitivity ratings were assigned as follows: 1.0-1.4 (Low), 1.5-2.4 (Moderate), and 2.5-3.0 (High).

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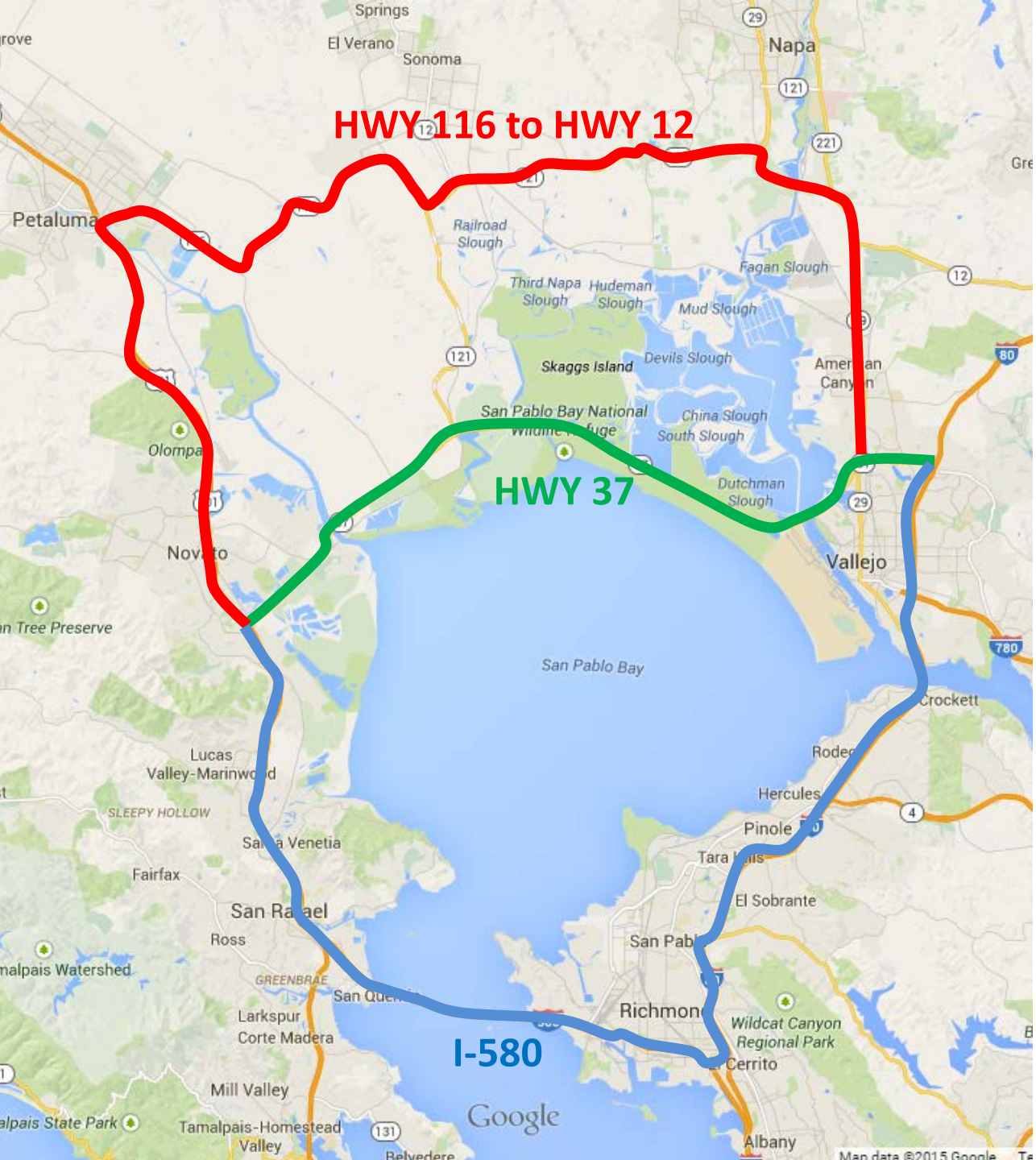

Adaptive Capacity: Alternate Routes

- HWY 37: 21 miles
- Northern Route: 44 miles
- Southern Route: 43 miles

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Adaptive Capacity (Alternate Routes)

- Other routes do exist, but not convenient:
  - Northern route: through Napa and Sonoma
  - Southern route: Richmond/San Rafael Bridge
  - Both routes approximately double mileage
- Intersections along HWY 37 alignment also vulnerable to SLR:
  - Lakeville Road (impacted at MHHW + 24”)
  - HWY 121 (impacted at 100-yr SWEL + 12”)
- Adaptive capacity rated low for all reaches

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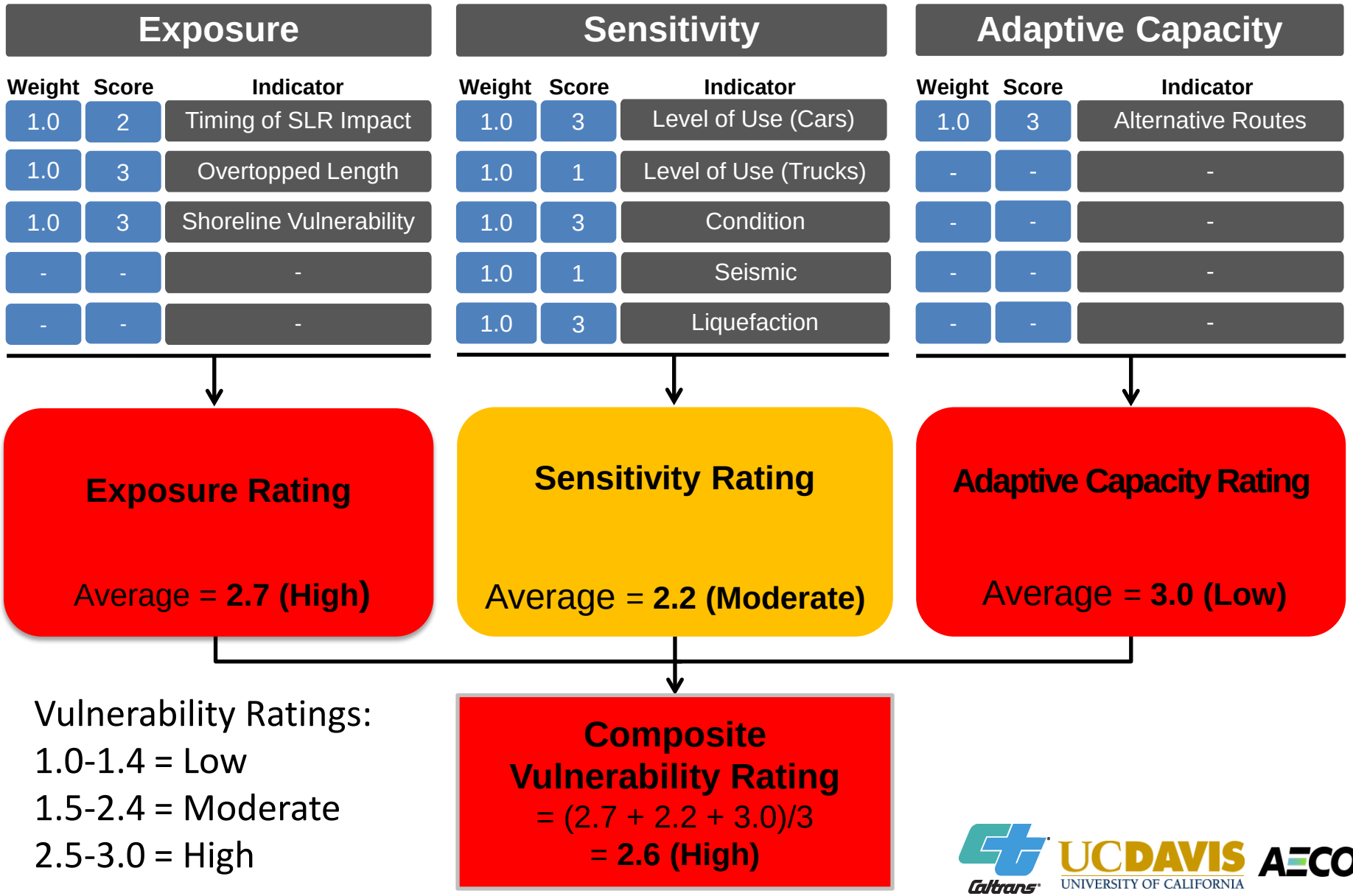
Example Vulnerability Rating – Reach A1



Vulnerability Ratings:
1.0-1.4 = Low
1.5-2.4 = Moderate
2.5-3.0 = High

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Composite Vulnerability Ratings

Table 9: Summary of Composite Vulnerability Ratings for HWY 37

Reach and Weighting	A1	A2	B1	B2	C
Exposure (50%)	2.7	3.0	2.7	1.7	1.7
Sensitivity (25%)	2.2	2.0	2.4	2.4	1.6
Adaptive Capacity (25%)	3.0	3.0	3.0	3.0	3.0
Composite Vulnerability Value	**2.6**	**2.8**	**2.7**	**2.2**	**2.0**
Composite Vulnerability Rating	**High**	**High**	**High**	**Moderate**	**Moderate**

Note: Composite vulnerability ratings were assigned as follows: 1.0-1.4 (Low), 1.5-2.4 (Moderate), and 2.5-3.0 (High).

- Apply weighting to exposure (50%), sensitivity (25%), and adaptive capacity (25%) to derive composite vulnerability rating
- Reaches A1, A2, and B1: **High**
- Reaches B2 and C: **Moderate**

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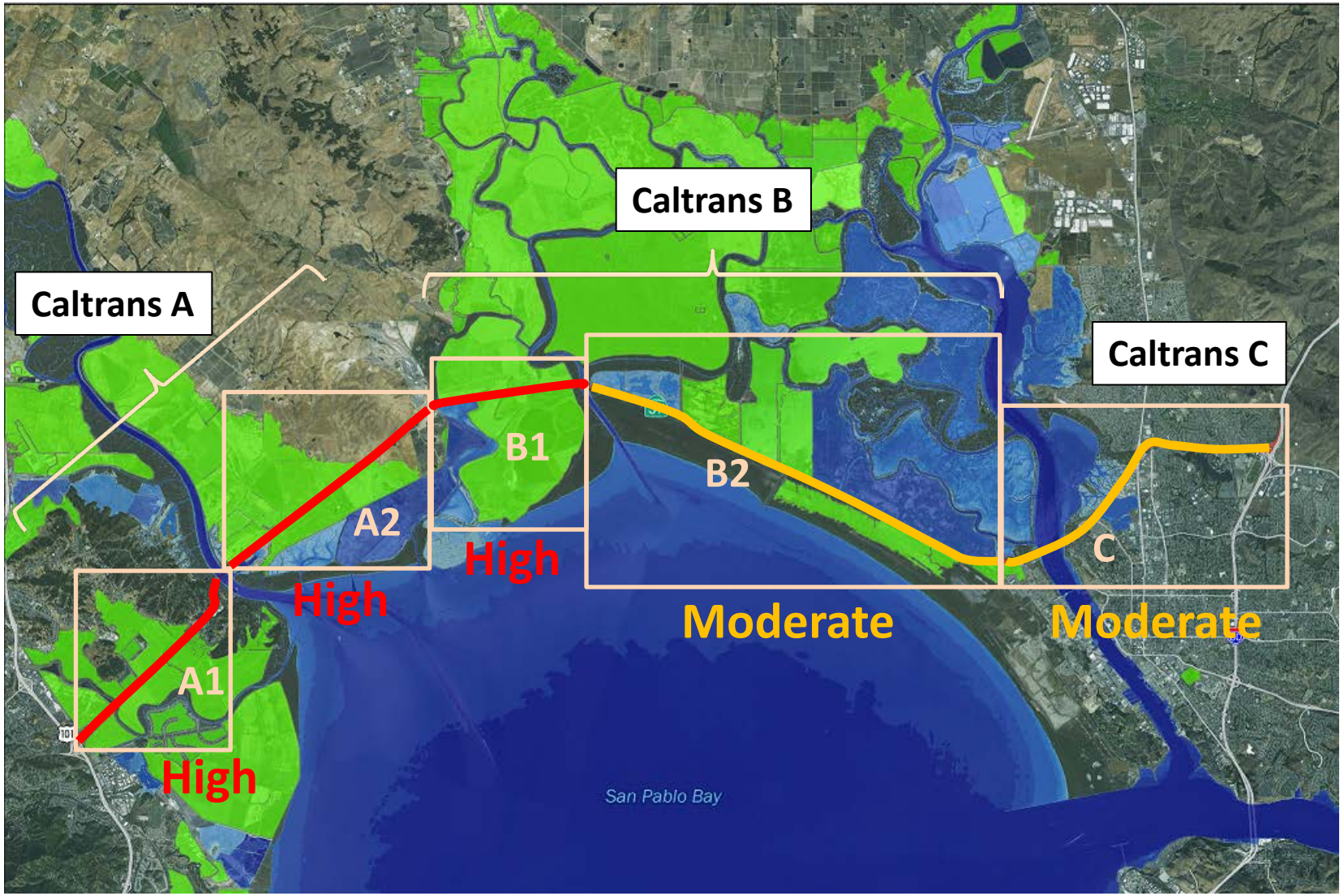
HWY 37 Preliminary Vulnerability Ratings



Preliminary Risk Assessment
(in progress)

- Likelihood of SLR impacts
- Consequences
  - Capital improvement costs
  - Recovery time
  - Public safety impacts
  - Economic impact on commuters
  - Economic impact on goods movement
  - Impacts on disadvantaged populations
  - Impacts to recreational activities (wine country, Sonoma Raceway, etc)
- Follows similar process to vulnerability assessment
- Compiling data, still in progress

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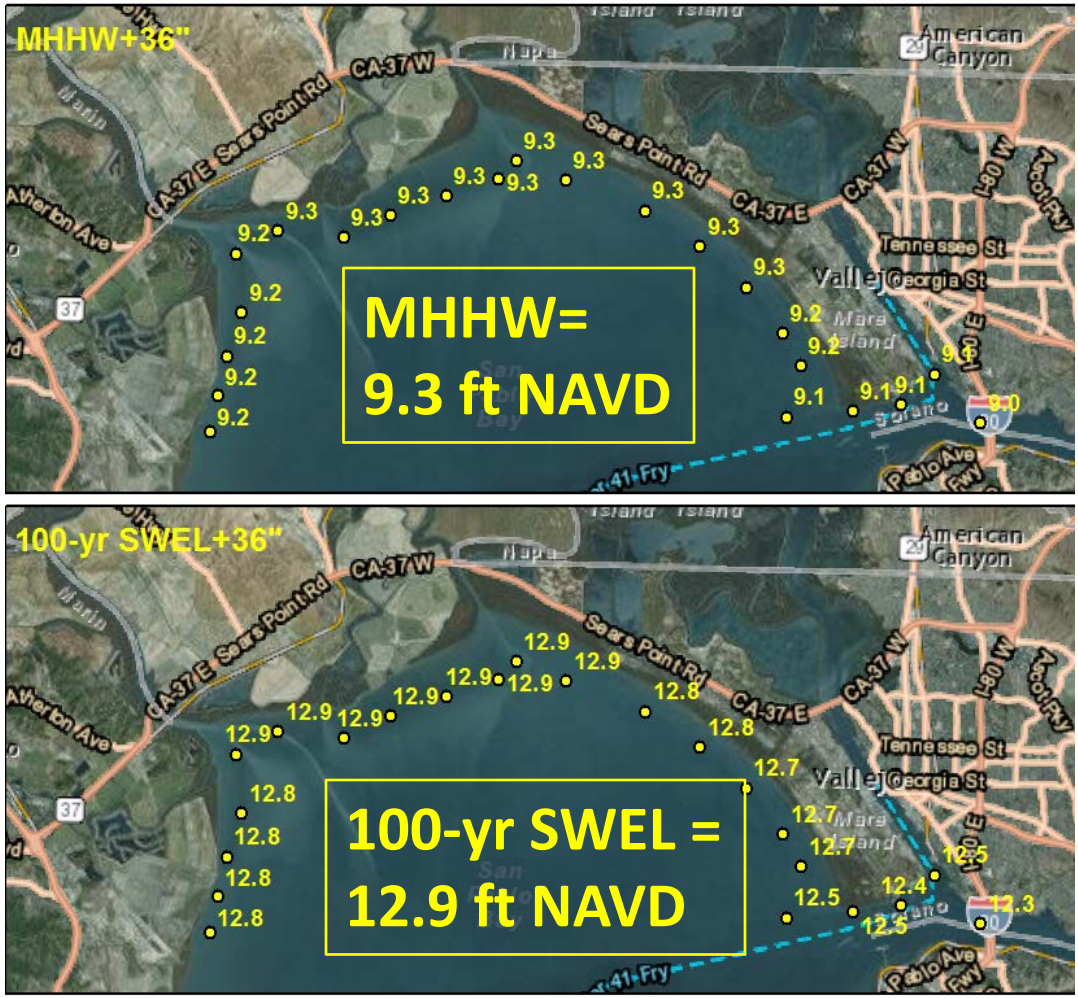
Next Steps

- Solicit stakeholder feedback
- Finalize vulnerability and risk assessment of HWY 37
- Conceptual engineering design and cost estimates (Joy to present next)

MHHW and 100-yr SWEL with 36” SLR



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HWY 37 SLR Engineering Concept Design and Cost Estimates

Joy Villafranca, PE
AECOM – Oakland, CA
Joy.Villafranca@aecom.com

Highway 37 Stewardship Study

Stakeholder Meeting – Vallejo, CA

April 21, 2015

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Presentation Outline

- Study Areas
- Study Scenarios
- Design Considerations and Issues
- Cost Estimates
- Next Steps and Stakeholder Feedback

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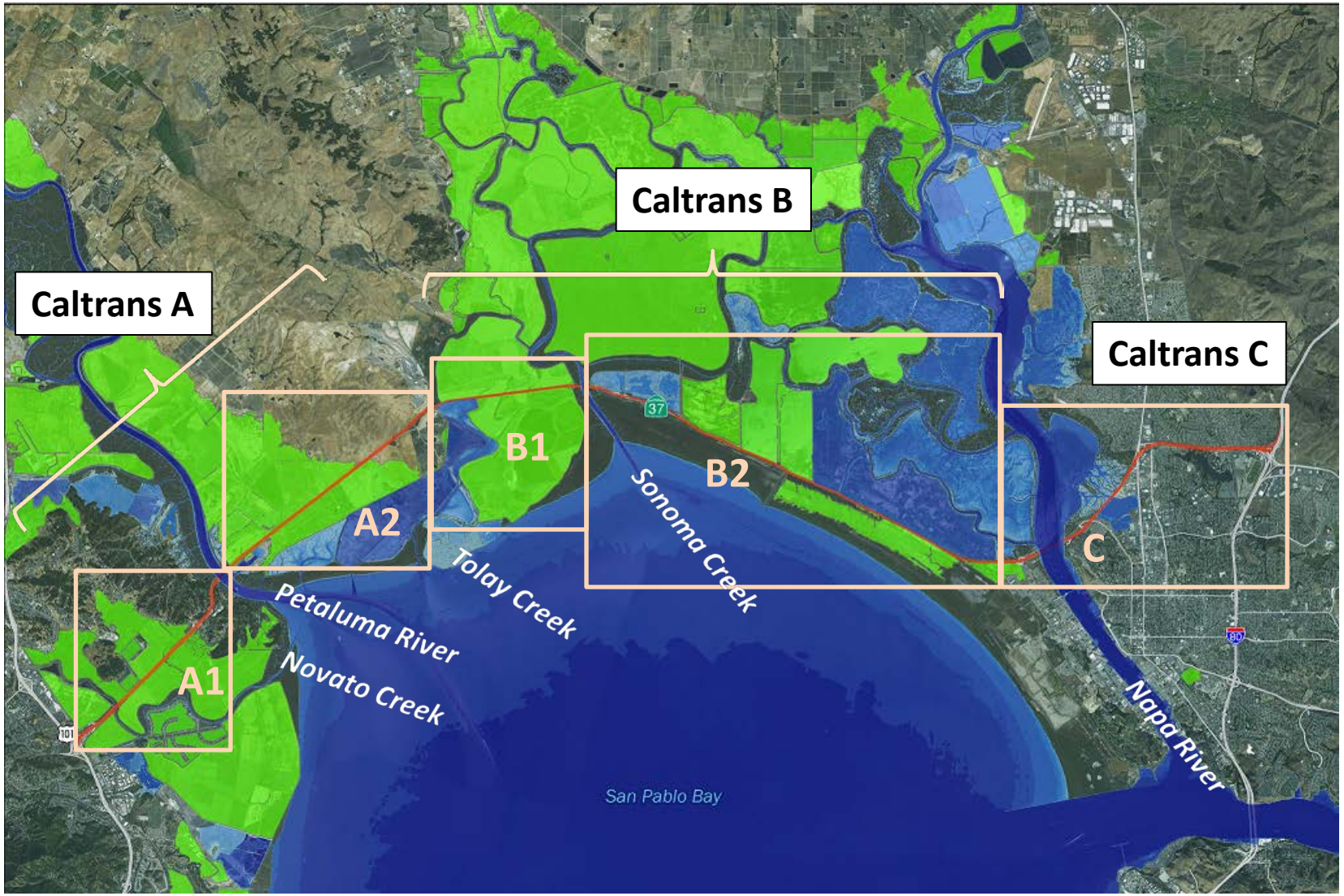
HWY 37 Reaches



Engineering Design Scenarios

1) Roadway elevated on levee
2) Roadway elevated on “monopod” concrete post causeway, and
3) Roadway elevated on wood or concrete “trellis”

Engineering Design Scenarios

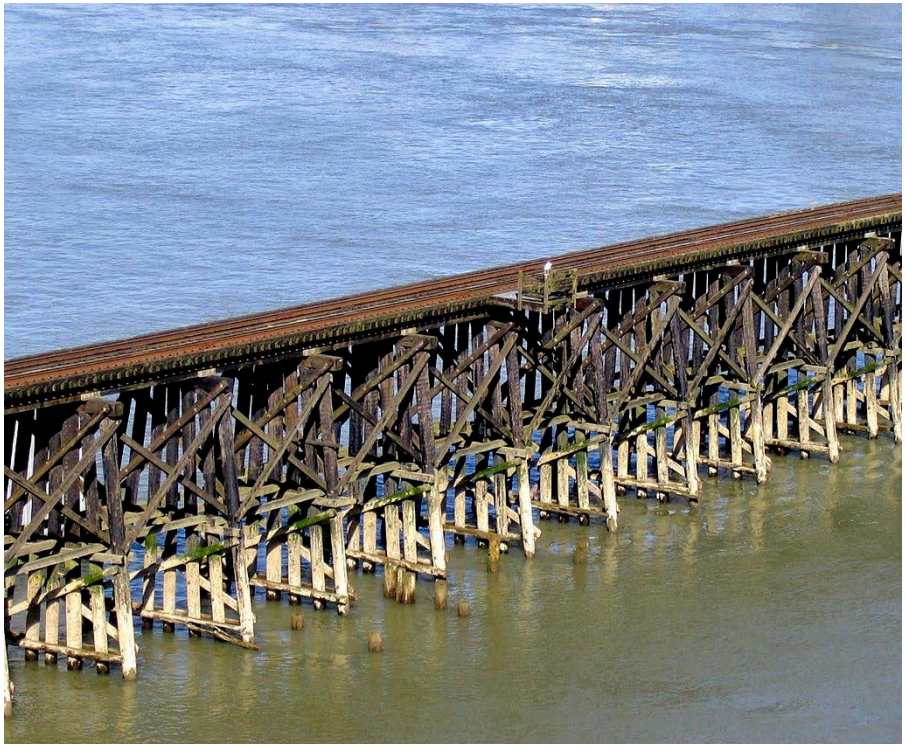
Roadway elevated on levee

Engineering Design Scenarios

Roadway elevated on “monopod” concrete post causeway

Engineering Design Scenarios

Roadway elevated on wood or concrete “trellis”



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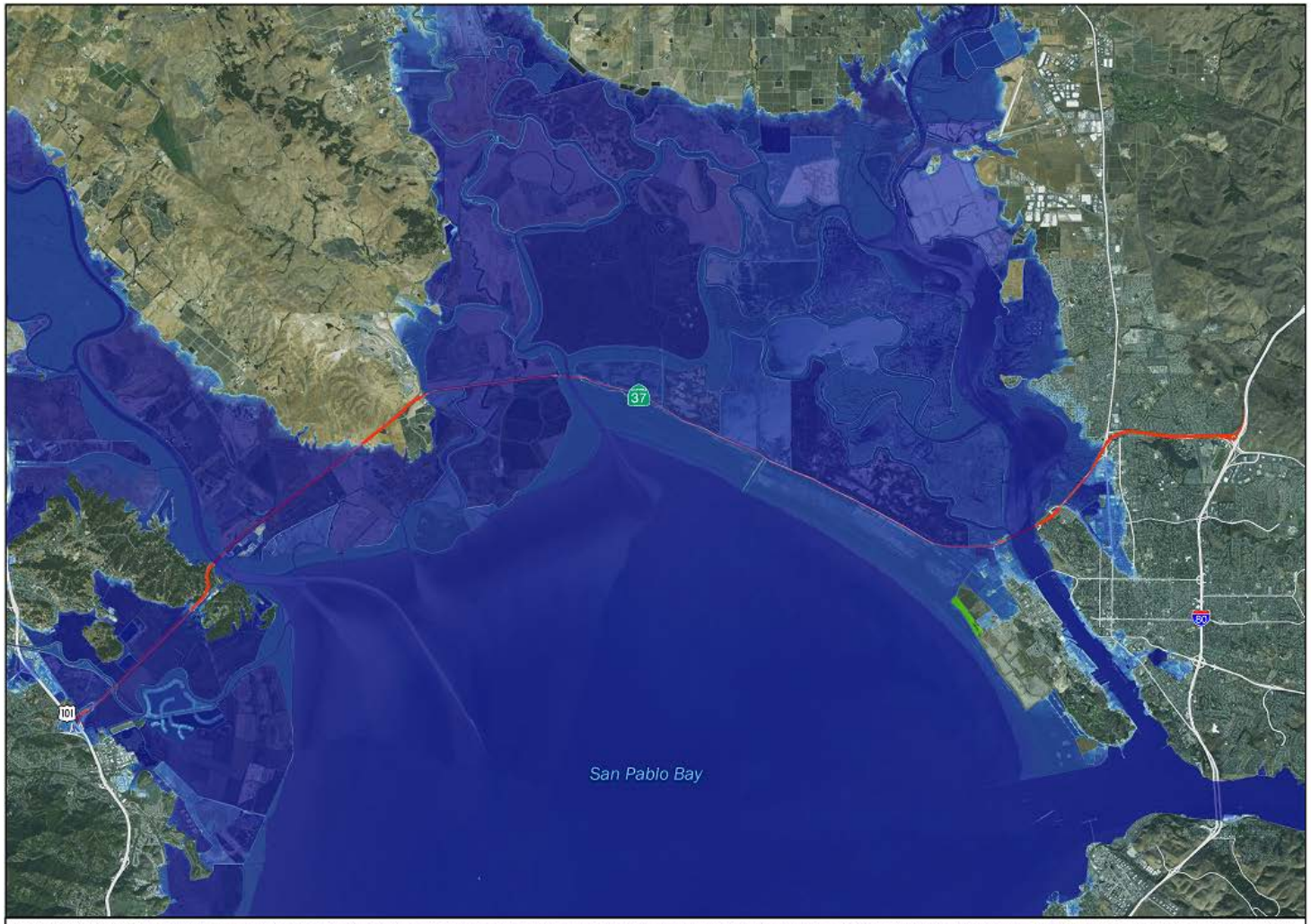
Design Considerations and Issues

- Raise highway above existing elevation to meet 2100 most-likely SLR (100-yr SWEL + 36”)
- Reach A: Raise highway about 9’ to 13’
- Reach B: Raise highway about 4’ to 7’
- Reach C: Maintain existing highway

100-yr SWEL + 36” (~13 ft NAVD)



HIGHWAY 37
Inundation Mapping

100-YR STORM SURGE + 36" SEA LEVEL RISE

60" SLR + 2-yr Storm Surge
54" SLR + 5-yr Storm Surge
48" SLR + 10-yr Storm Surge
48" SLR + 25-yr Storm Surge
42" SLR + 25-yr Storm Surge
42" SLR + 50-yr Storm Surge
36" SLR + 100-yr Storm Surge
24" SLR + 500-yr Storm Surge

Depth in Feet
0 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
2 - 2.5
2.5 - 3
3 - 5
5 - 7
7 - 10
10 +
Lowlying Areas > 1 Acre

N
0 1 2 Miles
0 5,000 10,000 Feet

AECOM

CALIFORNIA 37

Disclaimer: The inundation maps and the associated analyses are intended as planning level tools to illustrate the potential for inundation and coastal flooding under a variety of future sea level rise and storm surge scenarios. The maps depict possible future inundation that could occur if nothing is done to adapt or prepare for sea level rise over the next century. The maps do not represent the exact location or depth of flooding. The maps relied on a 5-ft digital elevation model created from LiDAR data collected in 2010. Although care was taken to capture all relevant topographic features and coastal structures that may impact coastal inundation, it is possible that structures narrower than the 5-ft horizontal map scale may not be fully represented. The maps are based on model outputs and do not account for all of the complex and dynamic San Francisco Bay processes or future conditions such as erosion, subsidence, future construction or shoreline protection upgrades, or other changes to San Francisco Bay or the region that may occur in response to sea level rise. For more context about the maps and analyses, including a description of the data and methods used, please see the Sea Level Rise Inundation Mapping for HWY 37 Region Memorandum. January 2015.

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Design Considerations and Issues

- Scenarios appropriate for each reach:
  - Reaches A & B: Elevate highway with levee, trellis and/or monopod
  - Reach C: Maintain existing highway
- Each scenario has different constructability and hydrodynamic and ecological impacts

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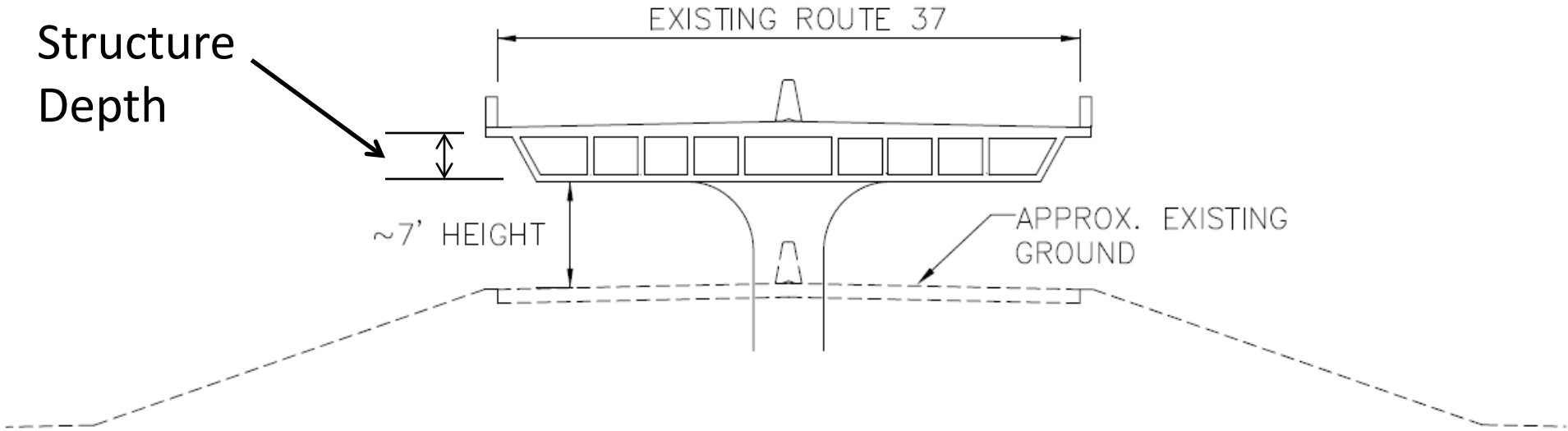
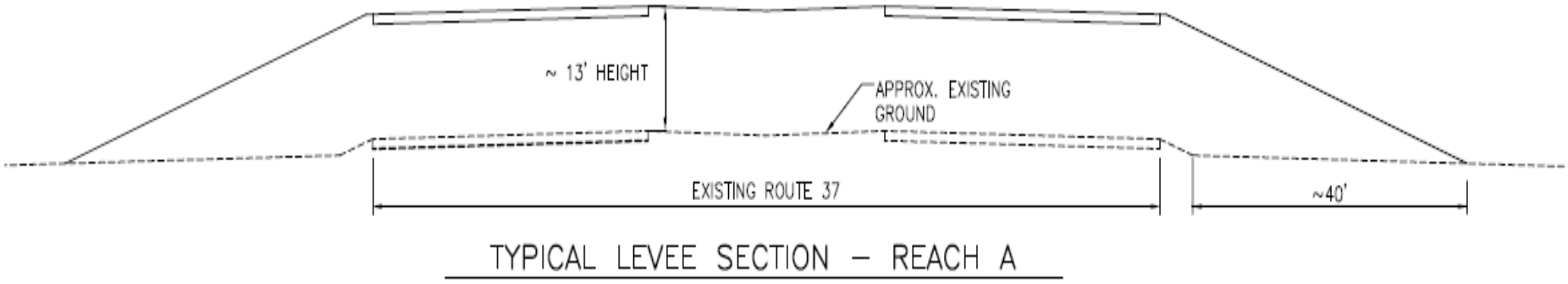
Design Considerations and Issues: Structure Depth

- For monopod structure, additional structural depth is required depending on span lengths. The longer the span, the deeper the structural depth.



Footprint of Scenario

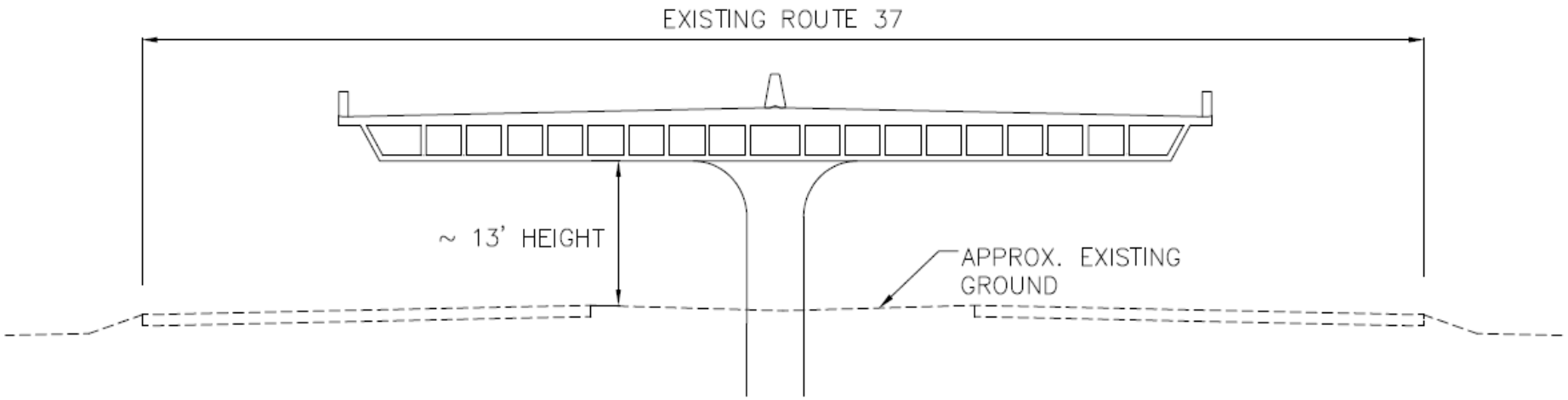
REACH A: Levee



TYPICAL LEVEE SECTION – REACH A

Footprint of Scenario

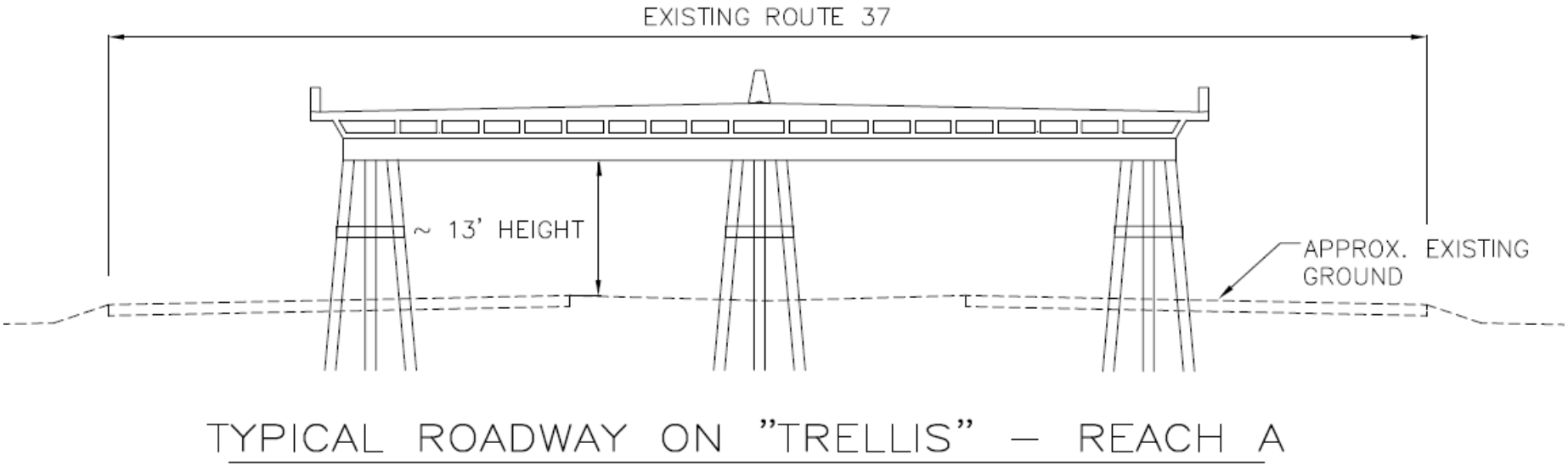
REACH A: Monopod



TYPICAL ELEVATED STRUCTURE – REACH A

Footprint of Scenario

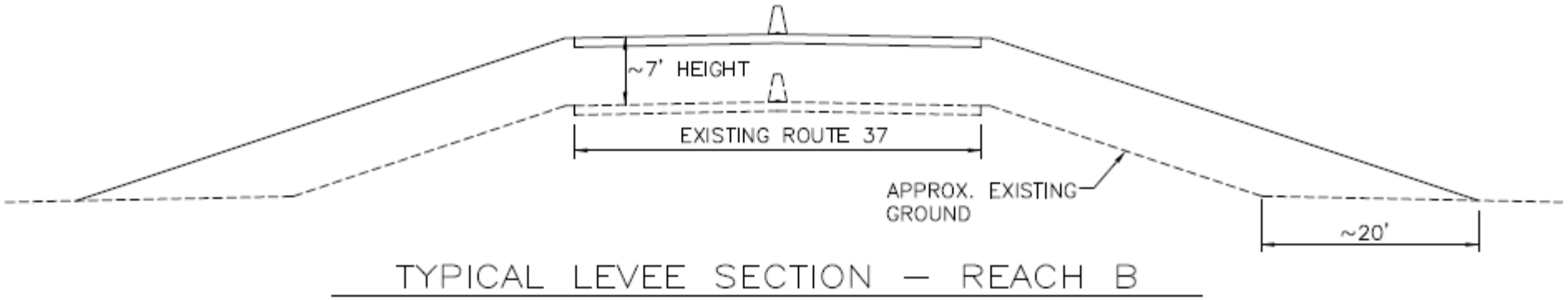
REACH A: “Trellis”



TYPICAL ROADWAY ON "TRELLIS" – REACH A

Footprint of Scenario

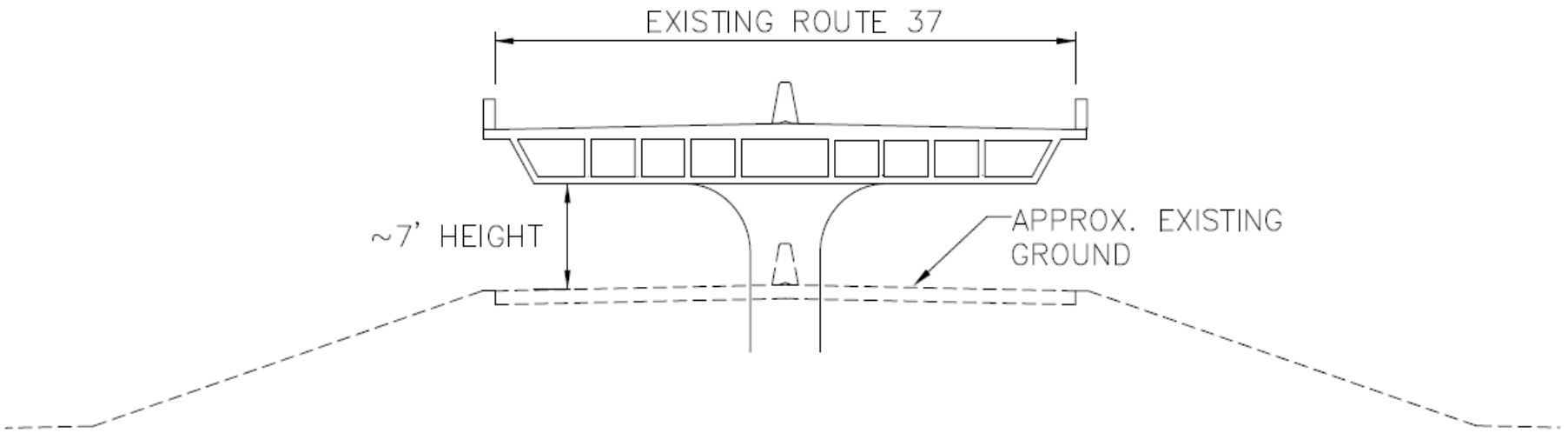
REACH B: Levee



TYPICAL LEVEE SECTION – REACH B

Footprint of Scenario

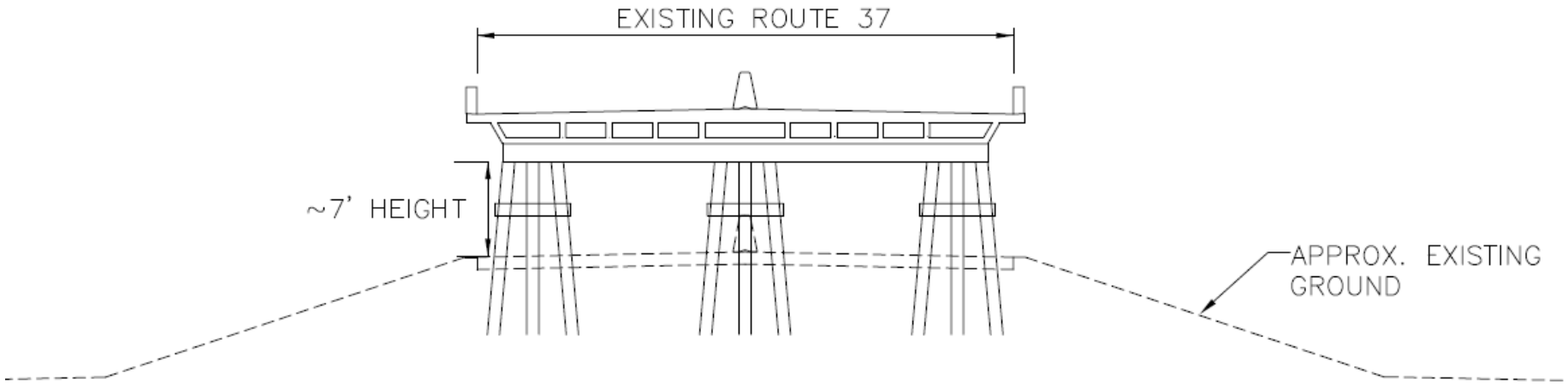
REACH B: Monopod



TYPICAL ELEVATED STRUCTURE – REACH B

Footprint of Scenario

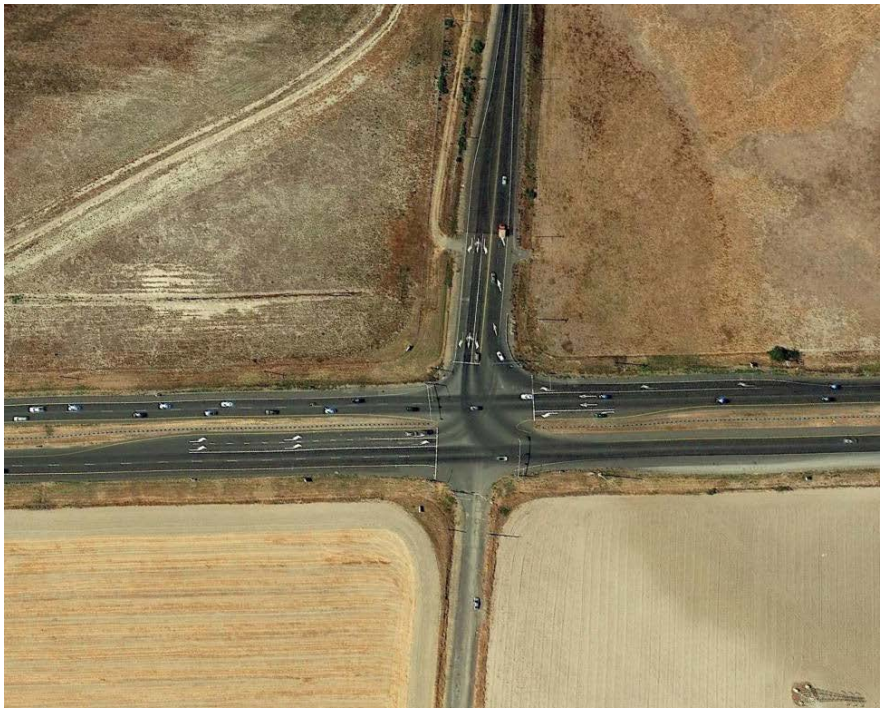
REACH B: “Trellis”



TYPICAL ROADWAY ON "TRELLIS" – REACH B

Design Considerations and Issues

- Constructability of scenarios
- How would intersections be handled in the conceptual design



Cost Estimates

- Order-of Magnitude Cost Estimates
  - Will be developed according to Caltrans project development cost estimating guidelines
  - Estimate may include:
    - Construction items (i.e. pavement, fill, drainage)
    - Structures as appropriate
    - Retaining walls as appropriate
    - Right of Way and Utilities
    - Support costs (planning, engineering, construction management)

Next Steps

- Prepare elevated highway concept design plans based on scenarios for each reach
- Prepare order of magnitude cost estimates for each reach based on scenario
- 3D visualizations of design scenarios

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ENVIRONMENTAL AND COMMUNITY BENEFITS FROM DIFFERENT SCENARIOS

Fraser Shilling
Road Ecology Center, UC Davis
Stakeholder Meeting #3
State Route 37 Integrated Traffic, Infrastructure and Sea Level Rise Analysis

Objective

"To identify benefits to the environment and nearby communities of taking different courses of action to improve transportation system resilience."

Possible Future Scenarios

Highway upon a levee in low-lying areas

Highway upon a causeway/bridge in low-lying areas

No action in near-term leading to highway failure/closure

What are Benefits and Dis-Benefits?

- The advantages and good things received by community/nature from an action
- The detriment received by community/nature from an action

How do Benefits and Dis-Benefits Relate to B/C?

B/C = (Benefits – Disbenefits)/Costs

B-C = Benefits – Disbenefits – Costs

Possible Benefits/Dis-Benefits

Environmental: 1) Gradual and stochastic change in hydraulic connection between Bay and inland marsh and current upland areas. 2) Change in vegetation and habitat value. 3) Gradual and stochastic geomorphic response to coastal structures and change. 4) Changes in population sizes of listed species due to habitat loss/degradation/improvement.

Possible Benefits/Dis-Benefits

Community: 1) Gradual and stochastic change in aesthetics of coastal marshes. 2) Changes in congestion along different portions of 37 and corresponding change in delay. 3) Addition of transit hubs/nodes within or between communities. 4) Change in public transit availability and vehicle travel.

Possible Benefits/Dis-Benefits

Transportation: 1) Temporarily reduced congestion. 2) Construction-related delays. 3) Reduced travel time and improved travel time reliability. 4) Changed emissions (AQ and GHG). 5) Changed highway-surface runoff. 6) Increased cross-Bay transit use.

How Do we Know What the (Dis-) Benefits are?

- What stretches of highway and regions of landscape are most vulnerable to change and what kind of change?
- What intended and unintended future scenarios can we imagine for the highway and landscape?
- Previous studies of valuation for marshes, congestion/delay, transit

Questions?

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http://hwy37.ucdavis.edu