

Sea Level Rise Vulnerability and Adaptation Workshop

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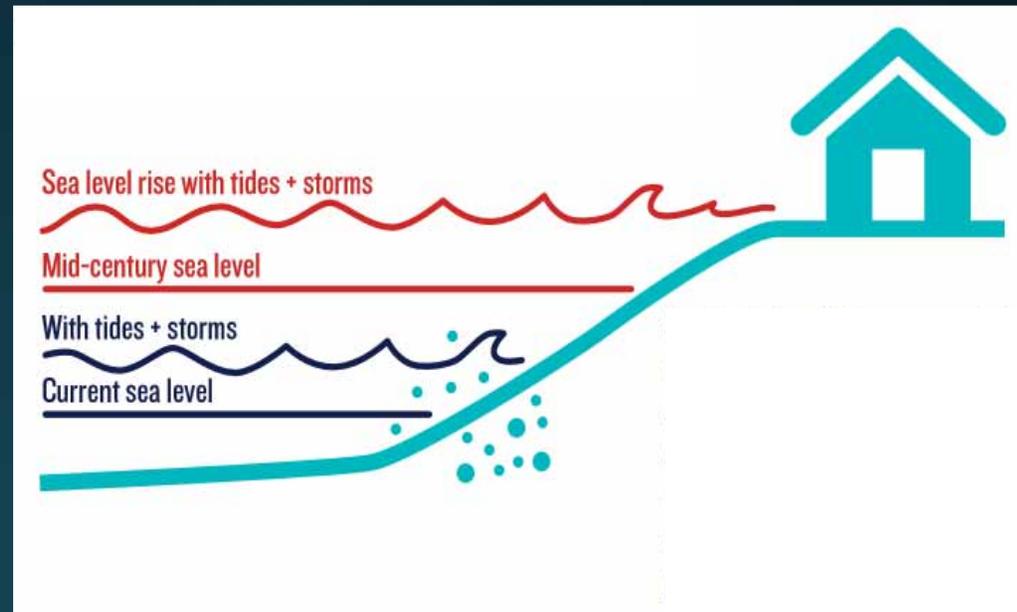
IMPERIAL BEACH
California

<http://dornsife.usc.edu/uscseagrant/ib-slr/>



Presentation Outline

- Report Purpose
- IB Sea Level Rise Study: Report overview
- Results Vulnerability Assessment
- Results Adaptation Strategies
- Future Work



Project Goals

- Identify Imperial Beach-specific coastal vulnerabilities from sea level rise and coastal hazards
- Identify range of adaptation strategies including tradeoffs and economics
- Recommend strategies that are politically digestible and economically feasible



Coastal Hazards Analyzed



Erosion



Flooding



Inundation

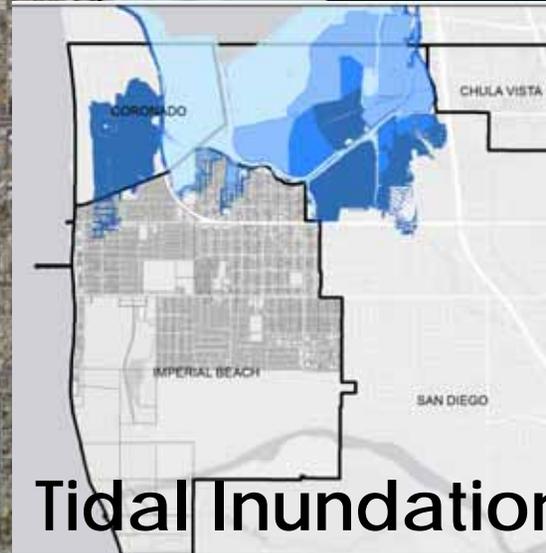
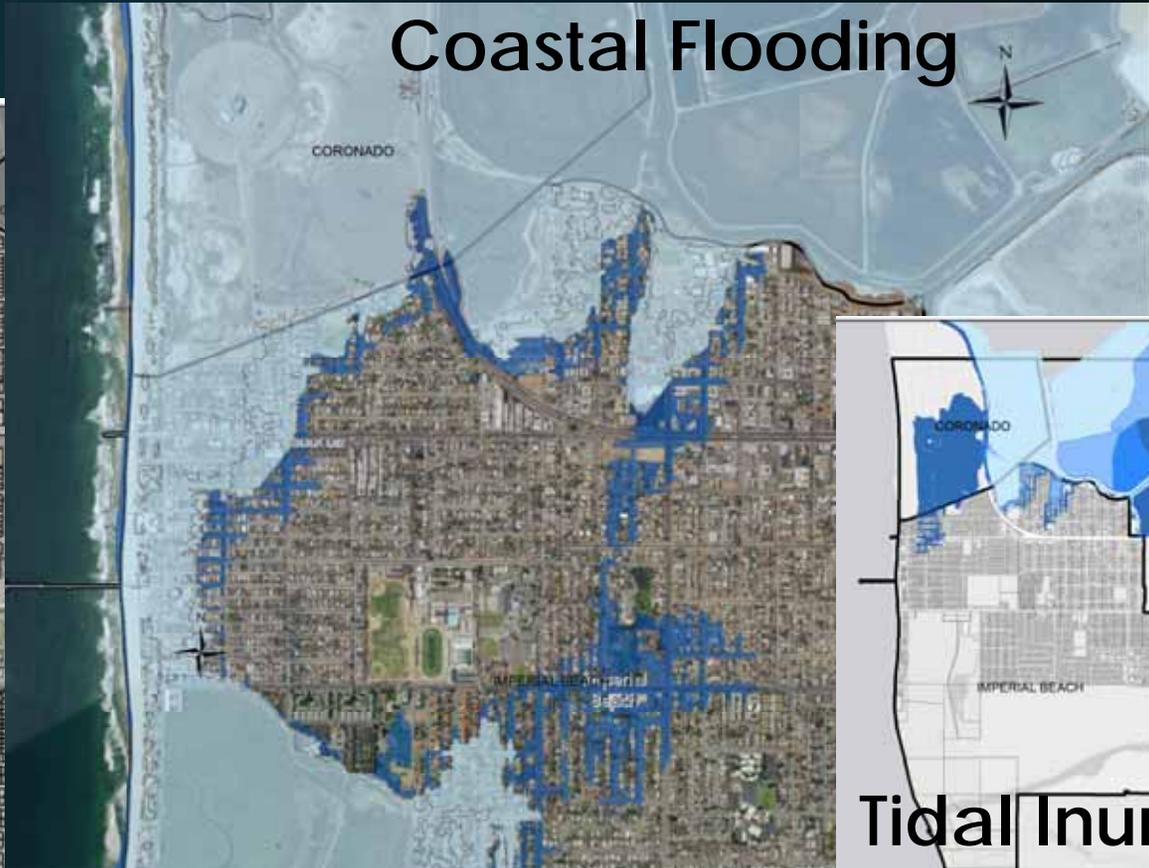


Nuisance Flooding

Coastal Erosion



Coastal Flooding

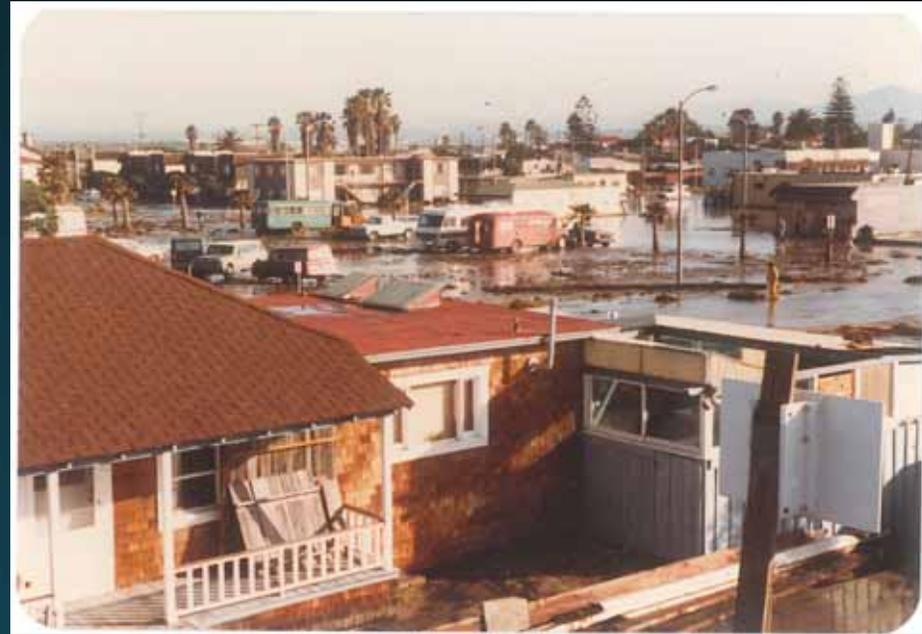


Tidal Inundation

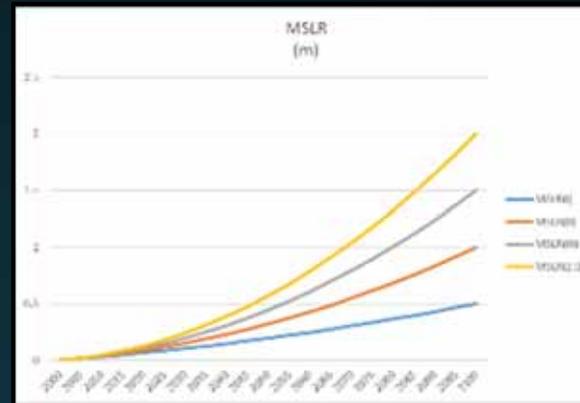
All Modeling assumes no adaptation

Modeling done separately by USGS and DoD - SPAWAR

January 1983 El Niño



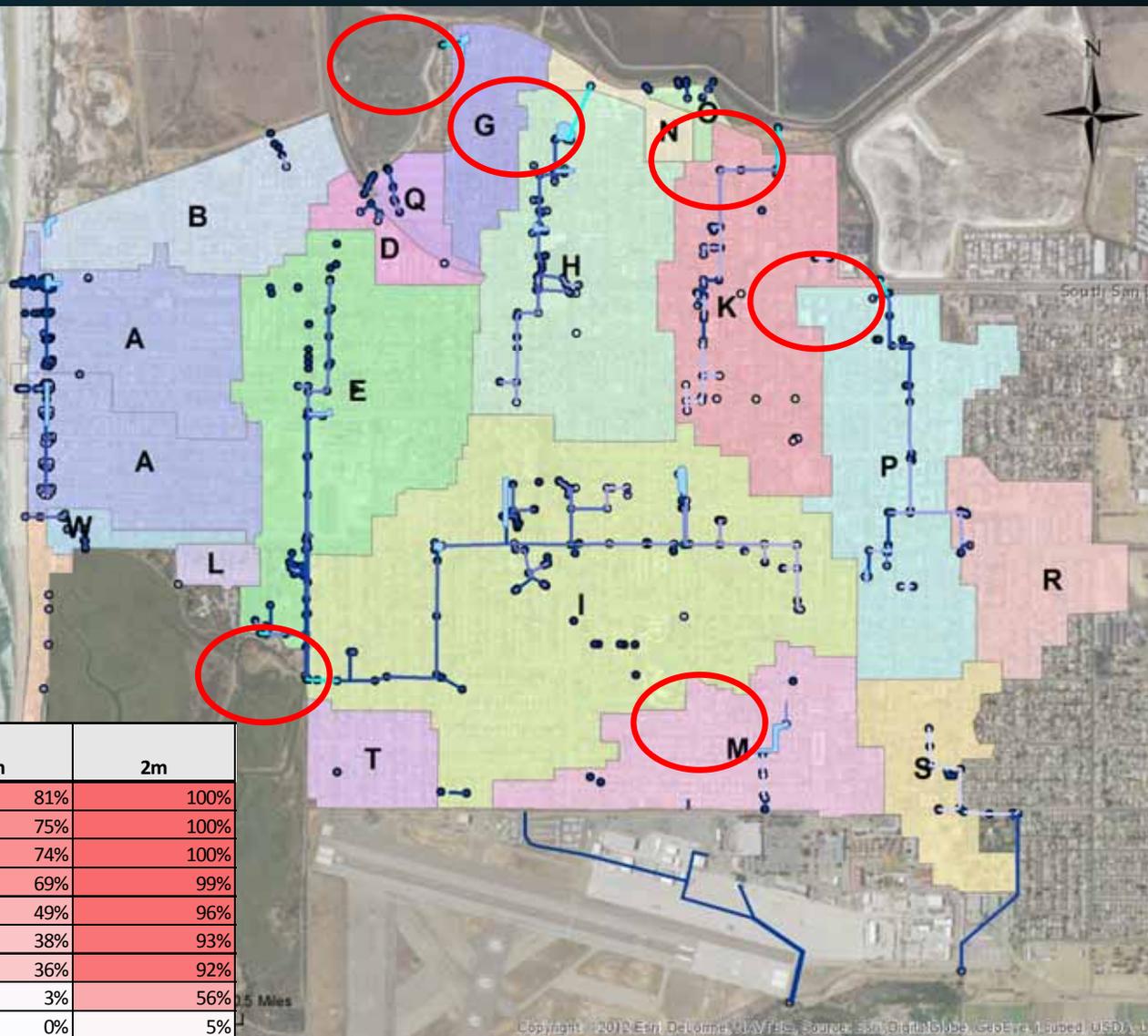
Sea level Rise and Erosion



- Sea Level Rise estimates vary widely
- Plan for the worst and hope for the best
- Study examines up to 6.5 feet by 2100
- Future erosion rates calculated based on existing erosion rates and escalated 6.5 foot SLR curve.
- **7.4 inches/year to 6.2 feet/ Year**
- Does not account for storm erosion events

Year	Erosion Rates (ft/yr) MSLR(2.0)
2000	0.62
2005	0.62
2010	0.92
2015	1.21
2020	1.50
2025	1.79
2030	2.09
2035	2.38
2040	2.67
2045	2.97
2050	3.26
2055	3.55
2060	3.84
2065	4.14
2070	4.43
2075	4.72
2080	5.02
2085	5.31
2090	5.60
2095	5.89
2100	6.19

Future Nuisance Flooding



Drainage Basin	Elevation top of Pipe - (ft NAVD)	Baseline	0.5m	1m	2m
I	4.3	18%	49%	81%	100%
G	4.7	12%	40%	75%	100%
I	4.8	11%	38%	74%	100%
I	5.1	8%	32%	69%	99%
H	6	2%	16%	49%	96%
I	6.5	1%	10%	38%	93%
K	6.6	0%	9%	36%	92%
K - P	9	0%	0%	3%	56%
E	12.1	0%	0%	0%	5%

Vulnerability Assessment Sectors

- Land Use
- Roads
- Public Transportation
- Wastewater
- Stormwater
- Schools and Parks
- Hazardous Materials



Photo C. Helmer

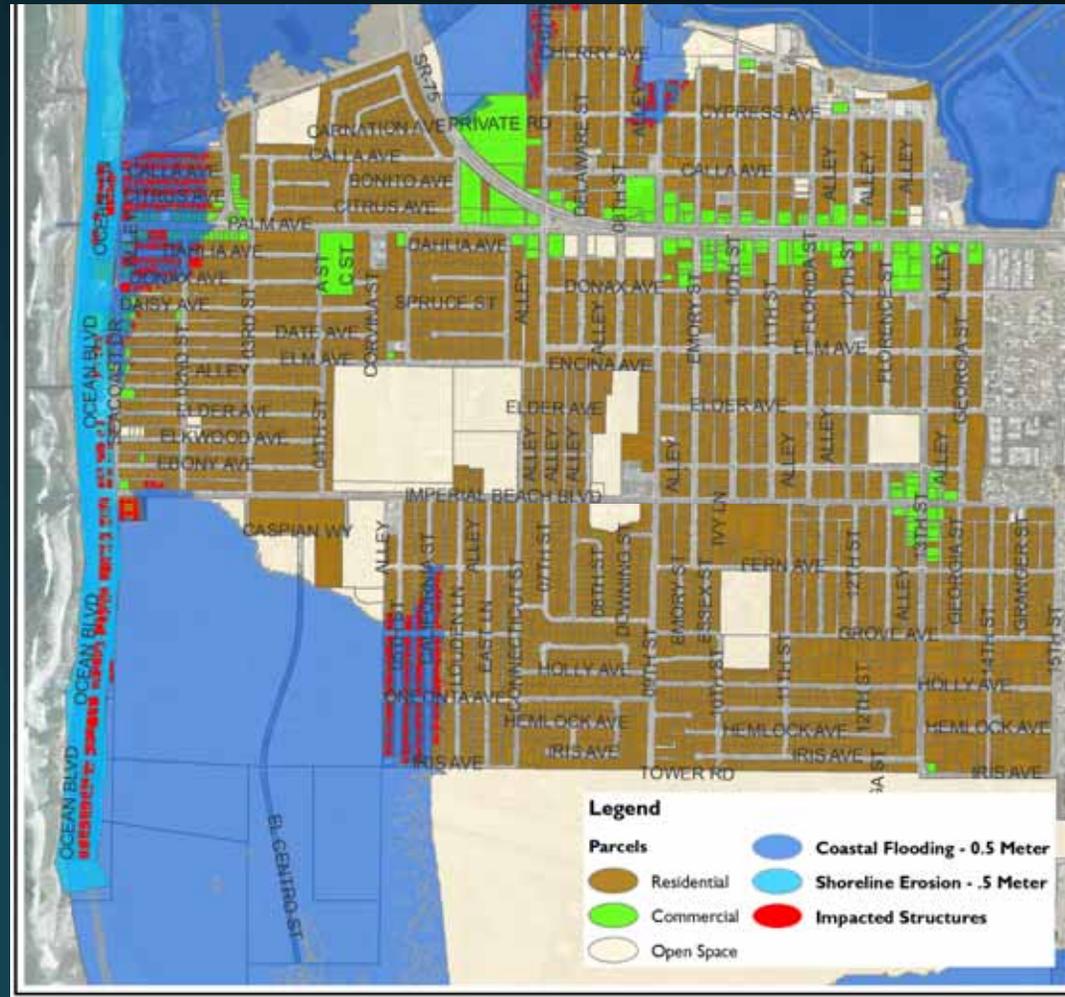
Land Use – Existing Conditions

- Number of parcels in existing Hazard Zones vs total
 - Total = 5955
 - Nuisance = 77 (74 residential, 3 public (school))
 - Coastal Flooding = 1082
 - 55 Open Space
 - 940 Residential
 - 87 Commercial
 - Coastal Erosion = 383
 - 9 Open Space
 - 351 Residential
 - 23 Commercial



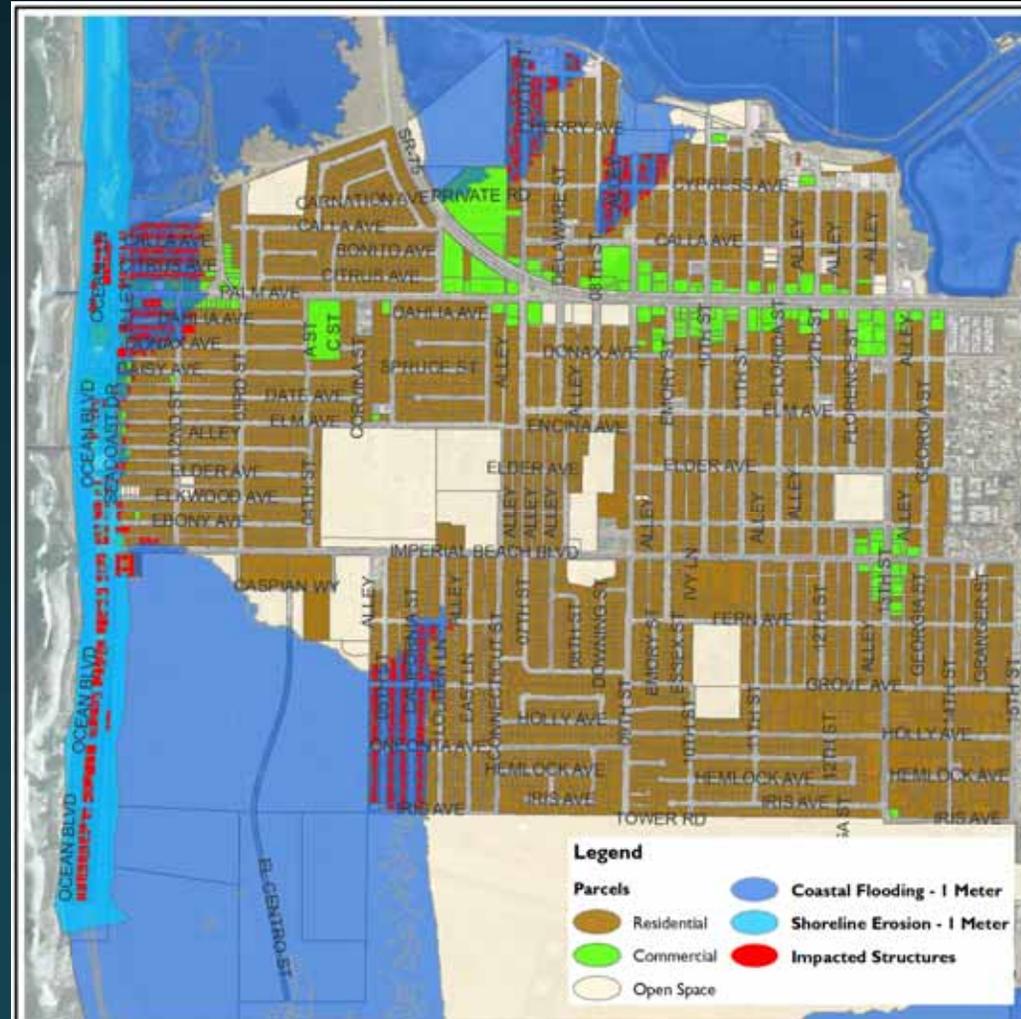
Commercial vs Residential 0.5 meters

- Number of parcels in existing Hazard Zones vs total
 - Total = 5955
 - Nuisance = 77 (74 residential, 3 public (school))
 - Coastal Flooding = 1352
 - 62 Open Space
 - 1195 Residential
 - 95 Commercial
 - Coastal Erosion = 430
 - 16 Open Space
 - 379 Residential
 - 35 Commercial



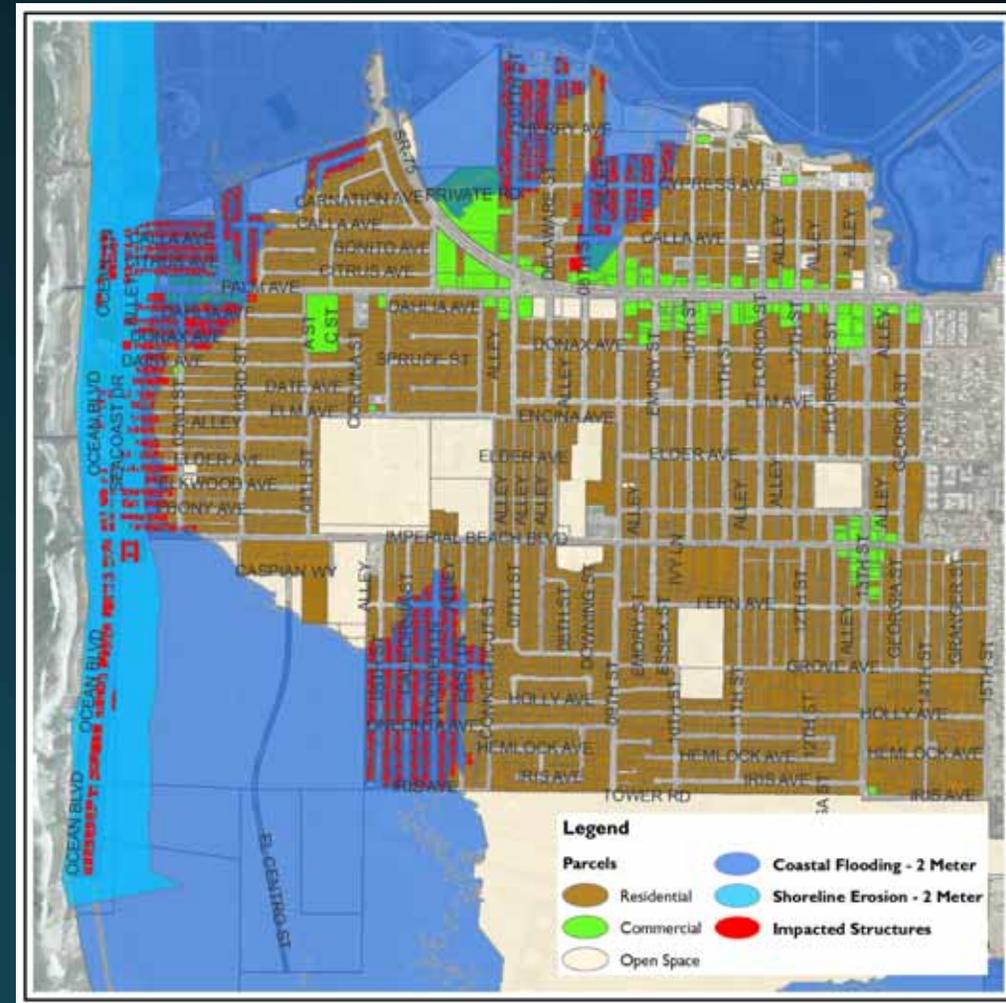
Commercial vs Residential 1.0 meters

- Number of parcels in existing Hazard Zones vs total
 - Total = 5955
 - Nuisance = 77 (74 residential, 3 public (school))
 - Coastal Flooding = 1573
 - 65 Open Space
 - 1409 Residential
 - 99 Commercial
 - Coastal Erosion = 544
 - 24 Open Space
 - 476 Residential
 - 44 Commercial



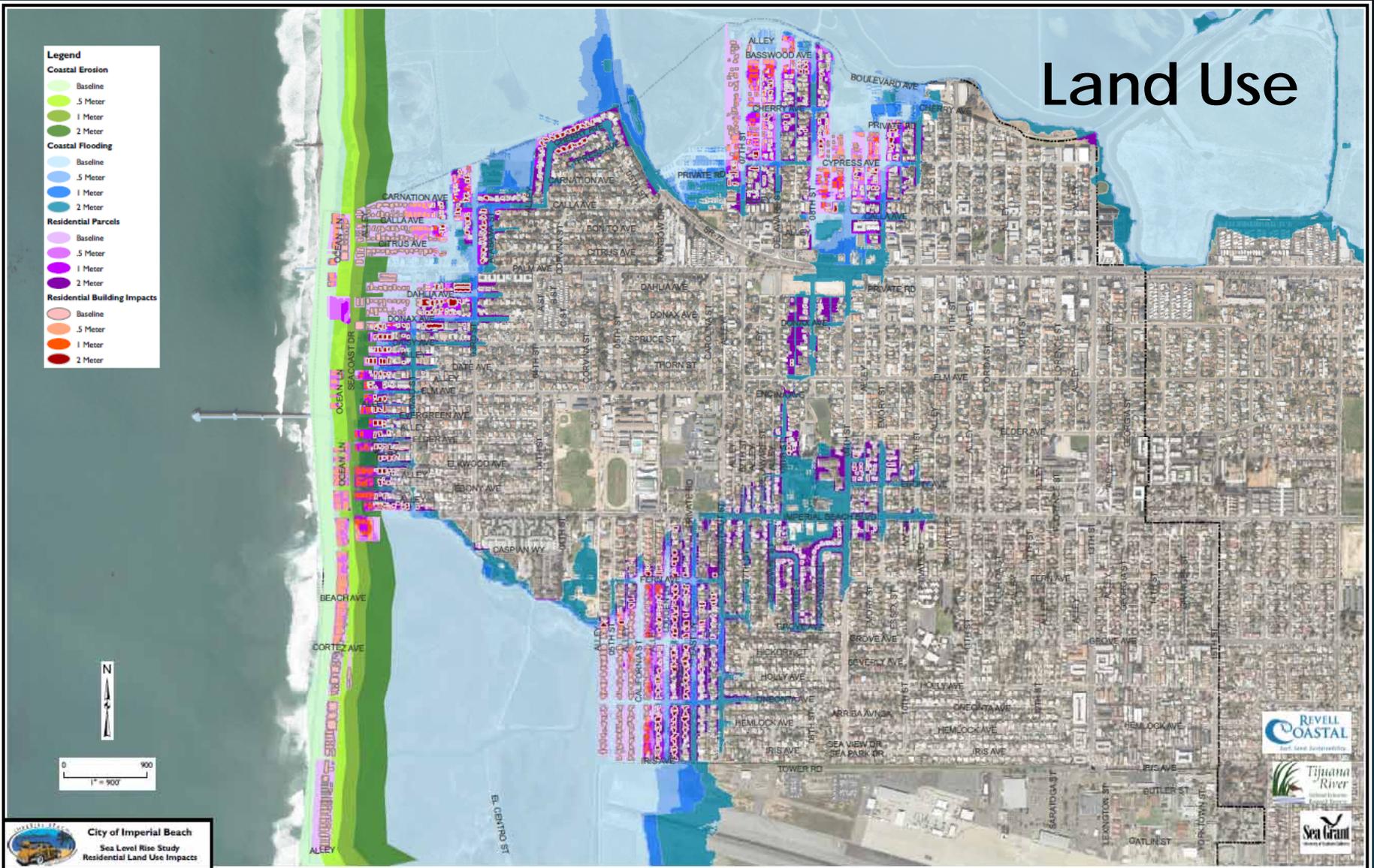
Commercial vs Residential 2100 – 2.0 meters

- Number of parcels in existing Hazard Zones vs total
 - Total = 5955
 - Nuisance = 77 (74 residential, 3 public (school))
 - Coastal Flooding = 2373
 - 73 Open Space
 - 2190 Residential
 - 110 Commercial
 - Coastal Erosion = 683
 - 27 Open Space
 - 594 Residential
 - 62 Commercial
 - **All Coastal Hazards = ~30% of all parcels**



Land Use

- Legend**
- Coastal Erosion**
 - Baseline
 - .5 Meter
 - 1 Meter
 - 2 Meter
 - Coastal Flooding**
 - Baseline
 - .5 Meter
 - 1 Meter
 - 2 Meter
 - Residential Parcels**
 - Baseline
 - .5 Meter
 - 1 Meter
 - 2 Meter
 - Residential Building Impacts**
 - Baseline
 - .5 Meter
 - 1 Meter
 - 2 Meter




City of Imperial Beach
 Sea Level Rise Study
 Residential Land Use Impacts


REVELL COASTAL
 East Coast Geotechnical


Tijuana River
 National Estuarine Research Reserve


Sea Grant
 University of California, San Diego

Losses and Damages to Private Property



Key Vulnerability Findings

- Storm water – substantial decrease in stormwater capacity
- Land Use – parcels and buildings 30%
- Roads – 40% of all roads impacted
- Most vulnerable neighborhoods –
 - South Sea Coast
 - North of Palm Ave/Carnation
 - Neighborhood around Bayside Elementary



Adaptation



- Project vs Policy Approaches
- Do Nothing
- Protect
- Accommodate
- Retreat

Opposing Viewpoints on Adaptation

What if...?



How much does it cost?

Beach front homeowners ask what will my house be worth in 30 years?

Beach communities ask what will my beach look like in 30 years?

Can't we make everyone happy?



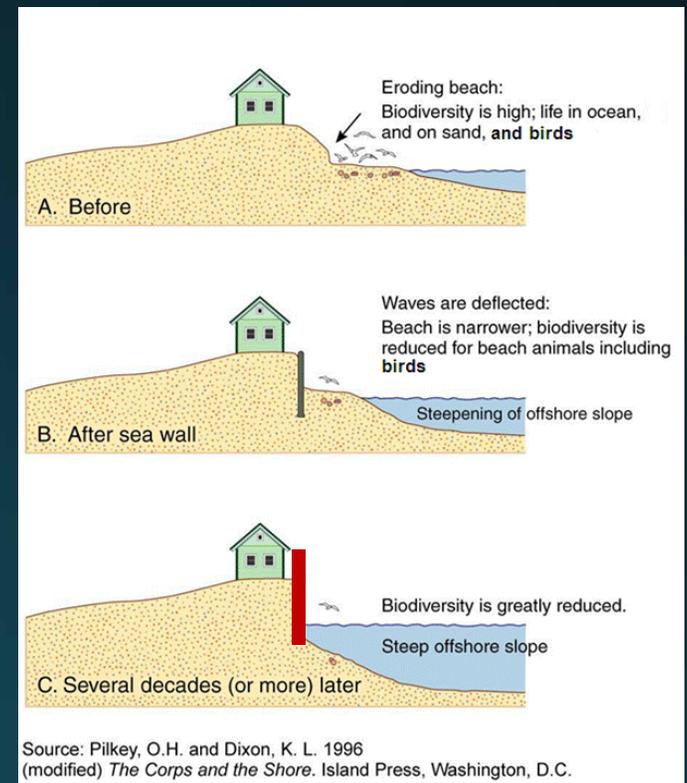
Adaptation Strategies - Projects

1. Fee Simple Acquisition:
2. Conservation Easements:
3. Transfer of Development
4. Rolling Easements
5. Managed Retreat
6. Structural or Habitat Adaption
7. Setback Development
8. Controlling Surface Run-off
9. Controlling Groundwater
10. Beach Nourishment
11. Harbor By-Passing
12. Back-Passing
13. Subaerial Placement
14. Artificial Seaweed
15. Geotextile Core
16. Nearshore Placement
17. Offshore Sand Deposits
18. Added Courser Sand than Native
19. Opportunistic Sand
20. Canyon Interception
21. Inter-littoral Cell Transfers
22. Berms/Beach Scraping
23. Perched Beaches
24. Groins
25. Breakwaters
26. Dune Nourishment
27. Delta Enhancement
28. Headland Enhancement
29. Geotextile Groins
30. Branch Box Breakwaters
31. Floating Breakwaters
32. Submerged Breakwaters
33. Dune Restoration
34. Beach Dewatering
35. Seawalls
36. Revetments
37. Gabions
38. Cobble Nourishment
39. Dynamic Revetments
40. Geotextile Revetment
41. Floating Reefs
42. Rubber Dams
43. Sand Fencing

Secondary Impacts

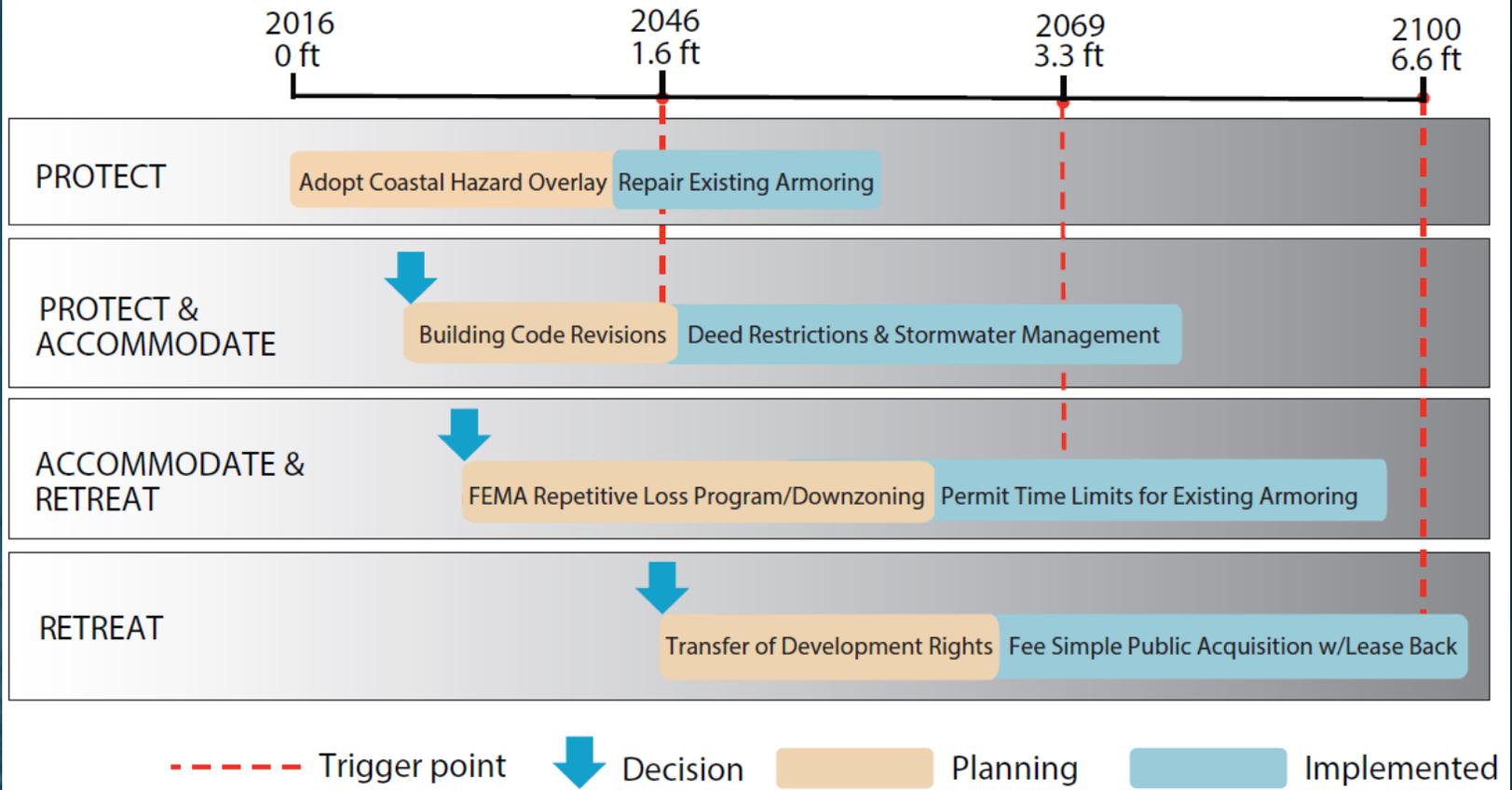
- Construction Costs
- Escalating Maintenance Costs
- Ecology
- Recreation
- Views
- Aesthetics

Seawalls destroy beaches and views



Policy - Implementation Times

Regulatory Timeline - Planning and Implementation Phases



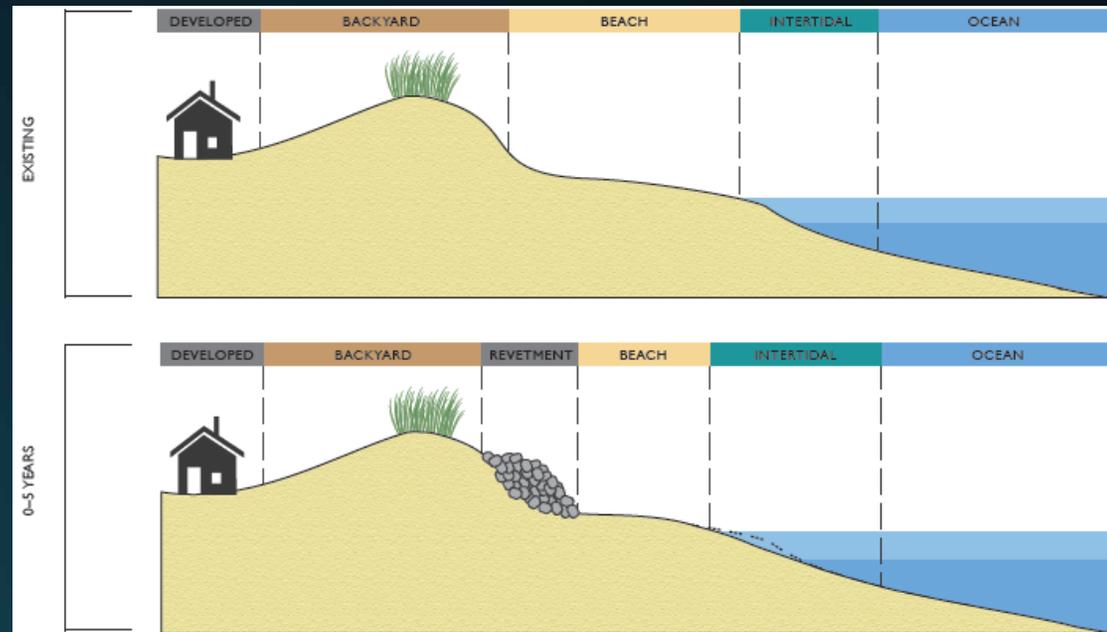


Adaptation Strategies chosen

- Represent a wide range of potentially feasible alternatives
 - Hardening and armoring of the entire IB coastline
 - Managed retreat or Phased relocation
 - “Business-as-usual” sand nourishment
 - Dynamic revetment and dune development
 - Extension of the north groin w/associated sand nourishment
- Assume strategy applied to urbanized portion of city down to South end of Seacoast Drive

Methods

For each
Adaptation
Strategy:



- Beach Width vs Upland – Physical modeling
(assumes erosion caused by accelerated erosion rates, not direct storm impacts)
- Physical and Economics over multiple horizons
- Recreation and habitat valuation
- Narrow versus wide beach

Net Benefits

1. The costs of adaptation implementation, maintenance and construction (e.g., seawalls, nourishment)
2. The losses and damages to public property and assets (e.g., beach erosion, ecological losses, recreation)
3. The losses and damages to private property and assets (e.g., flood losses, erosion losses)



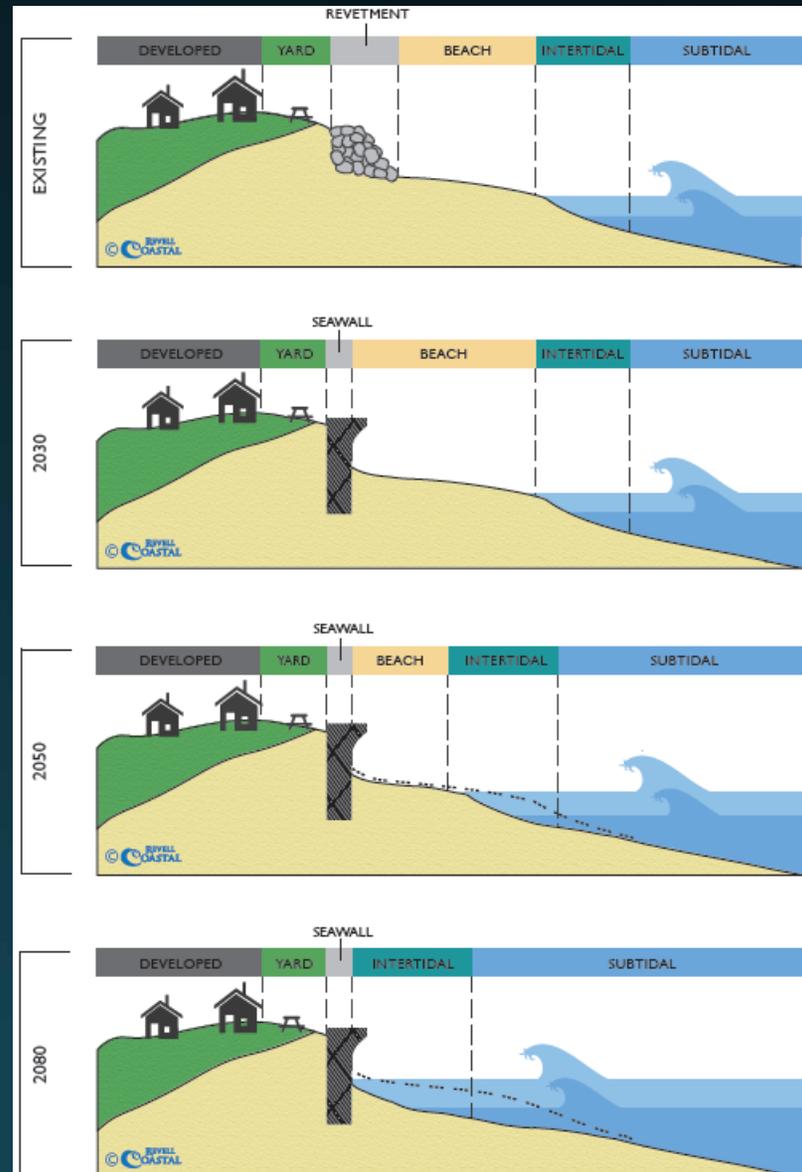
Initial Implementation Costs

Scenario	Component	Cost
Groins	2030 Seawall Removal	\$7,920,000
	New Groin (5 total assume 3 new and 2 halves)	\$14,880,000
	Beach Sand Nourishment	\$20,000,000
	Total:	\$42,800,000
Retreat	2030 Seawall Removal	\$7,920,000
	Building Removal	Unknown
	Infrastructure Removal	Unknown
	Beach/Dune Restoration	\$910,000
Total:	\$7,920,000	
Nourish	2030 Seawall Removal	\$7,920,000
	Beach Sand Nourishment	\$20,000,000
	Total:	\$27,920,000
Hybrid Dune	2030 Seawall Removal	\$7,920,000
	Cobble	\$23,760,000
	Dune Sand Nourishment	\$7,920,000
	Beach Sand Nourishment	\$20,000,000
	Dune Restoration	\$910,000
Total:	\$60,510,000	
Armor	2030 Seawall Removal	\$7,920,000
	New Seawall Construction	\$35,640,000
	Total:	\$43,560,000

Coastal Armoring

- Key findings:
- Dry sand beaches disappear between 2050 - 2075
- Only damp sand beaches by 2035 - 2065

***Not directly including storm impacts which could speed up impacts



Beach Changes

- Loss of sand from the beach
- Exposure of revetments and seawalls
- Difficult and unsafe beach access

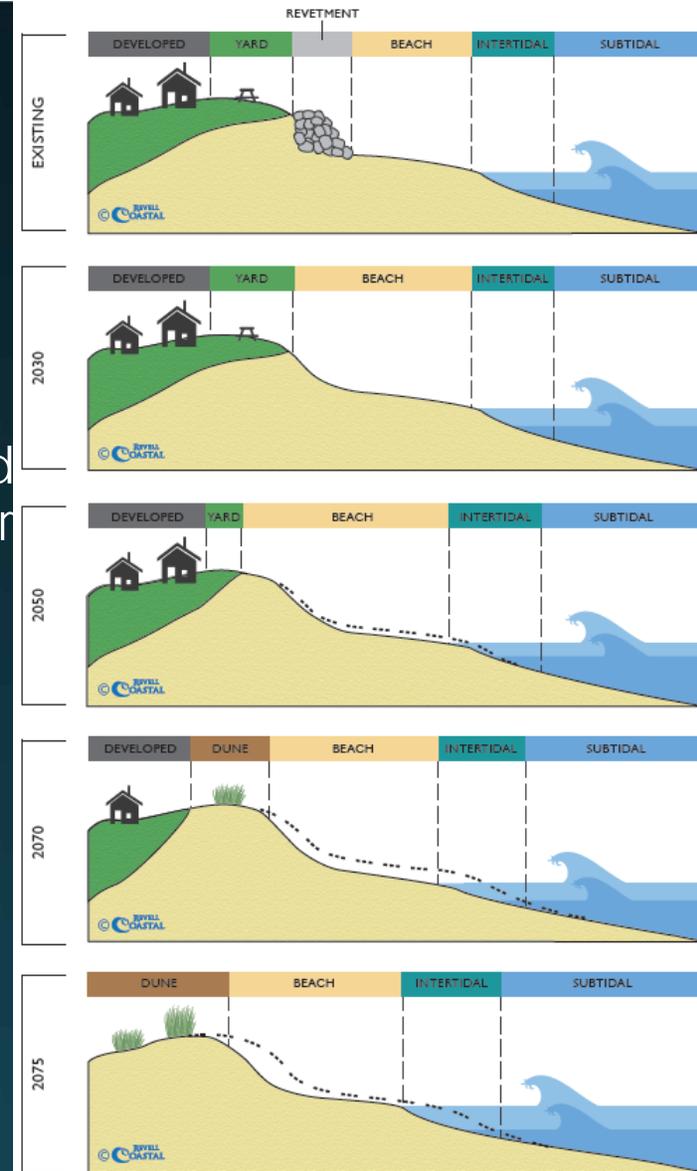


Managed Retreat

- Allow Erosion
- Variety of implementation options
- Structure, armoring removed when damaged
Infrastructure removed when damages occur
restoration of dune

Key findings:

- Beach is maintained
- Development eroded up to 3 parcels inland

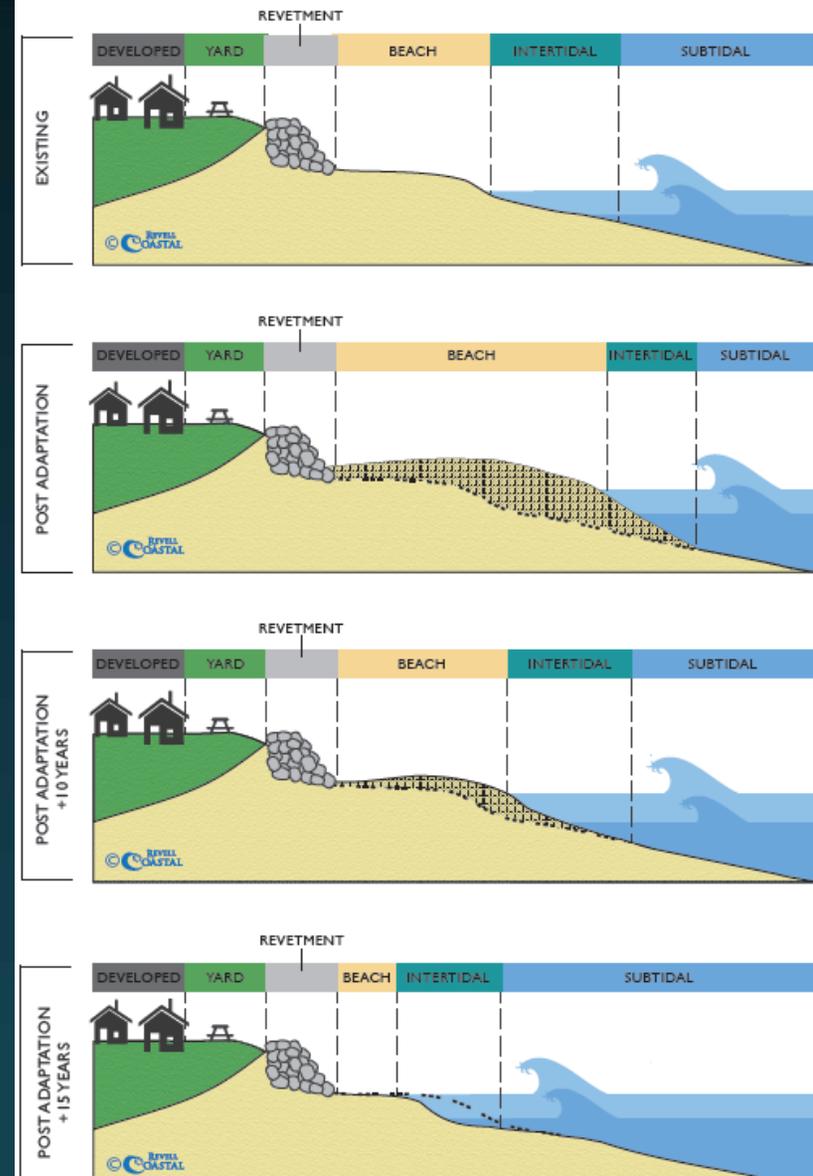


“Business-as-usual” sand nourishment

- Description: Continue to nourish beach and maintain armoring

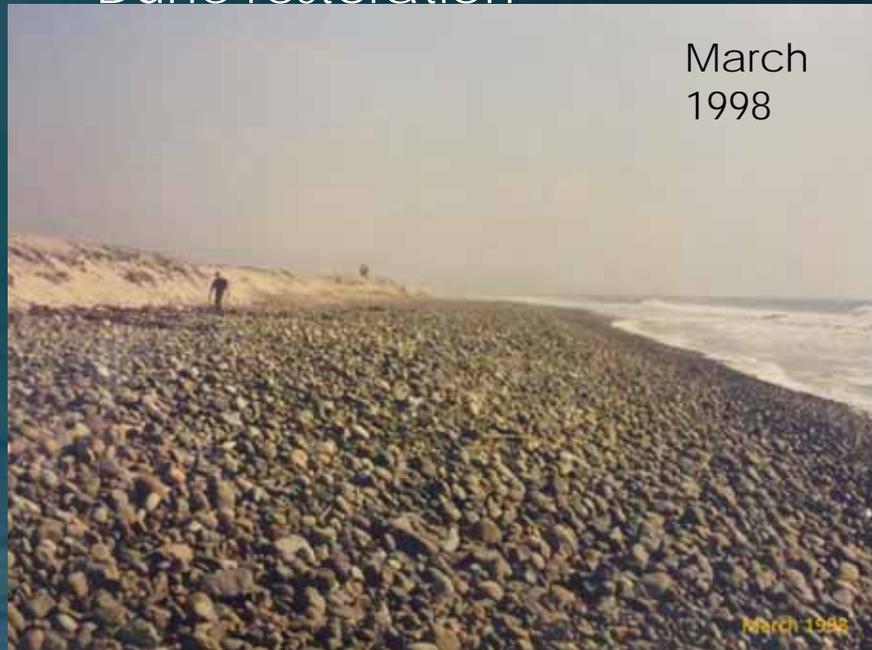
Key finding:

- Nourishment required 9 to 11 times by 2100 to maintain beach width
- Nourishment cycle goes from ~15 years to 5 years
- Upland remains protected

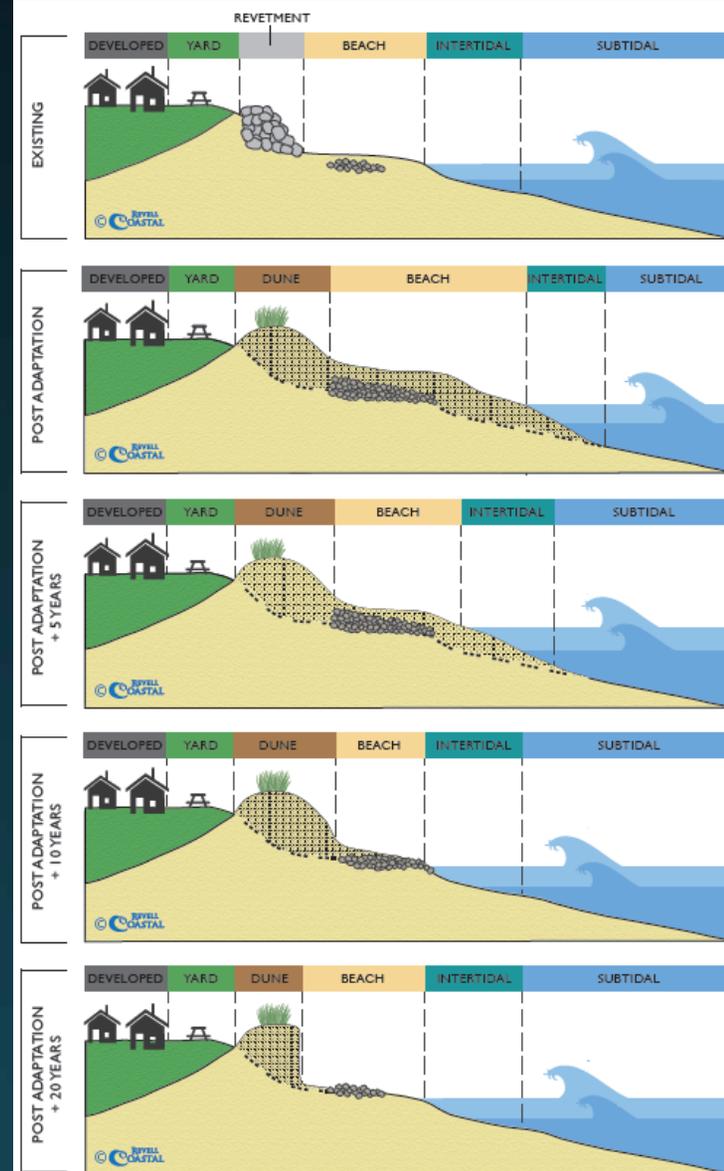


Natural hybrid dune

- Beach Nourishment
- Cobble Nourishment
- Removal of revetment
- Dune restoration



- 8 Reconstruction cycles by 2100

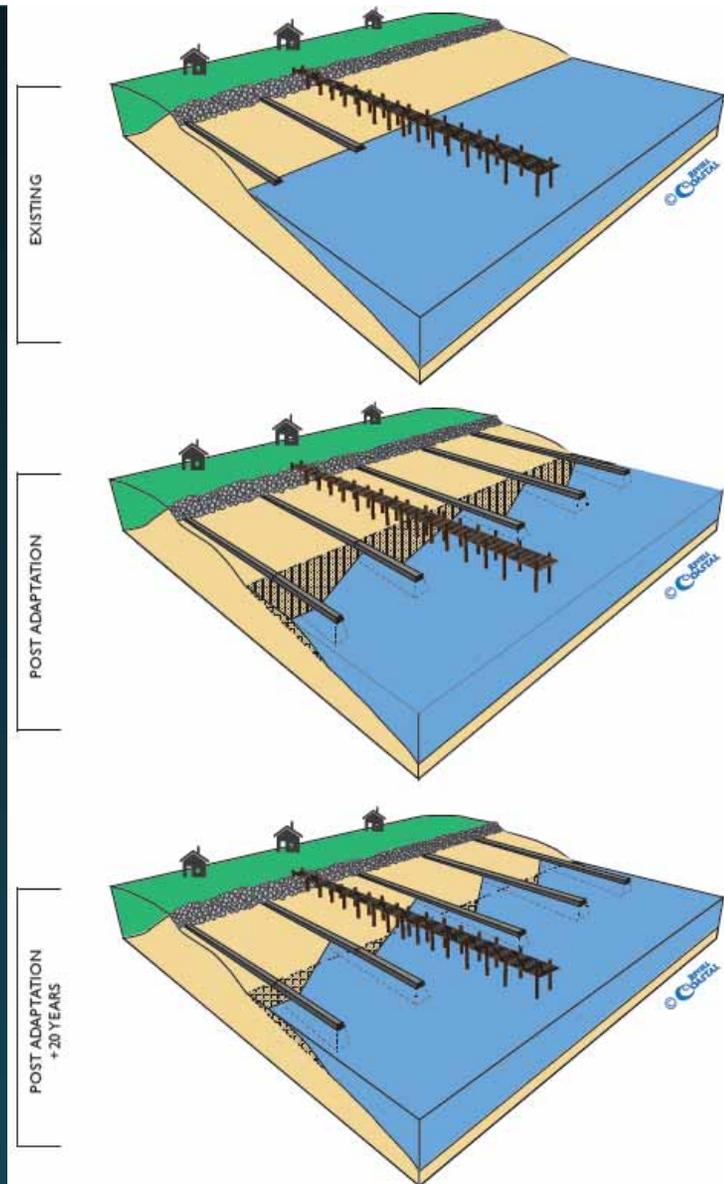


Sand Retention with Groins

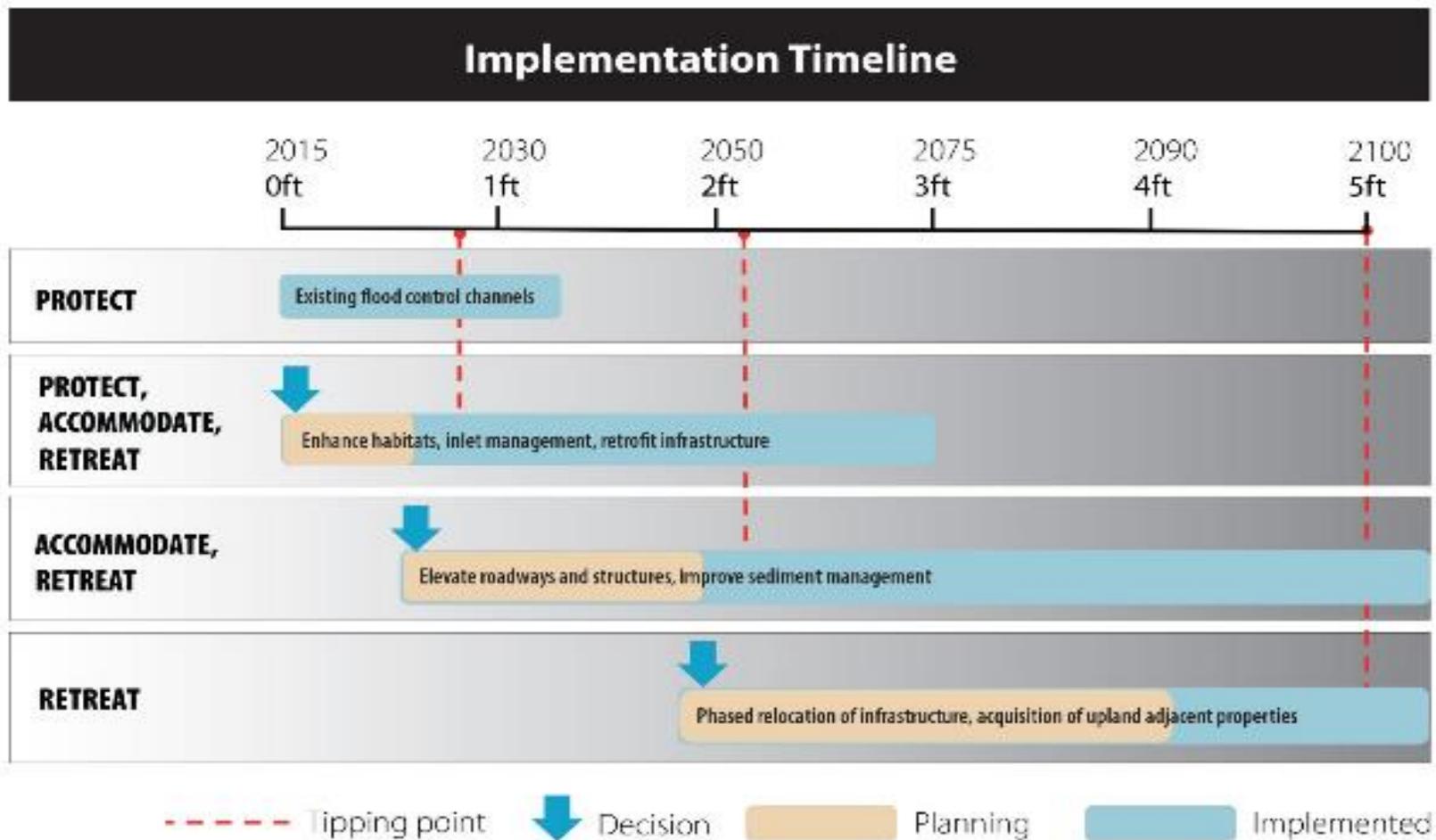
Complete original Army Corp of Engineers project with expanded groins

- 5 groins (cost of 4)
- Increase length
- Nourish

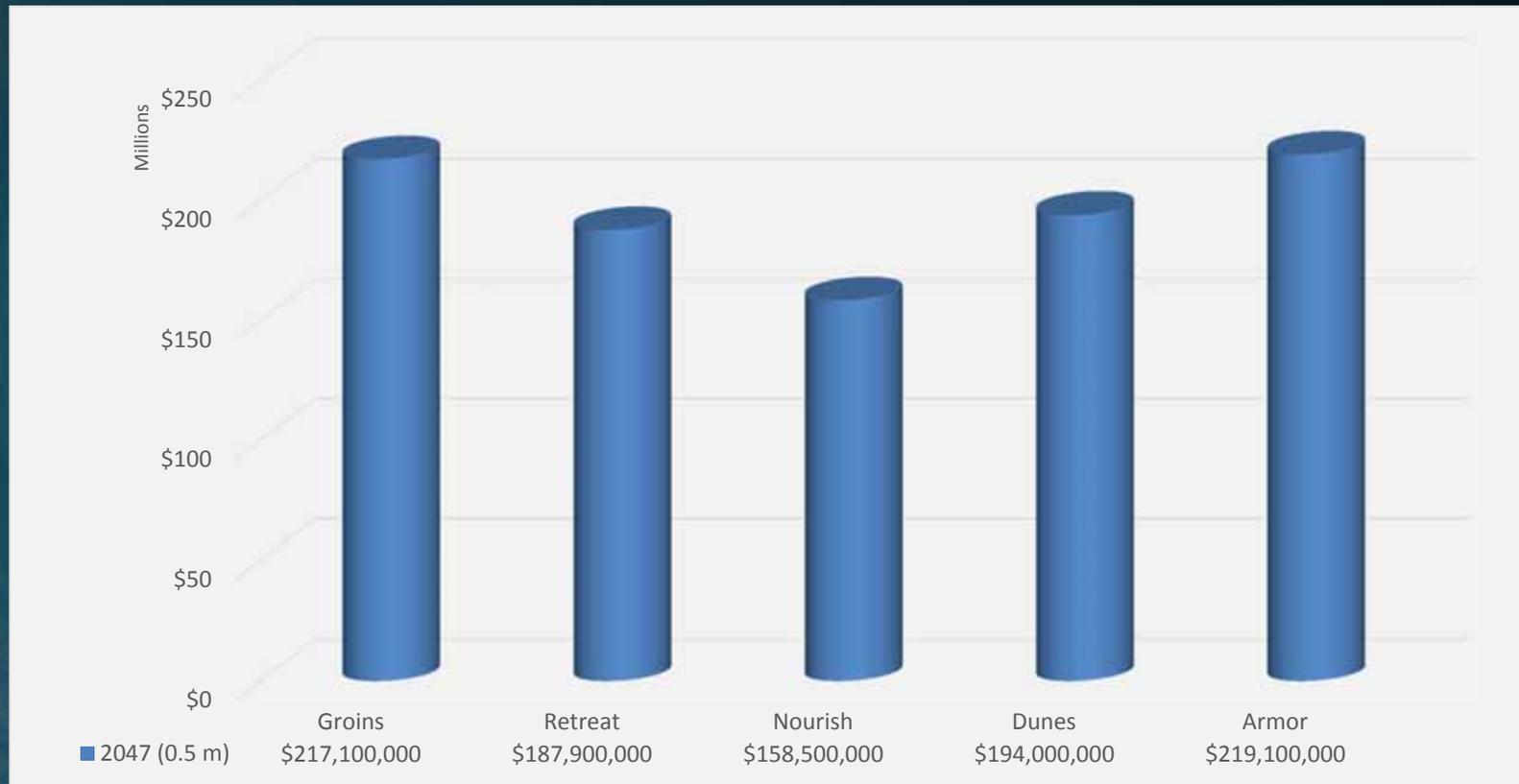
Key Findings:
Groins retain sand longer so nourishment cycles only **6 to 7 times** by 2100



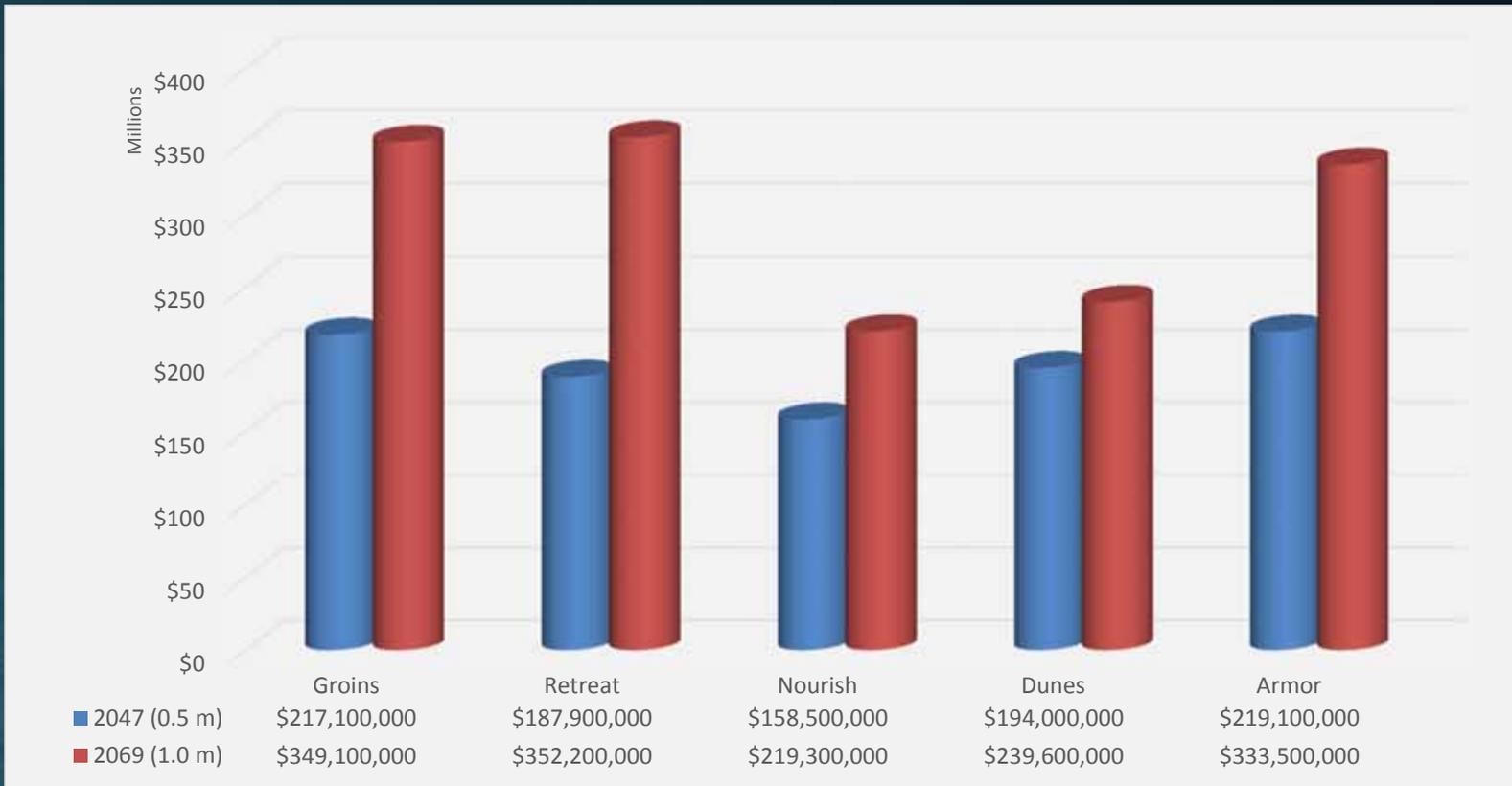
Project - Implementation Times



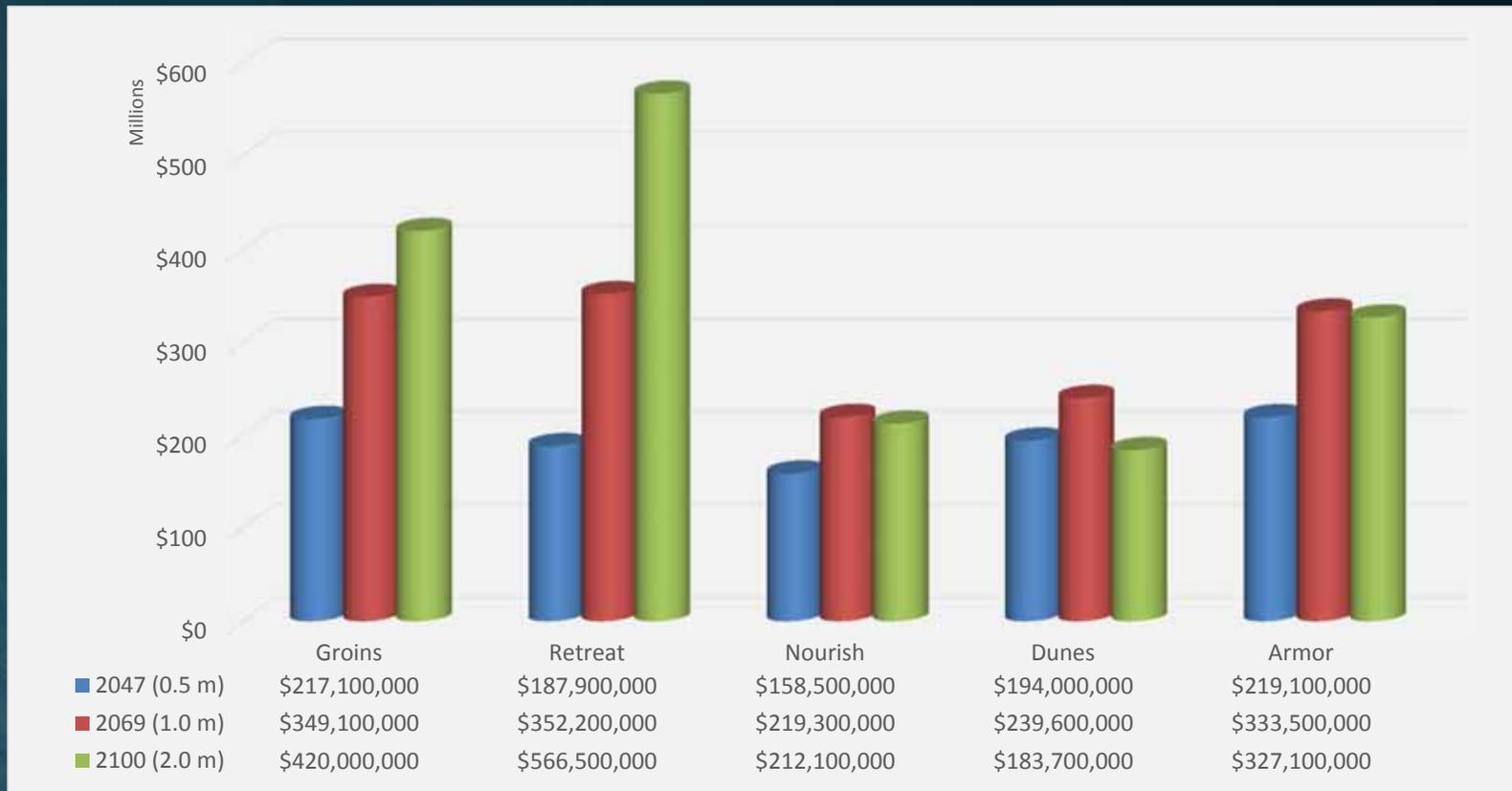
Net Benefits Through 2047 (0.5 m)



Net Benefits Through 2069 (1.0m)



Net Benefits Through 2100 (2.0 m)





Summary of Adaptation Findings

- Armoring leads to loss of beach recreation and ecological value
- Dunes/Nourishment is poor choice long term
 - Due to increasing costs and shorter construction cycles over time.
- Short term, armoring and groins about even in Net benefits
- Medium term, managed retreat and groins have similar Net benefits
- Over the long run managed retreat has highest Net benefits
 - Public benefits of recreation and ecological value as well as avoided construction costs offset losses to infrastructure and private property

Implementation

- Variety of different mechanisms
- Capital Improvement Plan
- Local Hazard Mitigation Plans
- Park Master Plans
- Shoreline Management Plans
- Local Coastal Program



Future Work

- Report and Recommendations 6/30/2016
- Local Coastal Program update
- Sand and Beach Management (capture and harvest sand)
- Consider building code changes
- Update Capital Improvement Plan
- Include appropriate projects the Local Hazard Mitigation Plan (FEMA)
- Identify hybridized strategies for different time horizons
- Continue outreach and education with community
- Regional engagement on solutions
- Fundraise



The City can't adapt to climate change alone... the County, SANDAG, the Port, City of Coronado, and the Navy must be partners.



Acknowledgements

Steering Committee

City of Imperial Beach

- Jim Nakagawa
- Hank Levien
- Chris Helmer
- Russell Mercer

Regional Stakeholders

- Port of San Diego
- Navy
- TRNERR

Tidelands Advisory Committee

- Joe Ellis (coastal engineer)

City Council Member

- Councilman Ed Spriggs

Funders



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