Vibrations & Excitations
…what The Beach Boys didn't tell you

Florida Shore & Beach Preservation Association
February 3, 2023

Photo: https://thebeachboys.com/releases/surfin-safari/

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Department of Environmental Resources Management

Vibrations & Excitations
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- County Projects
- FTA Manual
- Vibration Monitoring
- Results
- Conclusions

County Projects

- **Beach Nourishments**
  - ***NCCSPP Segment I (2021/22)***
  - ***NCCSPP Segment III (2020/21)***

County Projects

- **Beach Nourishments**
  - ***NCCSPP Segment I (2021/22)***
  - ***NCCSPP Segment III (2020/21)***

Photos: Gray Seismic Monitoring, LLC

County Projects

- **Dune Restorations**
  - ***Singer Island (2021/22)***
  - ***Coral Cove (2021/22)***

Photo: W.F. Baird & Associates Ltd

County Projects

- **Dune Restorations**
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County Projects

- **Dune Restorations**
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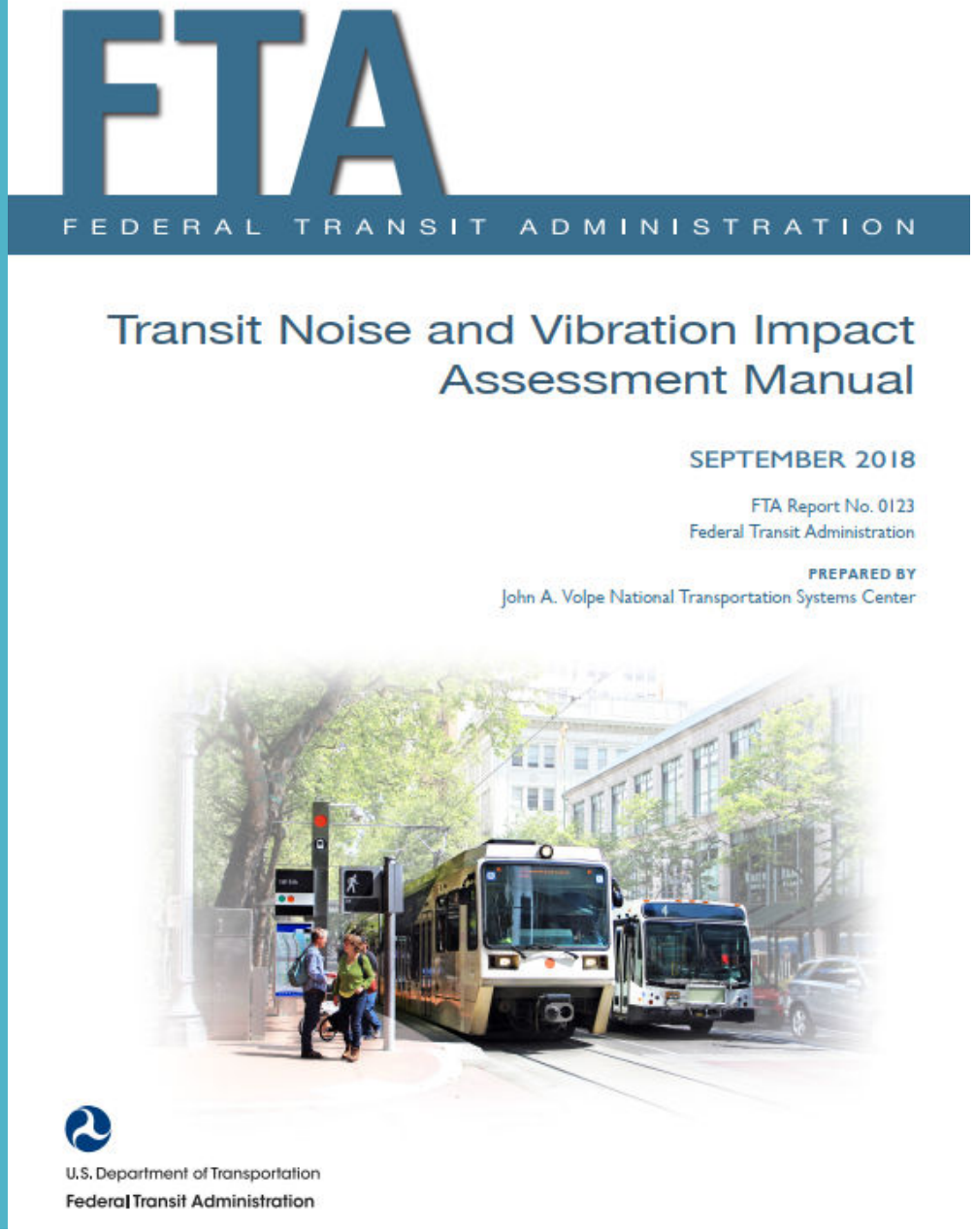
FTA Manual

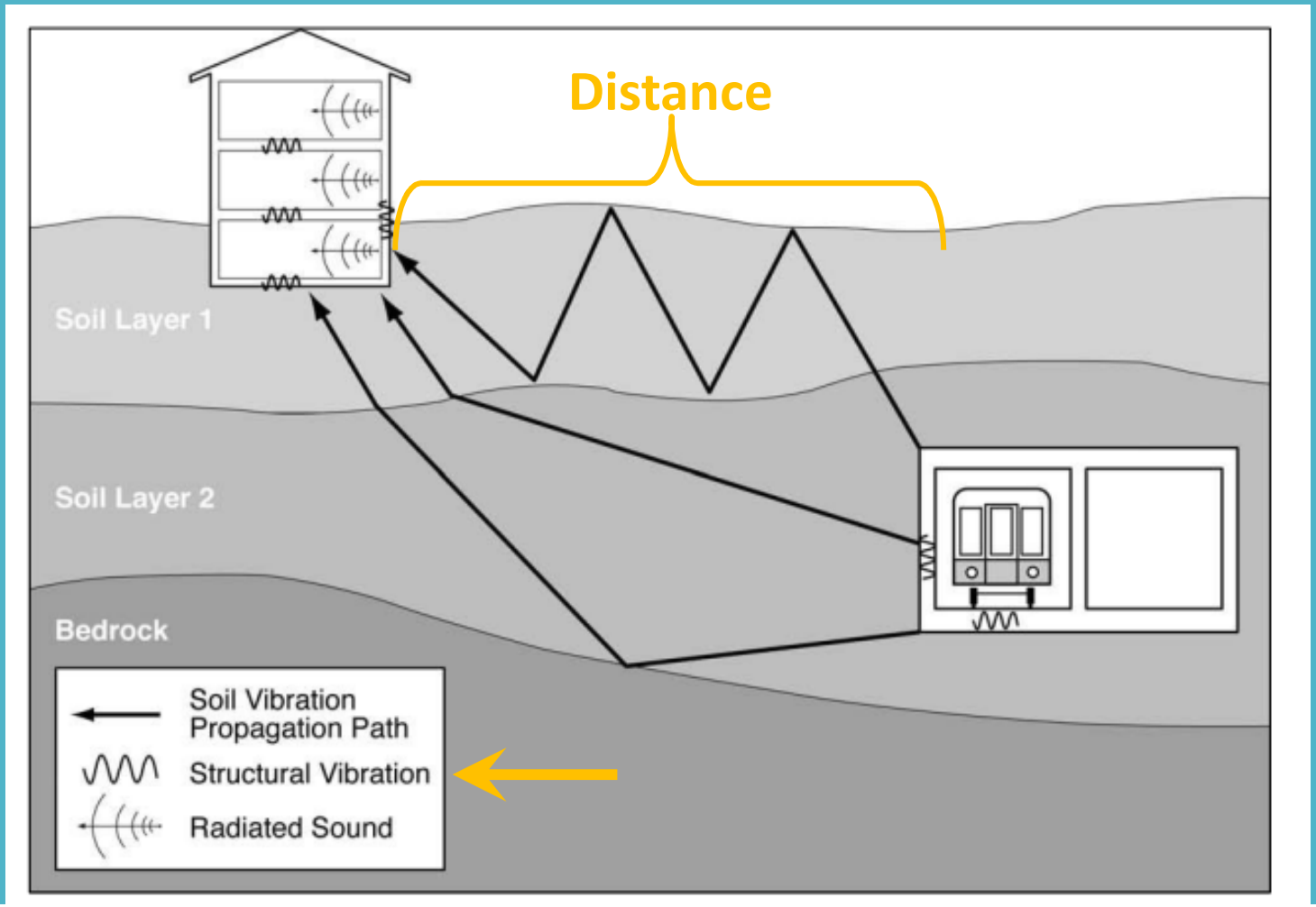
Transit Noise and Vibration Impact Assessment Manual (2018)

Federal Transit Administration (FTA), U.S. Department of Transporation



FTA Manual

- **Propagation of Ground-Borne Vibrations [Figure 5-1]**



FTA Manual

- **Vibration Signal [Figure 5-2]**

Peak Particle Velocity
(PPV, in/sec)

↕

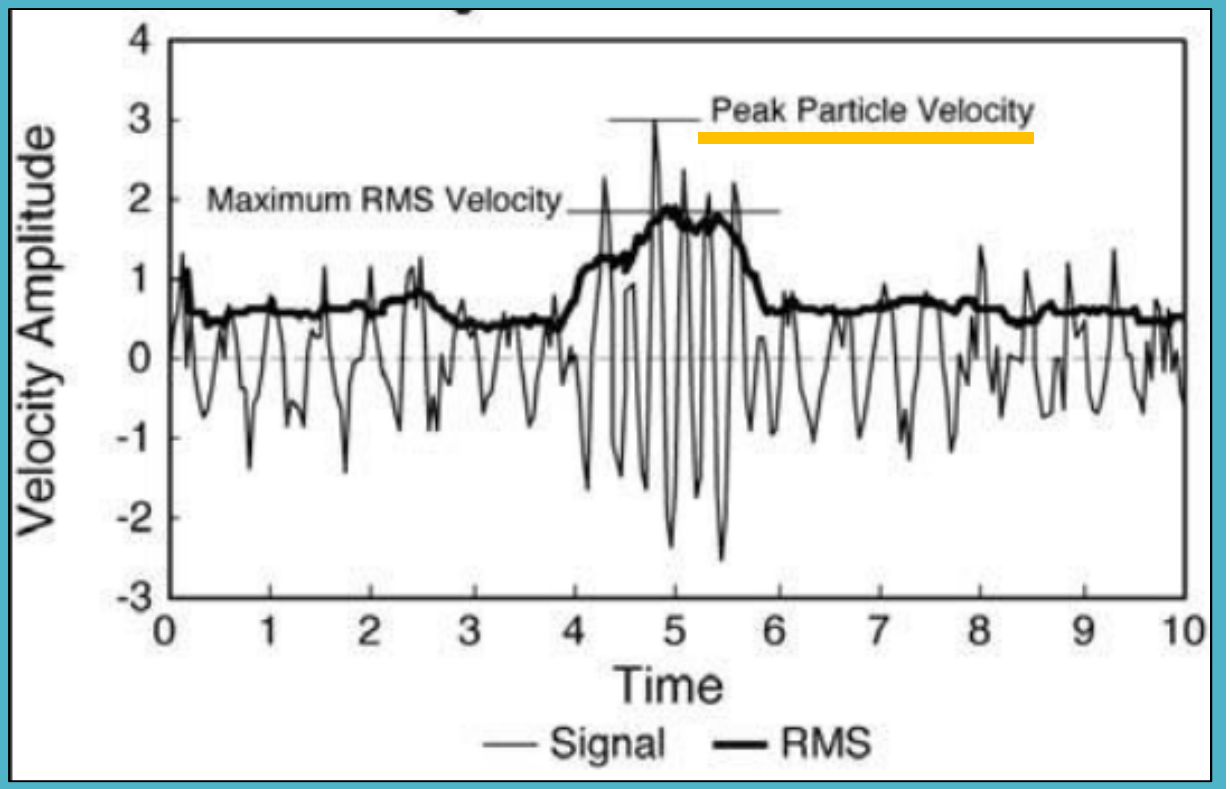
Crest Factor
(usually 4 to 5)

↕

RMS Velocity
(v, in/sec)

↕

RMS Vibration Velocity Level
(RMS L_v, VdB)



FTA Manual

- **Typical Levels of Vibration [Figure 5-4]**

Response	PPV* (in/sec)	RMS L_v (VdB)
Human Annoyance	0.07	85
Human Perception	0.01	65
Background	0.00	50

*Inferred assuming a crest factor of 4.

FTA Manual

- **Construction Vibration Damage Criteria [Table 7-5]**

Building/ Structural Category	PPV, in/sec	Approximate L_v*
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

*RMS velocity in decibels, VdB re 1 micro-in/sec

APT Bulletin, Journal of Preservation Technologies, 46 (2015)

Table 2. Damage Thresholds as Reported in USBM RI 8507

Conditions Observed	Typical Peak Particle Velocity (in/sec)
Threshold damage (hairline cracking in plaster, opening of old cracks, etc.)	2 - 3 Never at < 0.5
Minor damage (hairline cracking in masonry, breaking of windows)	4 - 5 Never at < 1.0
Major structural damage (cracking or shifting of foundations or bearing walls)	>5

FTA Manual

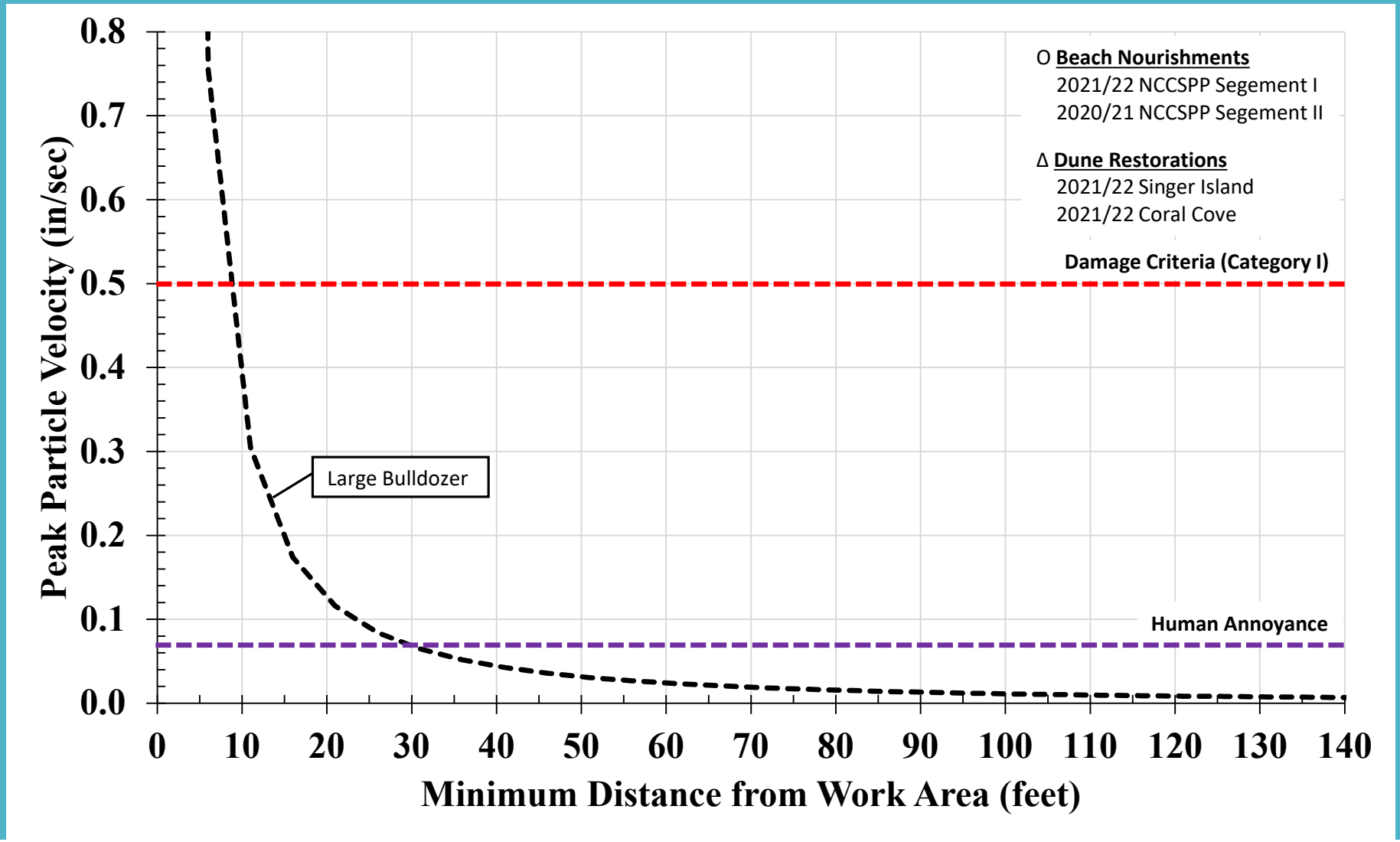
- **Vibration Levels for Construction Equipment [Table 7-4]**

Equipment		PPV at 25 ft, in/sec	Approximate Lv* at 25 ft
Pile Driver (impact)	upper range	1.518	112
	typical	0.644	104
Pile Driver (sonic)	upper range	0.734	105
	typical	0.17	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	in soil	0.008	66
	in rock	0.017	75
Vibratory Roller		0.21	94
Hoe Ram		0.089	87
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

* RMS velocity in decibels, VdB re 1 micro-in/sec

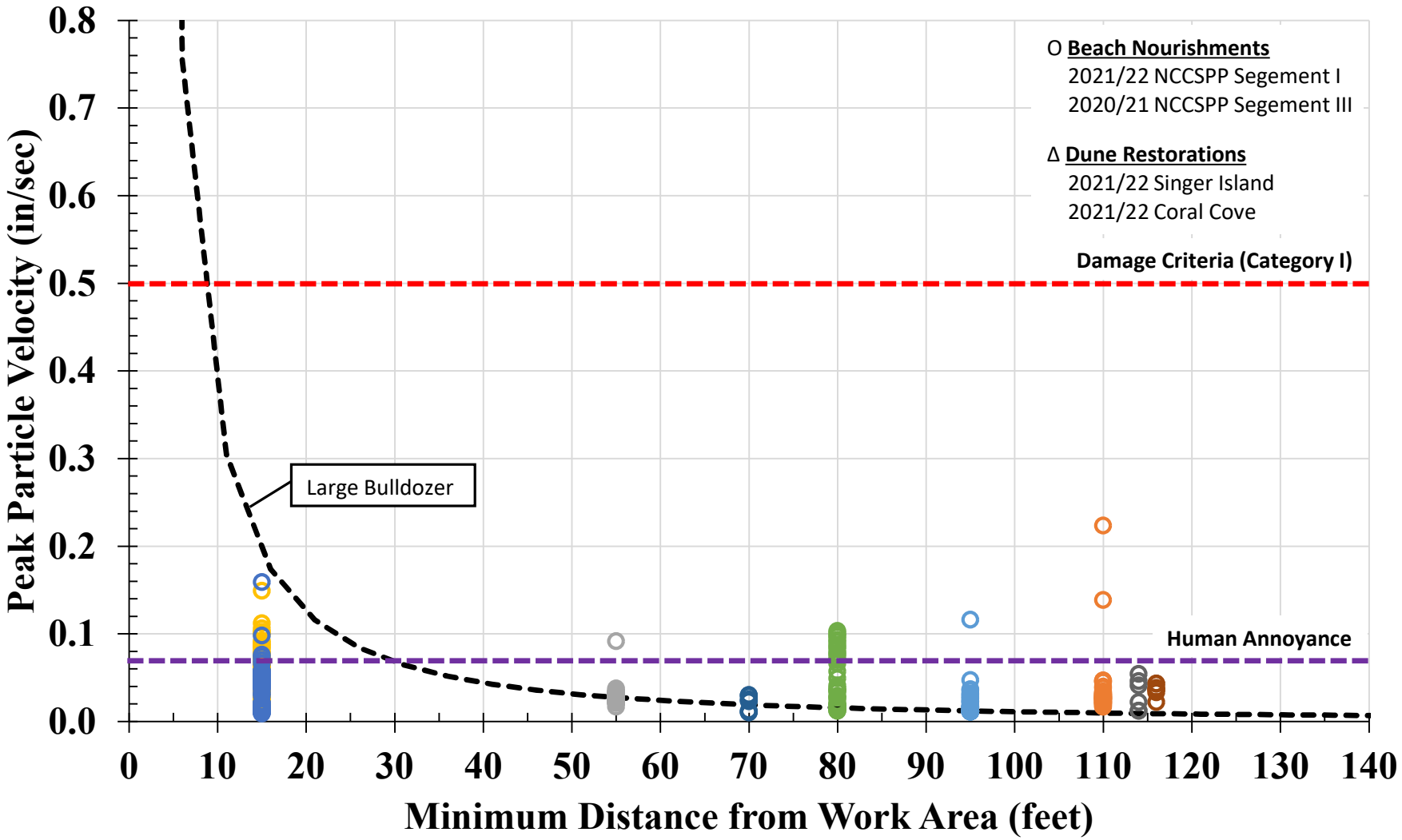
Vibration Monitoring

- **PBC County Vibration Monitoring**



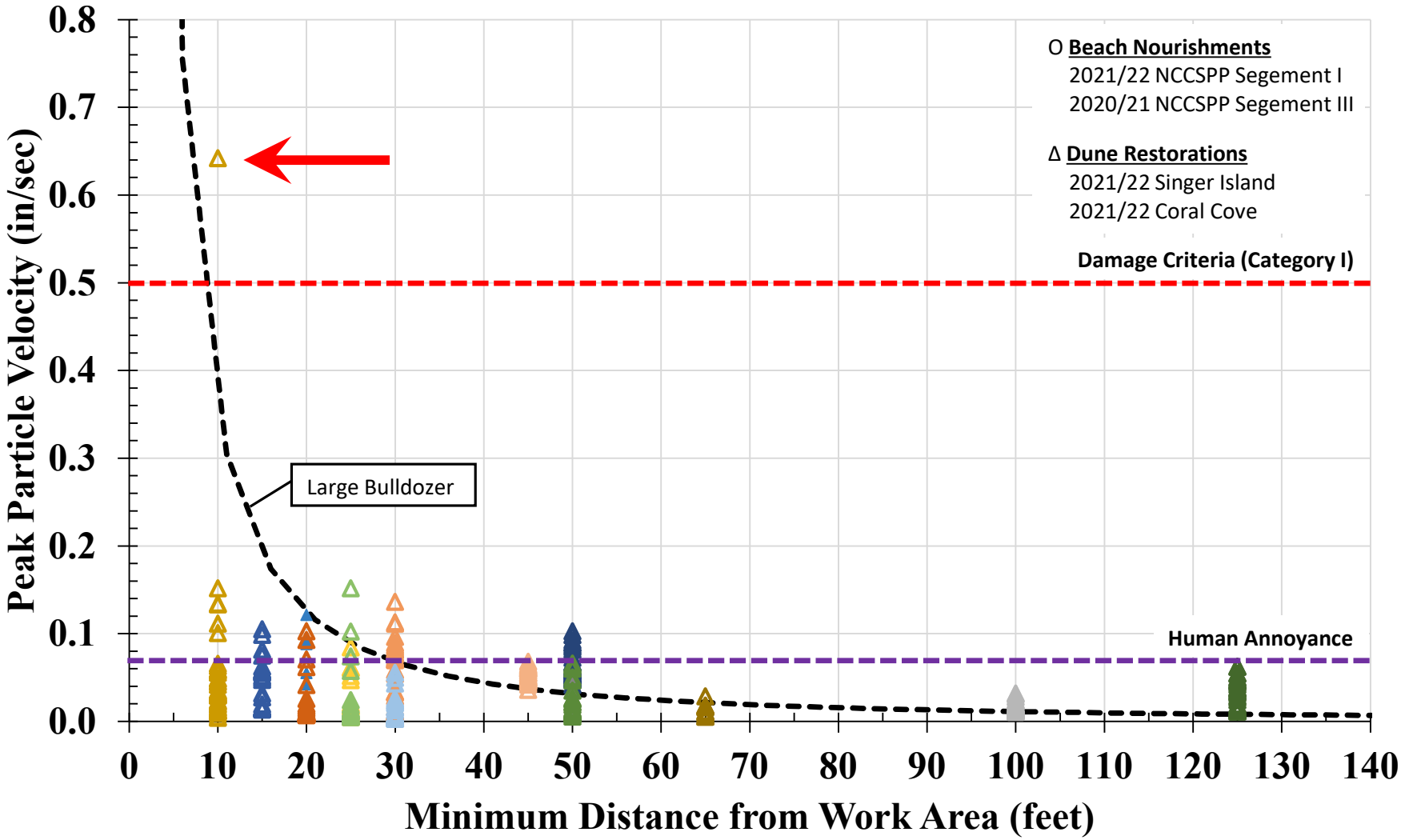
Vibration Monitoring

- **County Projects: Beach Nourishments**



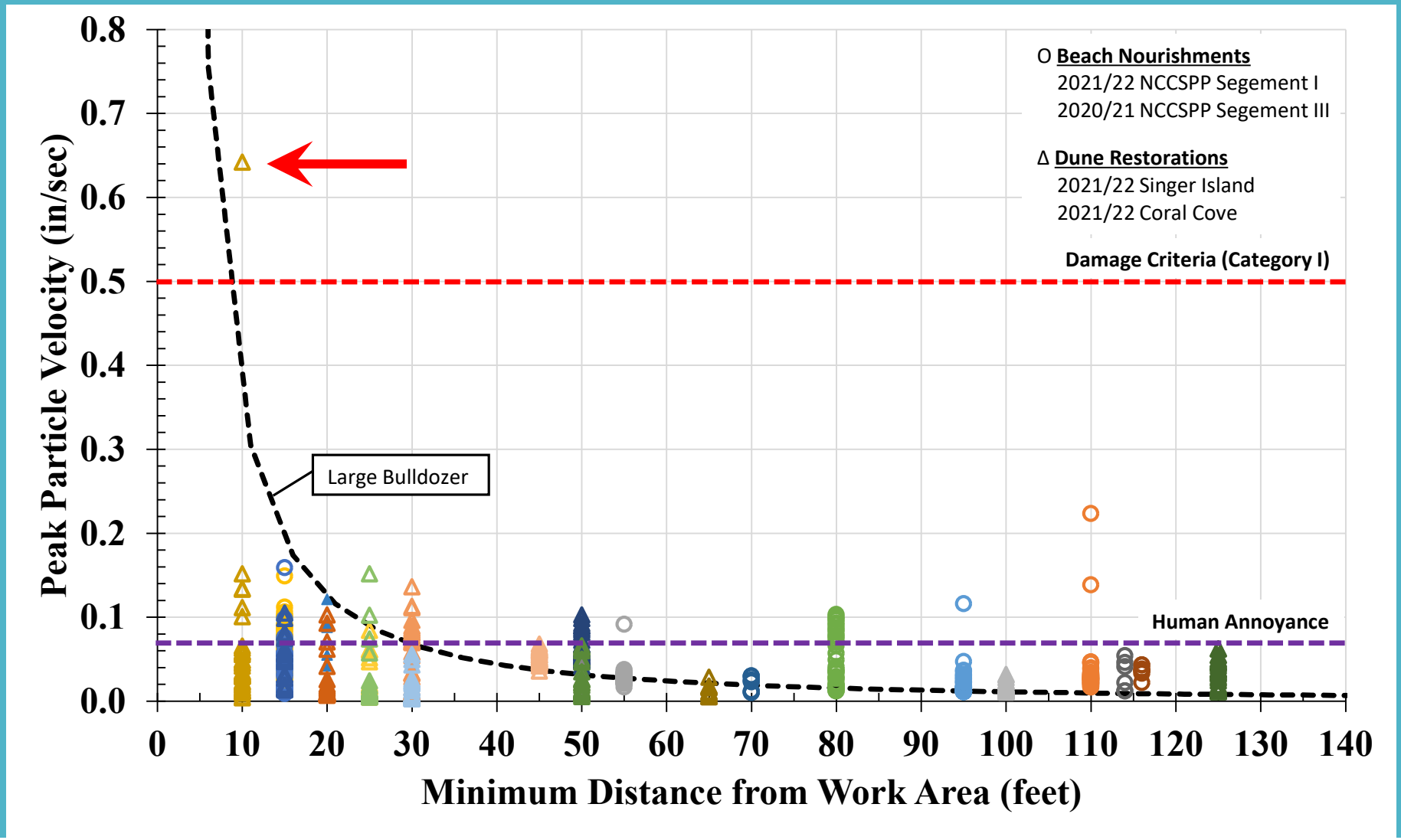
Vibration Monitoring

- **County Projects: Dune Restorations**



Vibration Monitoring

- **County Projects: Beach Nourishments + Dune Restorations**



Vibration Monitoring

- **Dune Restoration…Coral Cove**

Photo: W.F. Baird & Associates Ltd

Vibration Monitoring

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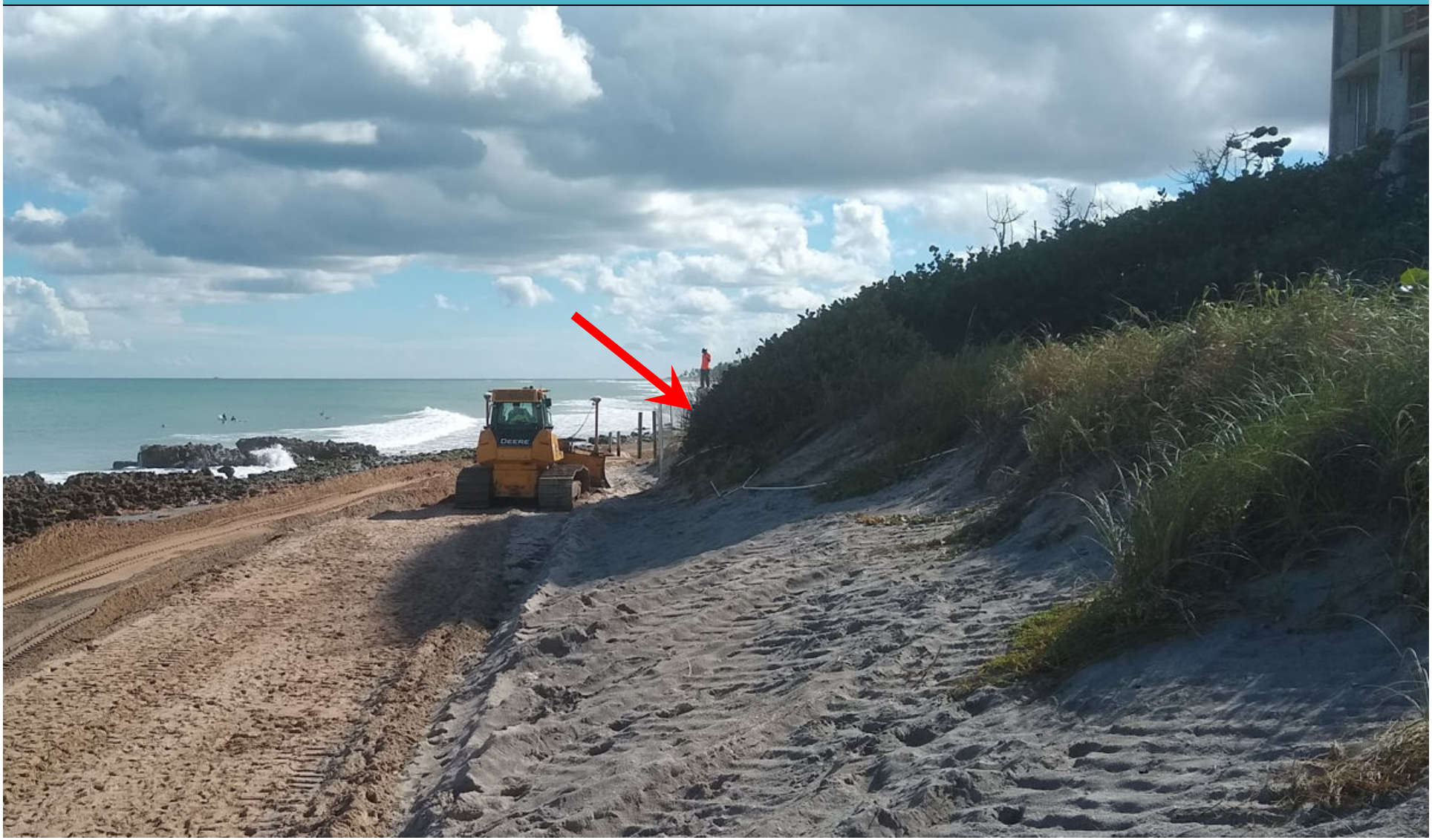
Vibration Monitoring

- **Dune Restoration...Coral Cove**



Vibration Monitoring

- **Dune Restoration...Coral Cove**

Results

- **Four County beach and dune projects... vibration monitoring resulted in one instance of the FTA damage criteria being exceeded.**

- **Exceedance during the Coral Cove Dune Restoration Project.**
  - **The parcel was under major redevelopment, which included structural rehabilitation of the condominium, promenade, and fronting seawall.**
  - **County's construction activities were within ~10 feet of the monitoring station. Activities included the use of bulldozers and offroad dump trucks.**
  - **Real-time monitoring allowed the County's contactor to be notified and to adjust operations. No damage reported.**

Conclusions

- **Site conditions...**
  - Narrower beaches force construction activities closer to upland structures
  - Eroded dunes are more likely to result in exposed coastal structures
  - Rock outcrops are areas where soil thickness is thinner

- **Mitigation measures...**
  - Increase distances to upland structures and soil thickness over rock outcrops
  - Adjust constuction means/methods (operations, equipment, access routes)
  - Install vibration monitoring based site familiarity and past monitoring data

- **Vibration monitoring...**
  - Monitoring goals need to be defined (structures, activities)
  - Siting of equipment can be influenced by background/ambient vibration
  - Availability of equipment may require relocation as construction progresses
  - Real-time reporting can allow contractors to make adjustments

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Thanks…Questions?