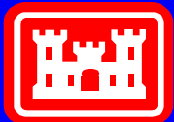


# Obstacles to Implementing Working with Nature Concepts

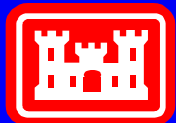
Douglas Clarke

Environmental Laboratory  
U.S. Army Corps of Engineers  
Engineer Research and Development Center



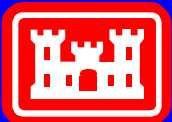
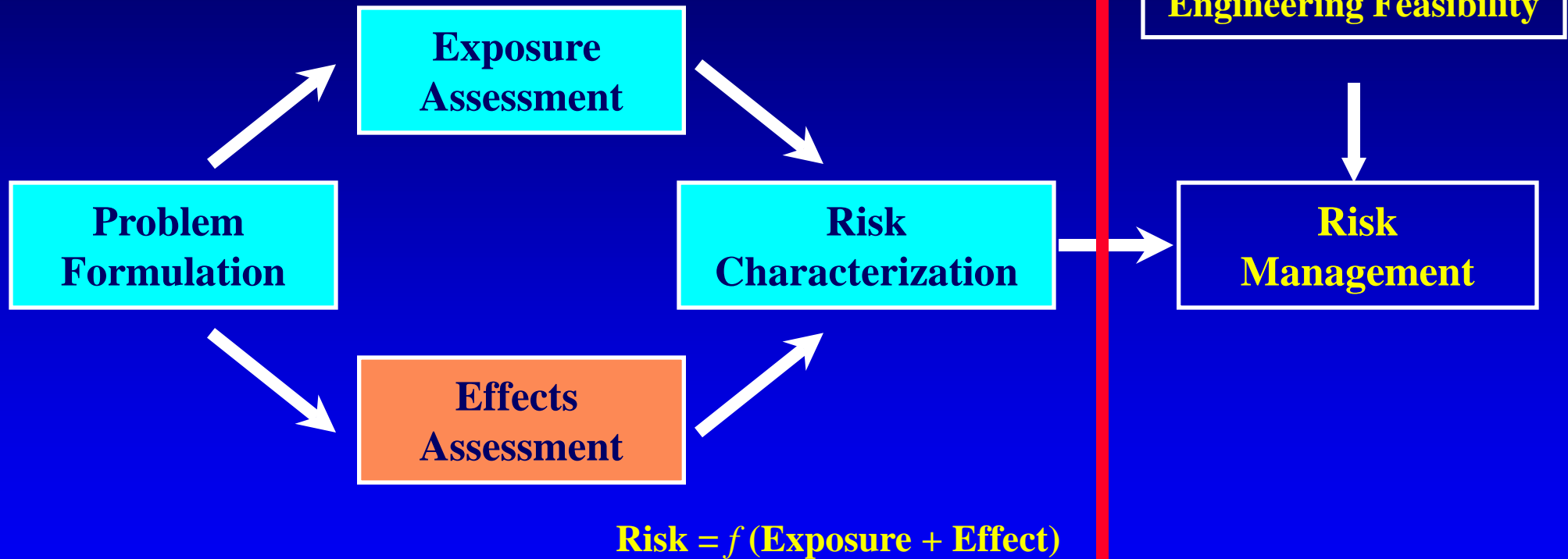
# Obstacles

- **Institutional constraints**
  - Sponsorship, cost sharing, stakeholder “buy in”
  - Regulatory authorities
- **Perceptions and concerns of resource agencies**
  - Water quality issues (e.g., DO, nutrients, ammonia, sulfides, etc.)
  - Turbidity and suspended sediment
  - Underwater noise associated with the dredging process



# RISK FRAMEWORK

## RISK ASSESSMENT PARADIGM



# Concerns Related to Resuspension

**Physiological  
effects on aquatic  
organisms?**

**Acute or chronic  
turbidity?**

**Sedimentation  
on spawning  
habitat?**

**SAV & seagrass  
bed effects?**

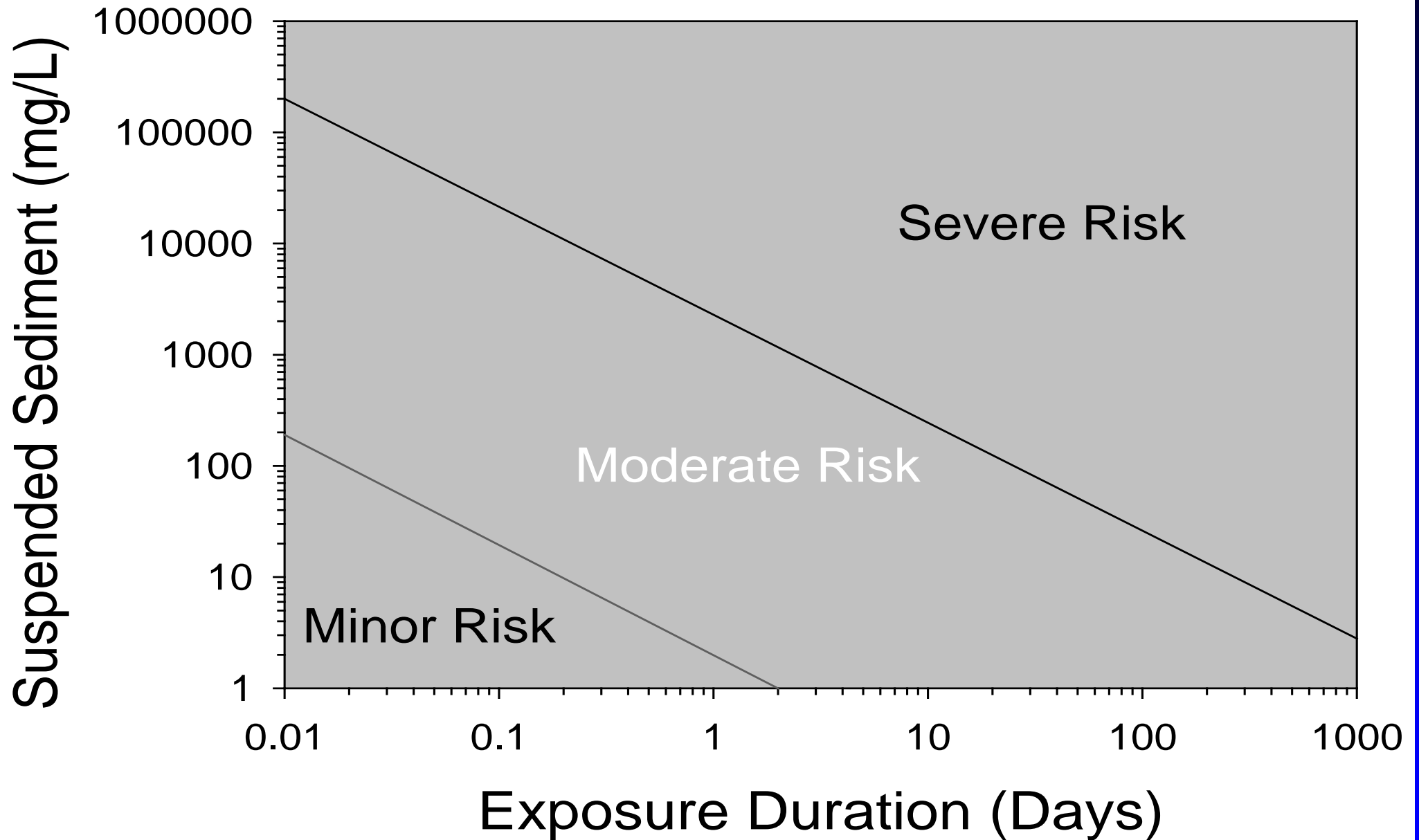
**Delayed fish  
migration?**



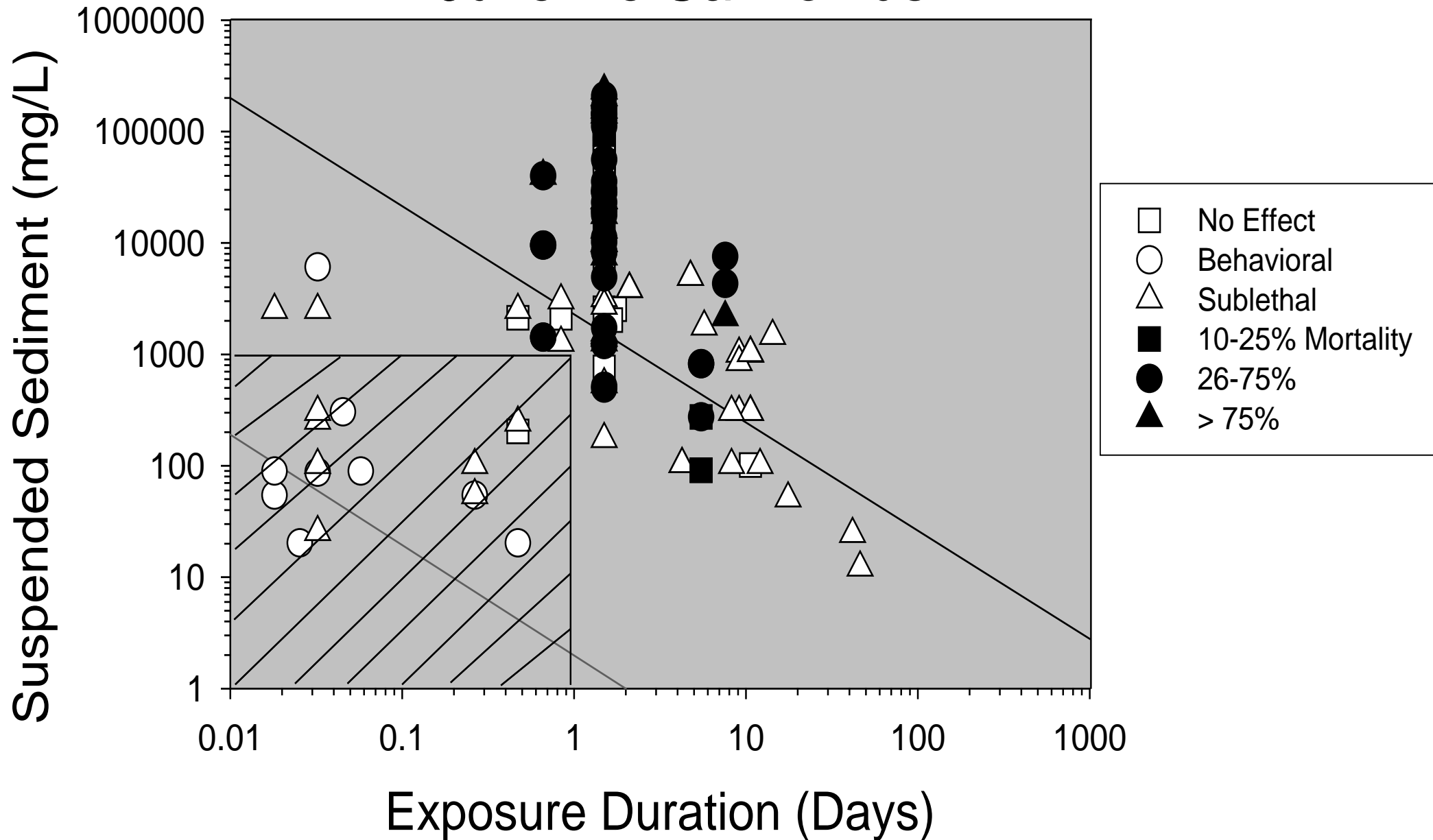
SEVERITY	EFFECT
0	No effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
4	Short-term reduction of feeding rate or success
5	Minor physiological stress; coughing or increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation or impaired homing
8	Major physiological stress; long-term reduction in feeding rate or success
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; severe habitat degradation
11	>20-40% mortality
12	>40-60% mortality
13	>60-80% mortality
14	>80-100% mortality

*(based on Newcombe and Jensen 1996)*

# Juvenile Salmonids

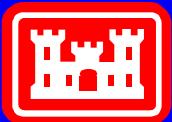


# Juvenile Salmonids



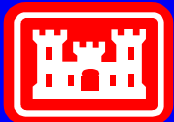
# Dredge Sounds Characterization

- **An opportunity to take a proactive approach before the issue is prematurely entrenched in the regulatory arena**
- **Environmental concerns related to underwater noise are emerging**
- **Few data on dredging-induced sounds exist**
- **Characterizations required to assess risk to specific biological resources**



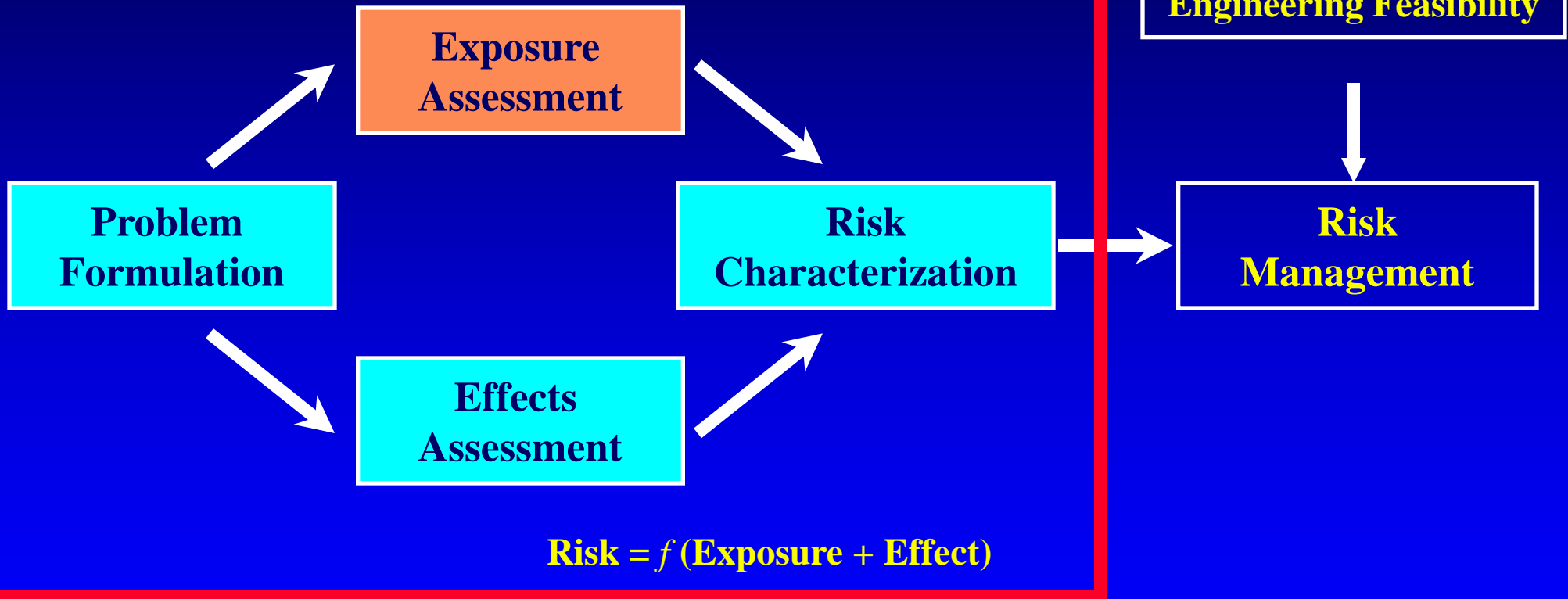
# R&D Thrust

- Add to library of dredging process sound characterizations
  - Different dredge types
    - ◇ Dominant sound sources
    - ◇ Sound attenuation rates
  - Different dredge sizes
  - Dredging in different substrates
- Place dredging sounds into perspective with ambient sound fields and other natural and anthropogenic sources
- Provide theoretical groundwork for assessments of dredging sound impacts on key species



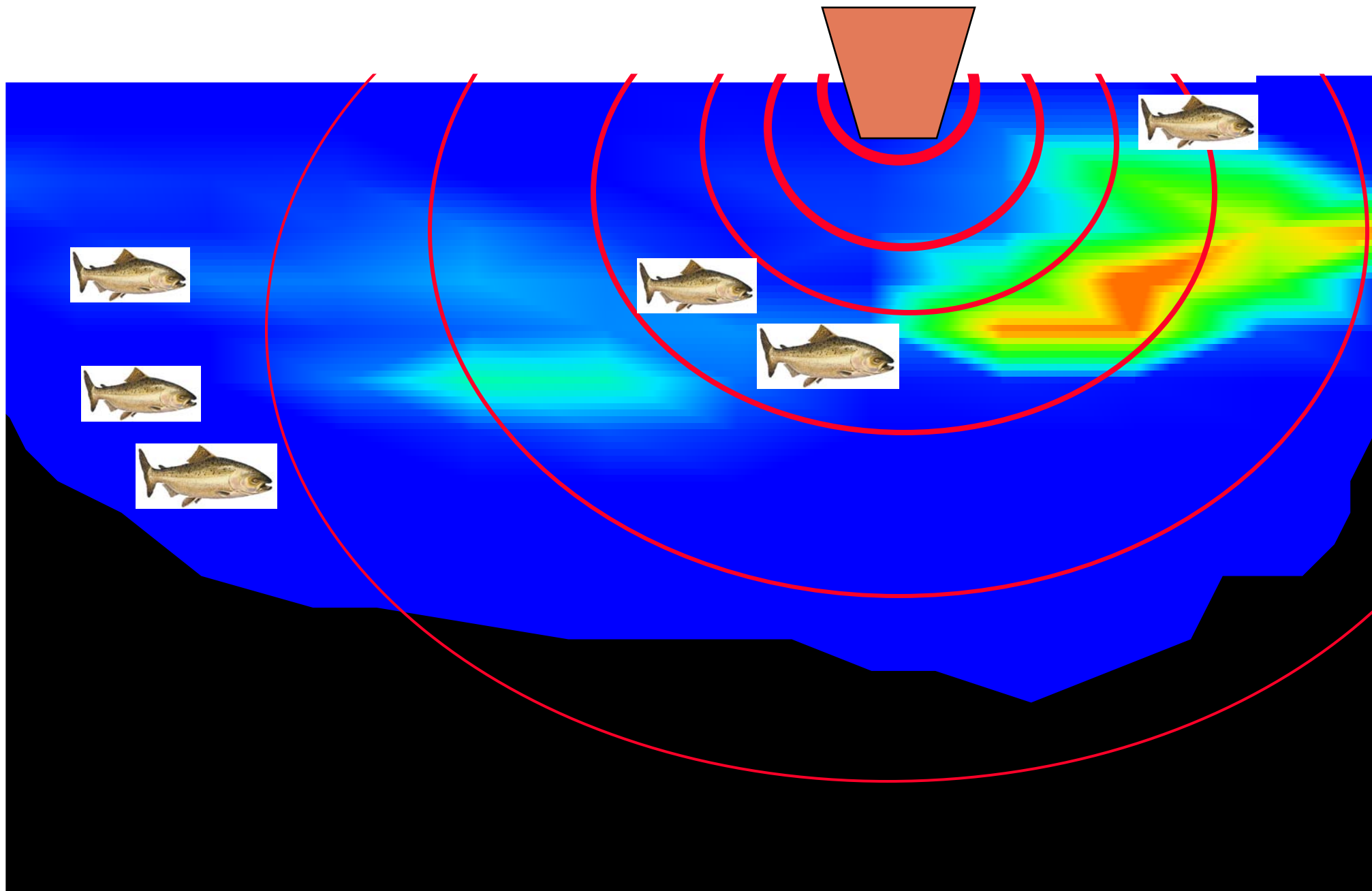
# RISK FRAMEWORK

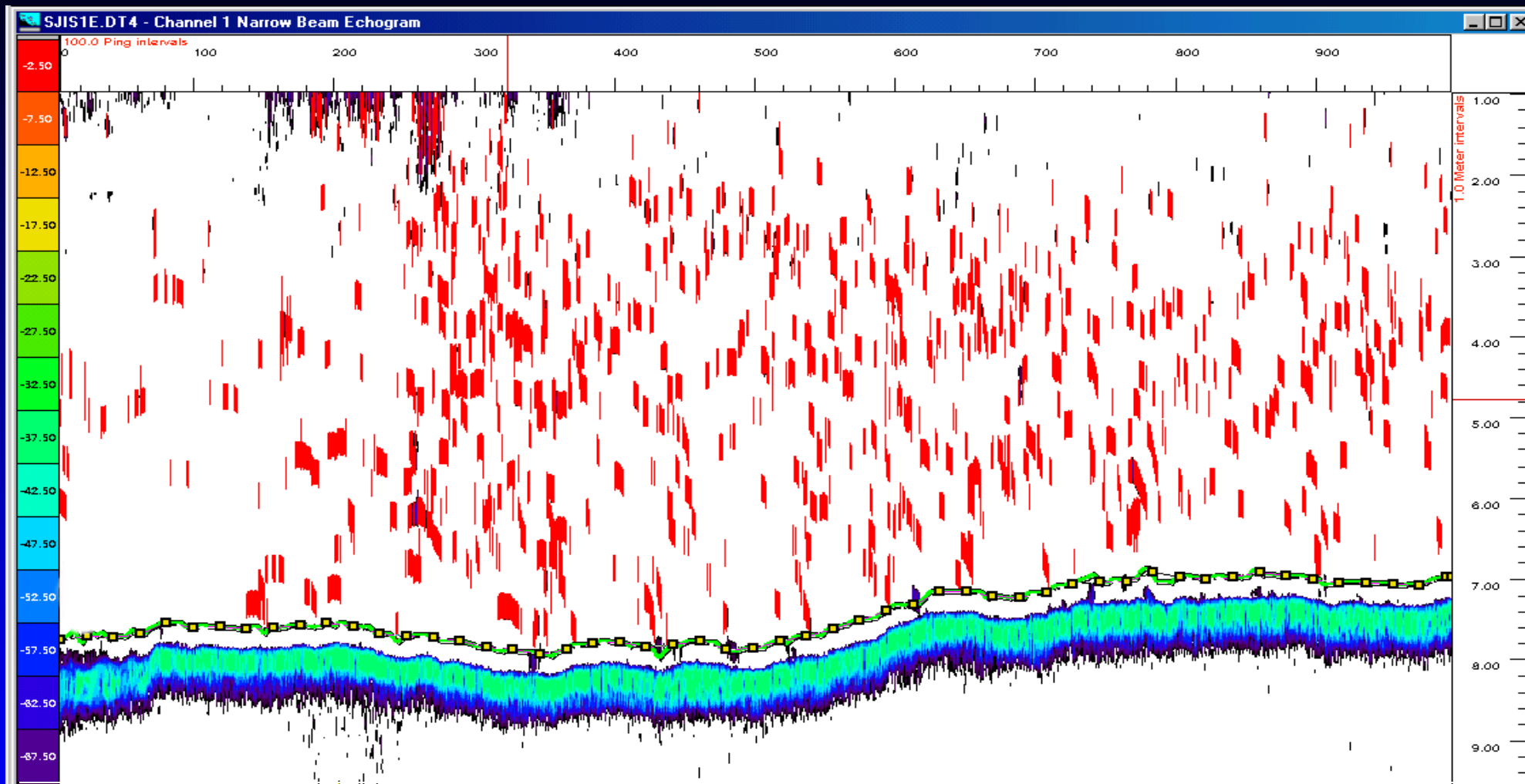
## RISK ASSESSMENT PARADIGM



Depth (m)

Cross-section Distance (m)





↑  
**DREDGE  
LOCATION**

↑  
**30 m**

Increasing Distance from Dredge  
→

# RECORDING UNDERWATER SOUNDS

Hydrophone

Amplifier

DAT Recorder

Analog to Digital  
Converter

Spectralab  
Analysis



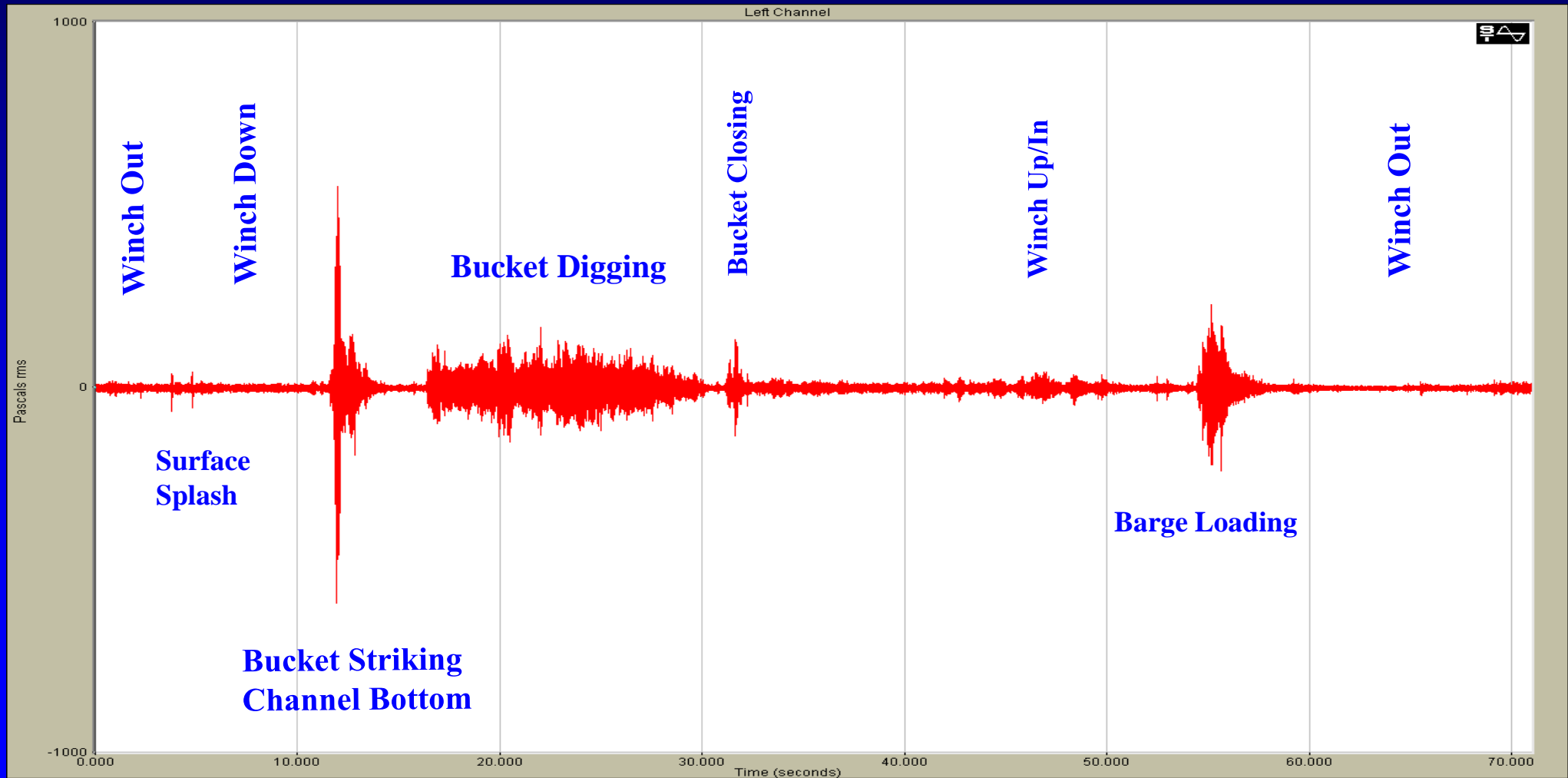
Hydrophone



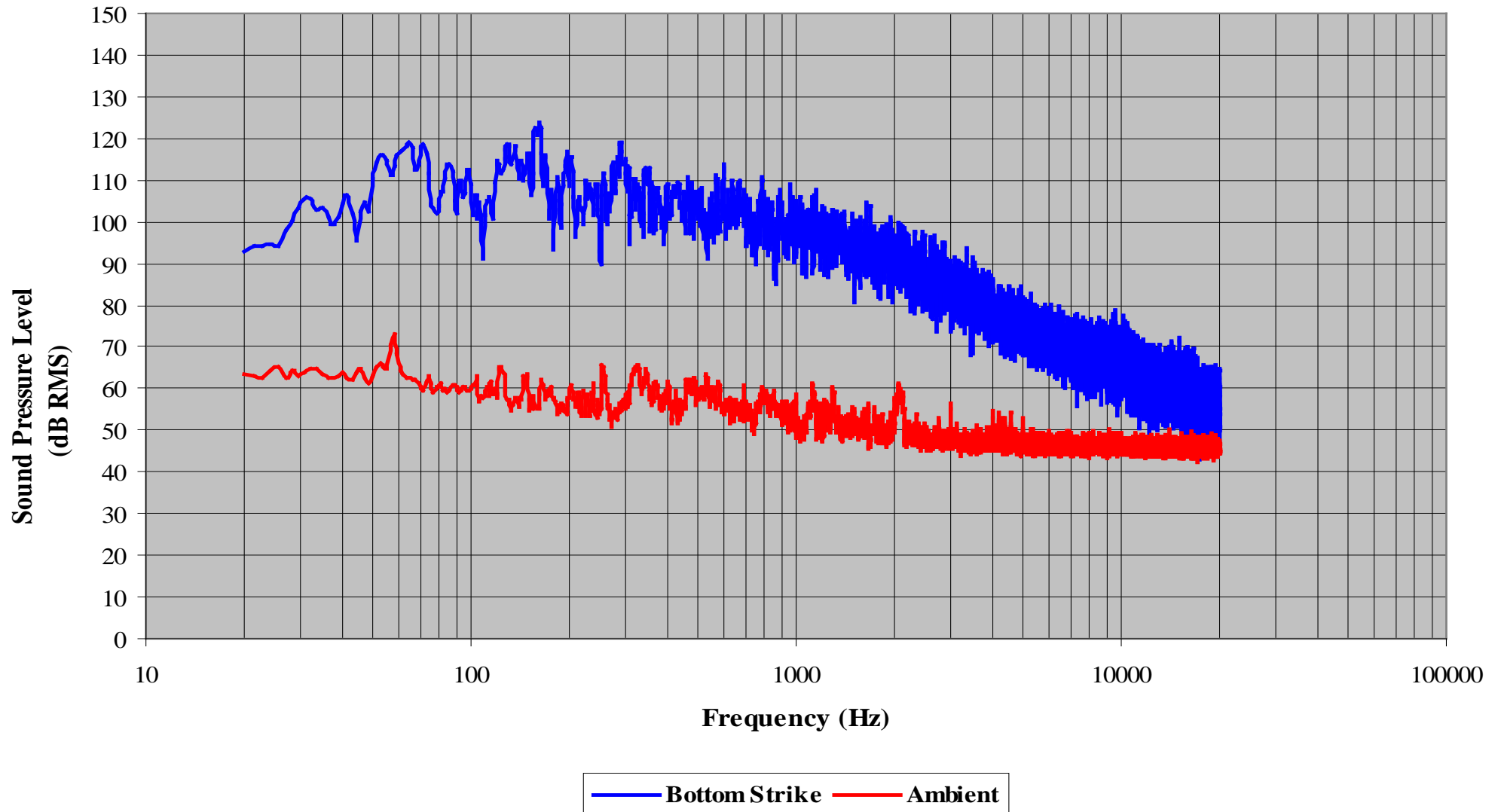


Manson Bucket Dredge *Viking* (1,500hp, 10cyd) Operating in Cook Inlet, Alaska

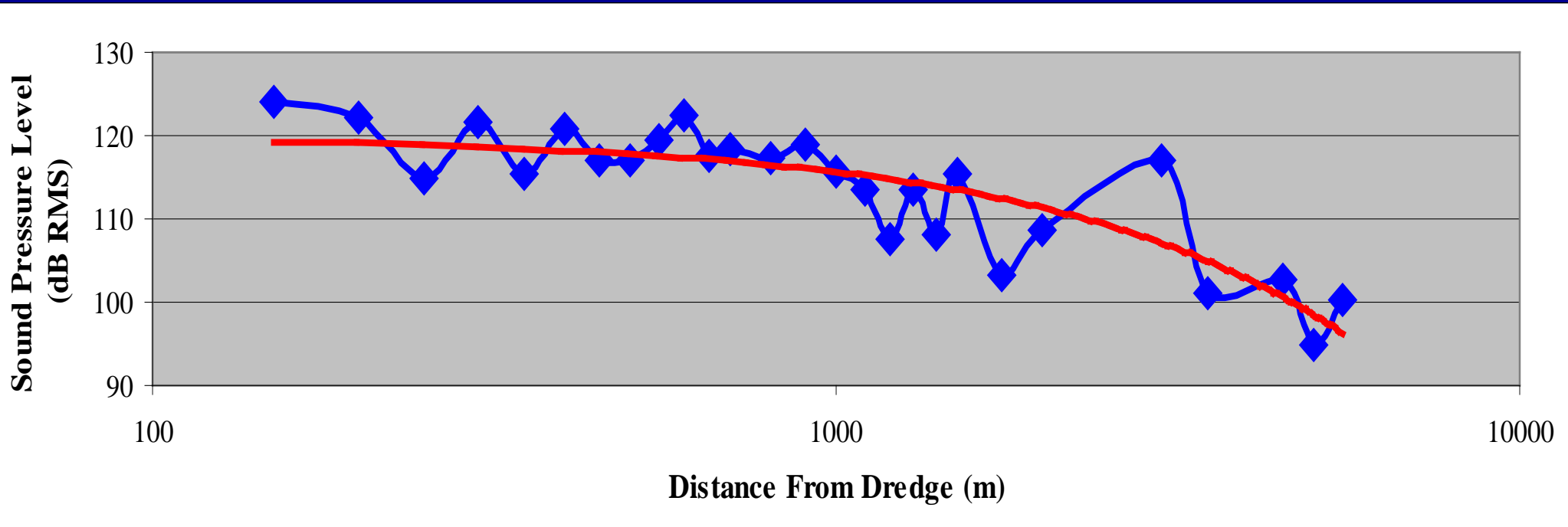
# Pressure Waveform for a Typical Bucket Deployment & Retrieval Cycle



# Sound Pressure Levels for Bucket Striking Bottom



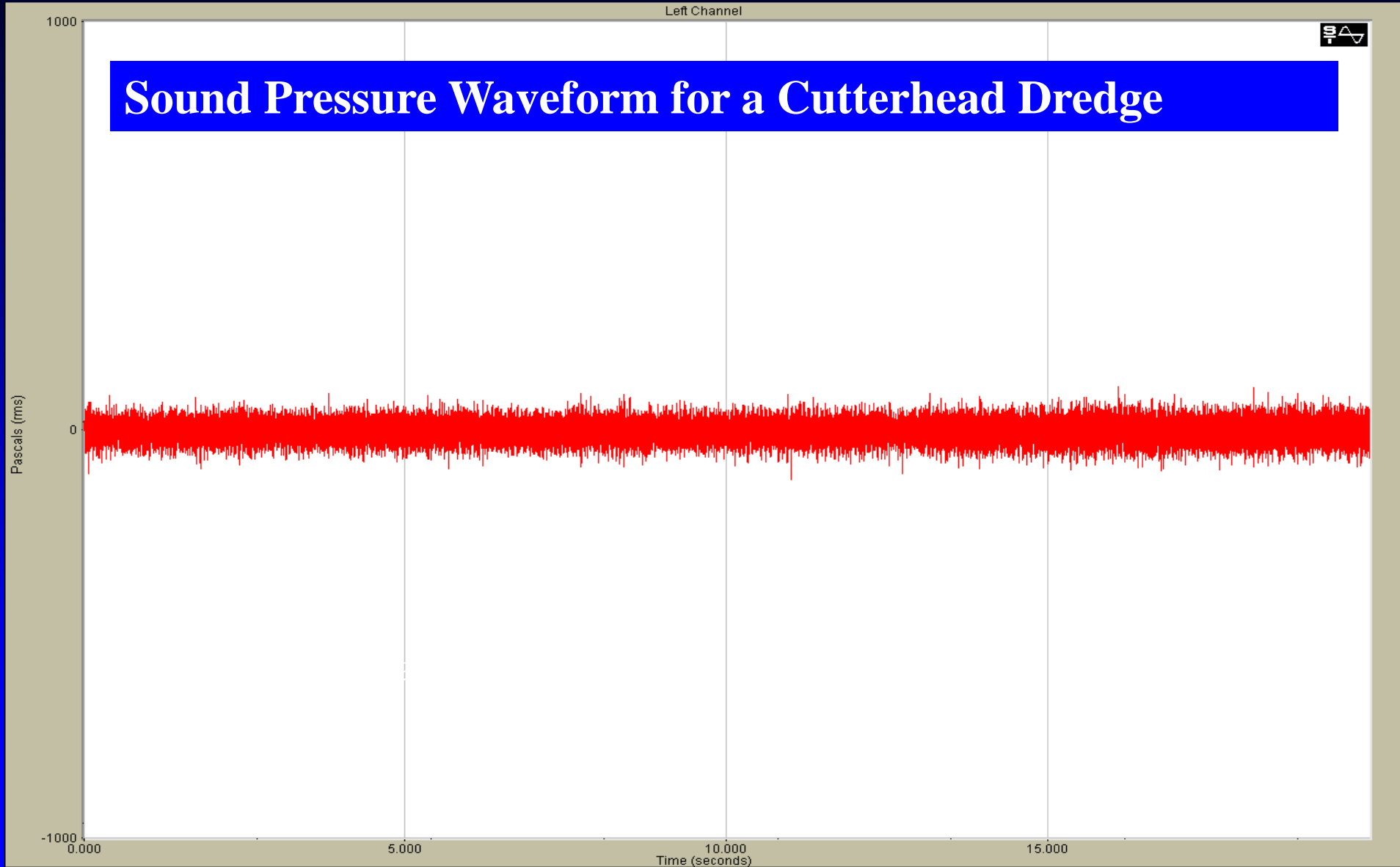
# Sound Pressure Attenuation with Distance from Bucket Dredge – Sound of Bucket Striking Channel Bottom



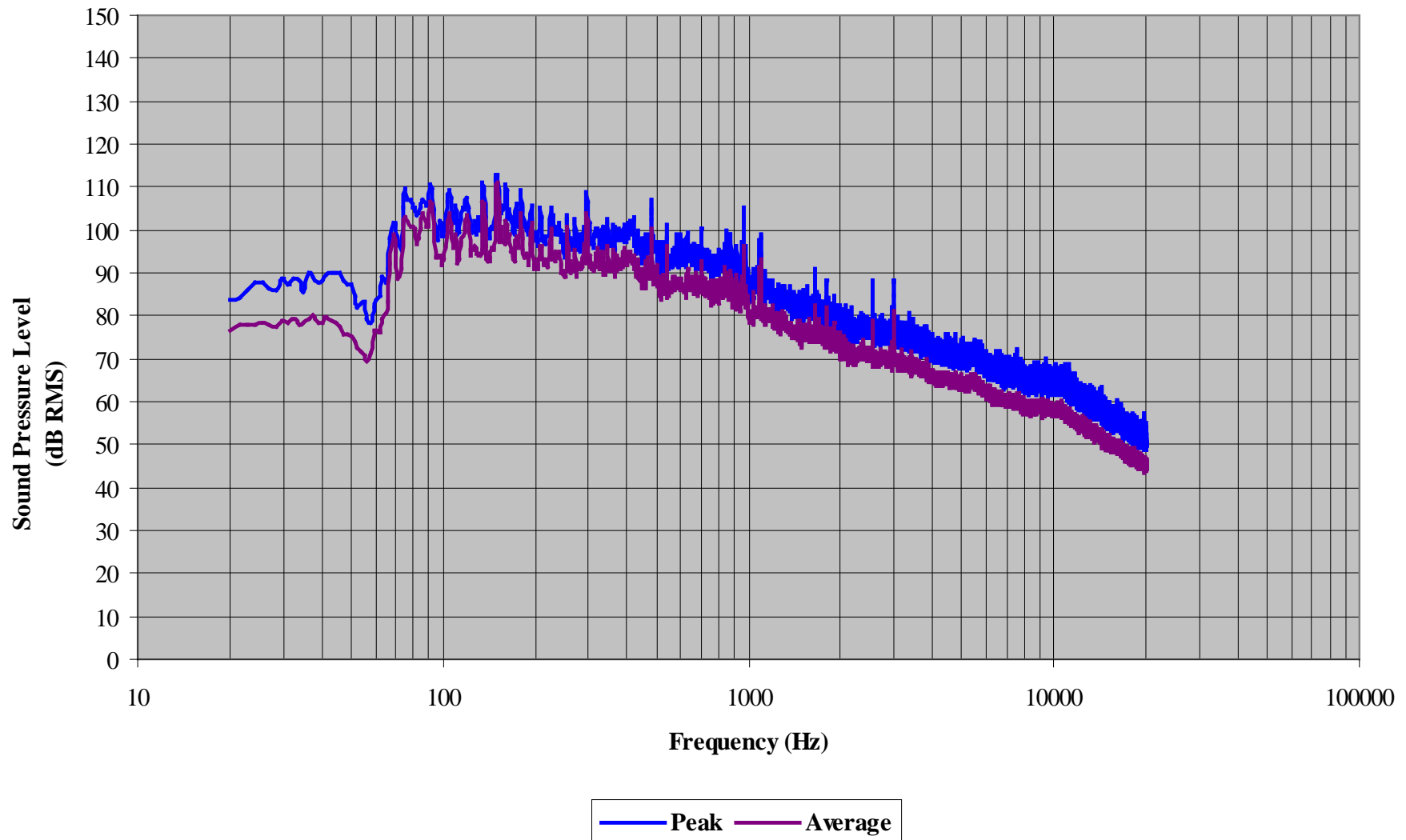


**LMC Hydraulic Cutterhead Dredge *James B* (24",  
10,000hp) Operating in Mississippi Sound off Gulfport, MS**

# Sound Pressure Waveform for a Cutterhead Dredge



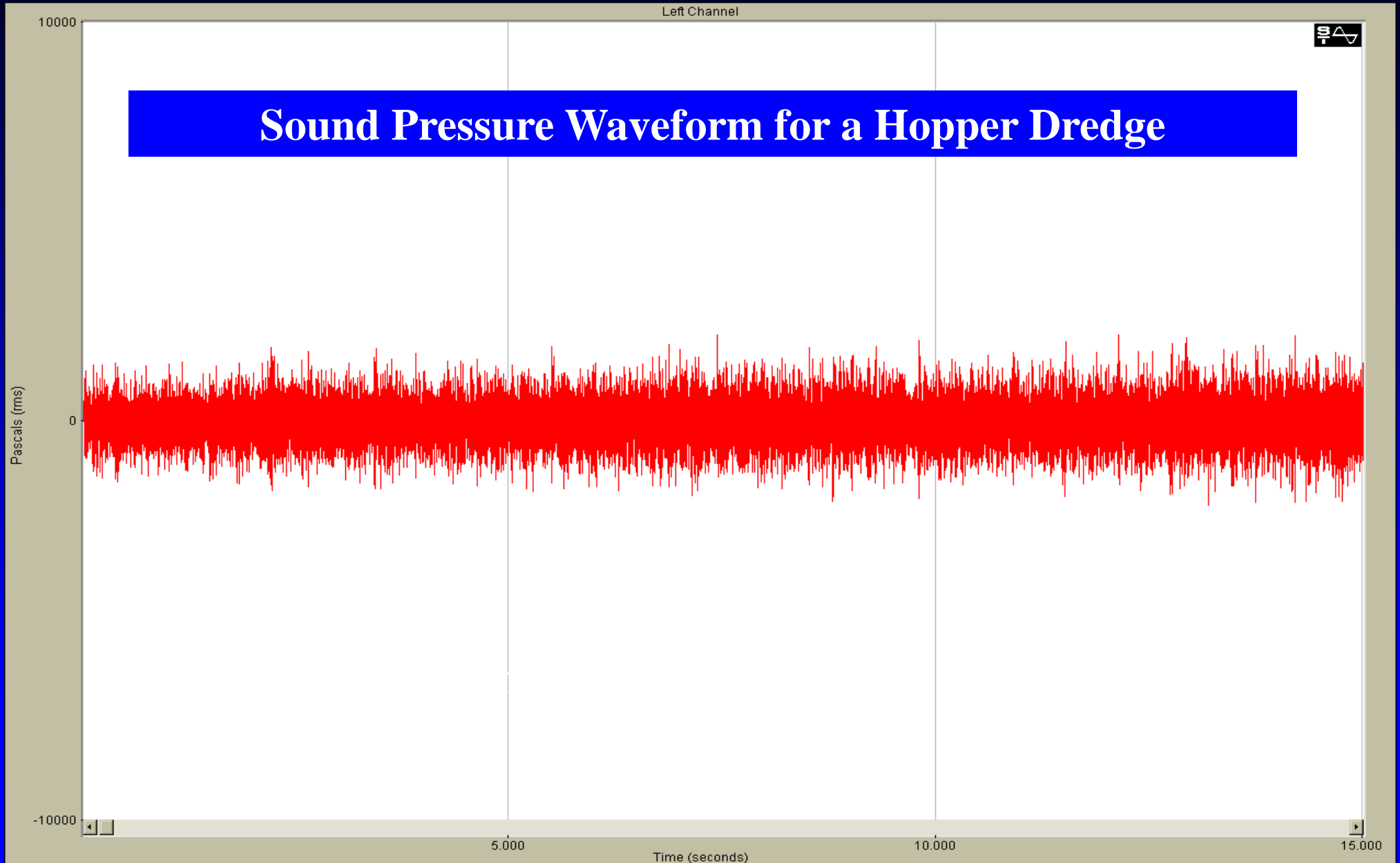
# Cutterhead Sound Pressure Levels



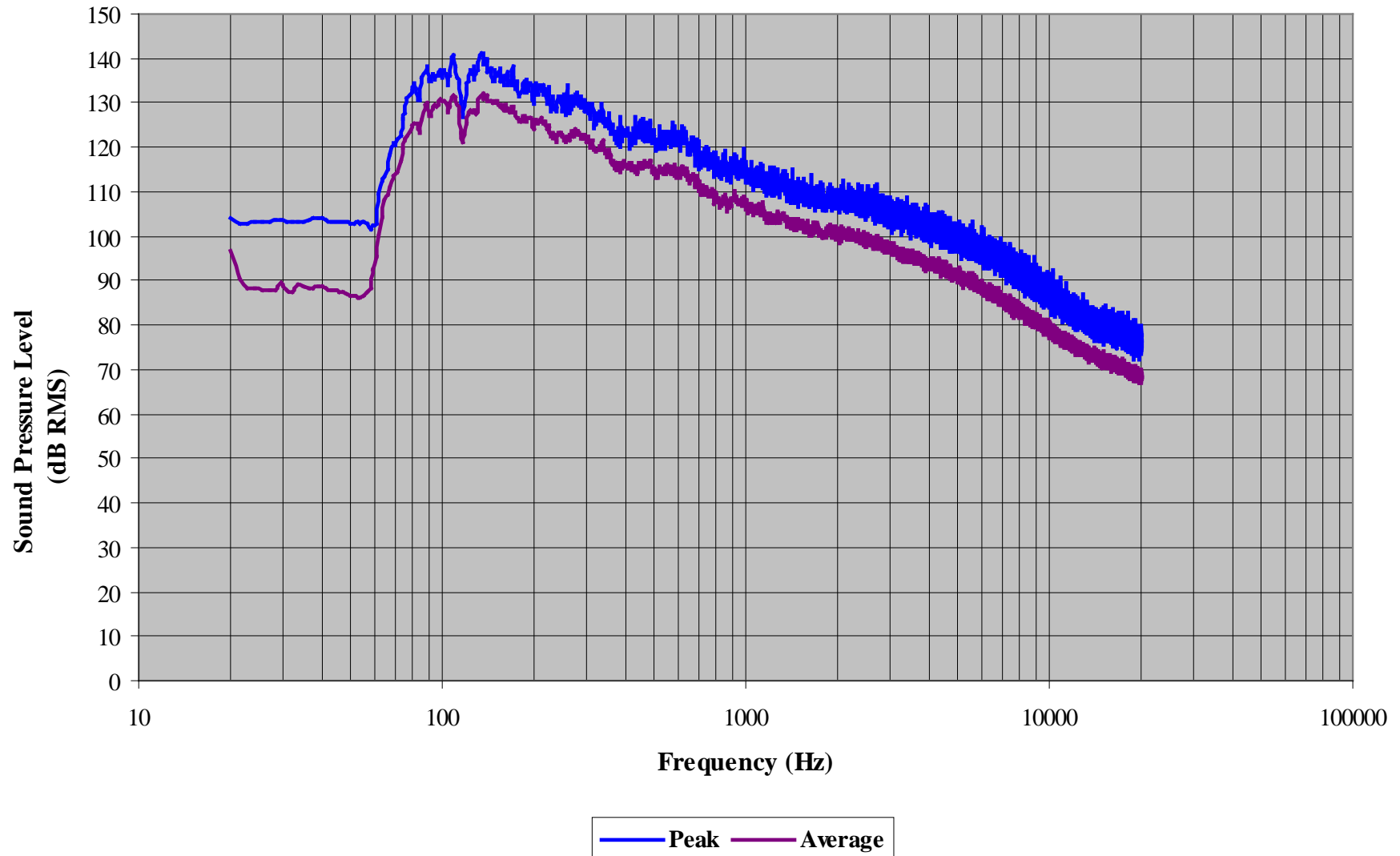


Bean Stuyvesant Hopper Dredge *Stuyvesant* (15,000hp, 11,140 cyd)  
Operating in Mobile Bay, Alabama

# Sound Pressure Waveform for a Hopper Dredge

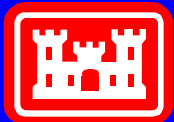


# Hopper Dredge Sound Pressure Levels



# Cutterhead vs. Hopper Dredge

- **24" Cutterhead at 68m**
  - Peak frequency ~ 150 Hz
  - Peak amplitude ~ 110 to 115 dB rms
  - Total power ~ 120 to 125 dB rms
- **15,000hp Hopper at 50m**
  - Peak frequency ~ 136 Hz
  - Peak amplitude ~ 132 to 145 dB rms
  - Total power ~ 148 to 155 dB rms



# Preliminary Conclusions

- **Bucket dredge**

- **Sounds cyclic**
- **Pressure levels largely dependent on substrate type, site conditions, and dredge operator**



- **Hopper Dredge**

- **Sounds continuous**
  - **Draghead and propulsion components**
- **Comparatively intense, low frequency sounds**

- **Hydraulic cutterhead dredge**

- **Sounds continuous**
- **Generally low intensity, low frequency**

# EXCAVATOR DREDGE *NEW YORK*

**WORST CASE SCENARIO?**



# Recommendations

- Build library of dredge process sounds representative of common dredging processes and scenarios
- Communicate findings with agencies and stakeholders before criteria are prematurely set
- With respect to turbidity/suspended sediment, shift emphasis from exposure assessment to effects assessment

