

***In Situ* Water Quality Monitoring During
Sediment Remediation Construction Activities
at the Denny Way CSO**



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Denny Way was the largest CSO in King County's system



- frequent overflows during rain events that exceeded system capacity
- average of 51 discharges/yr with 405 MG total volume/yr
- overflows during lower tides would discharge directly onto the beach
- system upgrade completed in 2005 and discharges moved offshore
- now designed to 1 untreated discharge/yr and 8 – 20 treated discharges/yr

Sediment Remediation

- legacy contamination at Denny Way site from CSO and other sources has required sediment remediation
- contaminated sediment were capped in 1990 and monitored for 10 years
- three offshore areas around cap currently being monitored for natural recovery
- one area inshore of cap required active remediation





Monitored Natural
Recovery Area C

Cleanup Areas A & B
Dredging Boundary

Elliott West/Denny Way Outfalls

Existing Sediment Cap

Monitored Natural
Recovery Area D

Monitored Natural
Recovery Area E

Areas A & B Nearshore Interim Sediment Cleanup Project

- 1.2 acres of contaminated sediment remediated
- mechanical dredging using clamshell bucket deployed from derrick barge – upland disposal
- 13,700 cy of sediment removed
- area backfilled with 14,500 cy well-graded clean sand and armored with 4,000 cy sandy-gravel habitat mix
- construction activities took place between 11/07 and 02/08





Water Quality Monitoring Required During All Construction Activities

- **Ecology required monitoring for turbidity and dissolved oxygen**
- Turbidity - *“Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.”*
- Dissolved Oxygen – *“Excellent quality . . . 6.0 mg/L . . . When a water body’s D.O. is lower than the criteria in Table 210 (1)(d) (or within 0.2 mg/L of the criteria and that condition is due to natural conditions), then human actions considered cumulatively may not cause the D.O. of that water body to decrease more than 0.2 mg/L.”*
- **Chapter 173-201A WAC**

***In situ* water quality monitoring using stationary buoy**

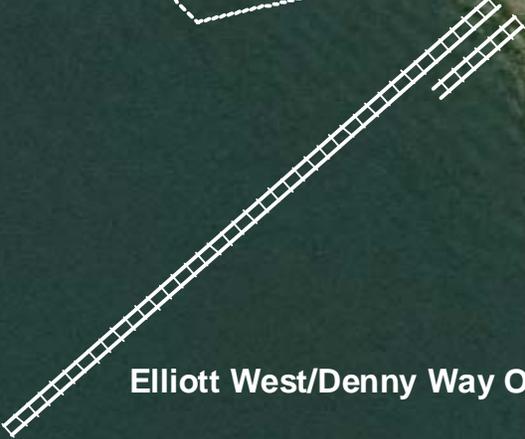


- preferred over once-daily discrete sampling with laboratory analysis
- less labor intensive
- real-time data
- web-accessible to all project staff

Water Quality Monitoring Buoy 

Dredging Boundary

Net Current Flow 

Elliott West/Denny Way Outfalls 



100 0 100 200 Feet

Equipment Used

YSI 6600EDS Multi-Parameter Sondes

Specifications for the YSI 6163 Turbidity Probe are:

- Range of 0 to 1,000 nephelometric turbidity units (NTU).
- Resolution of 0.1 NTU.
- Accuracy of $\pm 2\%$ or 0.3 NTU.

Sound Ocean Systems, Inc. (SOSI) Offshore Data Buoy

SOSI ODB-48-1500 buoy body with the following:

- Aluminum mast with sensor mounting plates.
- Autonomous mast light and radar reflector.
- Antifouling paint and rubber “rub-rails” at two heights.
- Cable fittings.

Water Quality Monitoring System

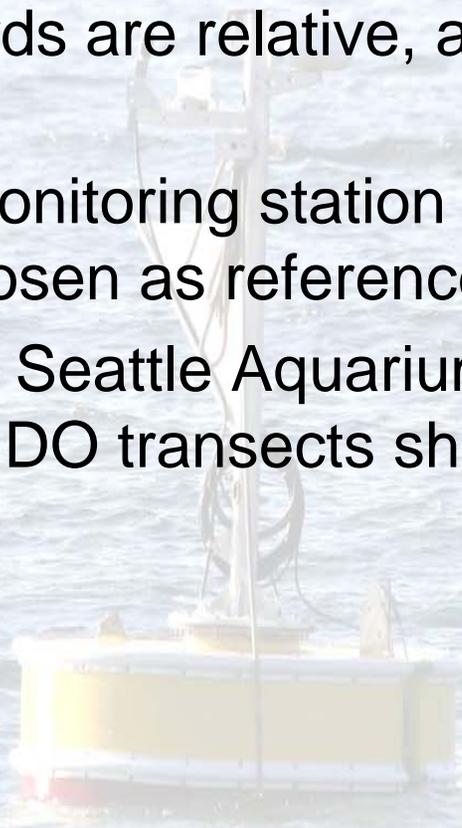
- water quality monitoring sensors mounted on a buoy at the construction site
- high-frequency data averaged every 15 minutes and uploaded through telemetry to a website
- water quality criteria for both turbidity and dissolved are relative to background
- reference station was established as a permanent sensor installation at the Seattle Aquarium

YSI Data Sonde



Reference Station

- since WQ standards are relative, a reference station was needed
- permanent WQ monitoring station installed at Seattle Aquarium was chosen as reference
- Ecology accepted Seattle Aquarium as reference station after turbidity and DO transects showed acceptable data



Water Quality Monitoring Buoy



Net Current Flow



Seattle Aquarium ●
Reference Station

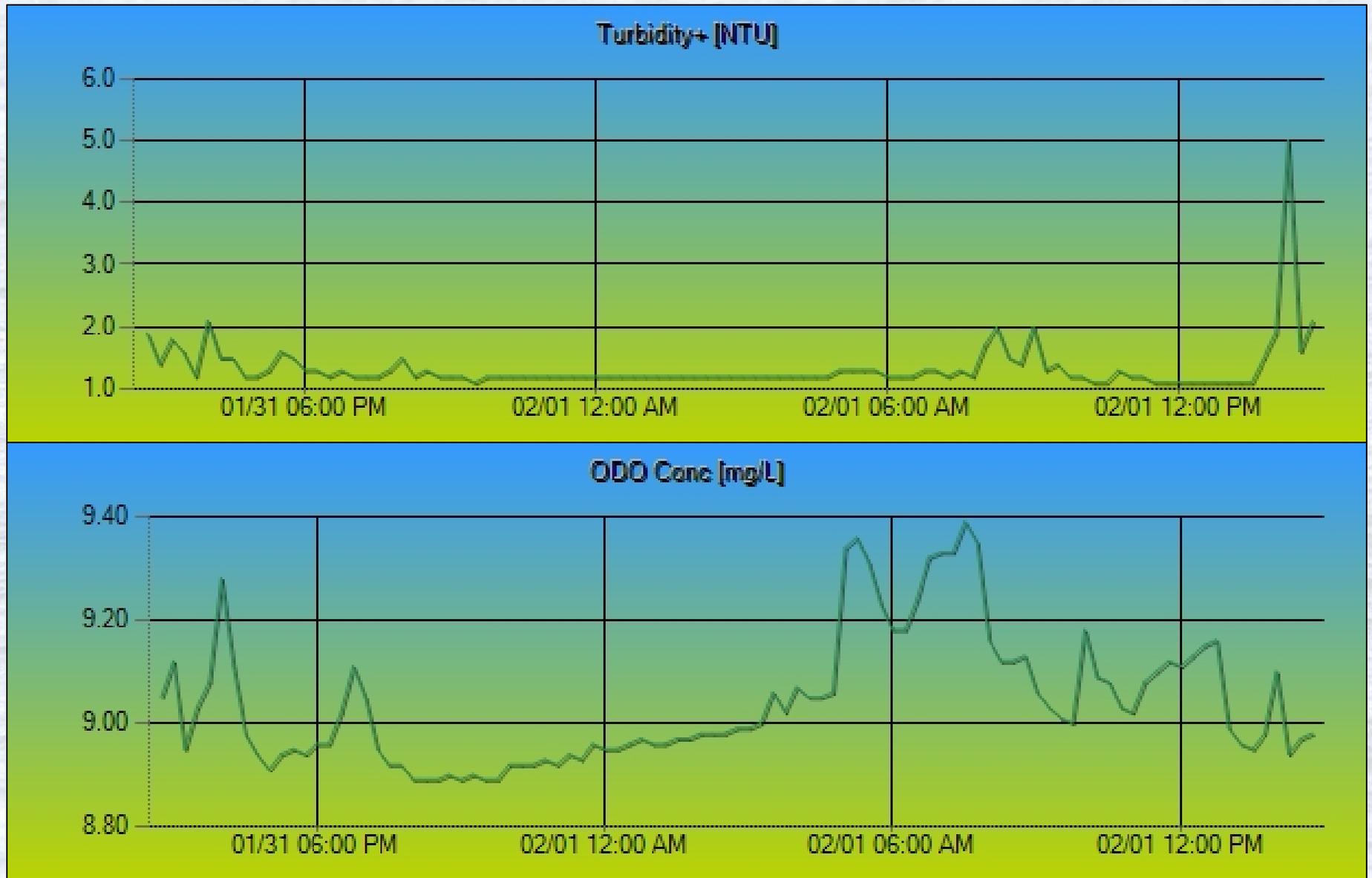
Seattle Aquarium Reference Station



Field Activities

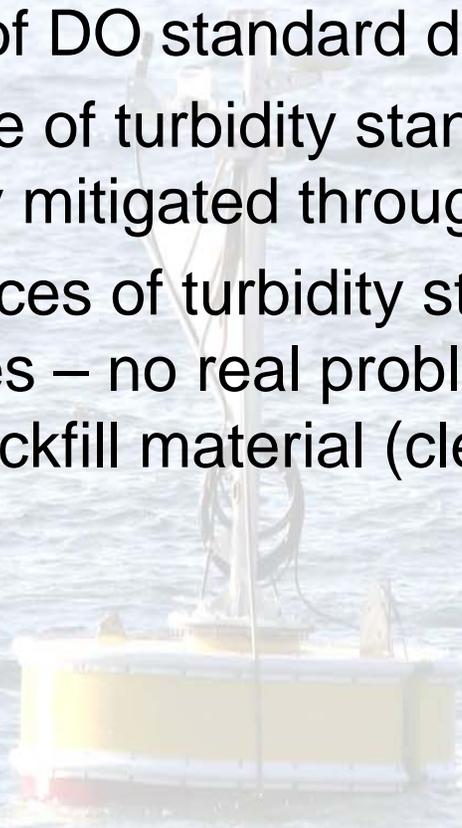
- monthly maintenance included cleaning and changing O-rings
- dissolved oxygen calibrated monthly in water-saturated air
- turbidity calibrated monthly to 0 and 10 NTU standards of RO water and formazin.
- QC included collection of water samples for laboratory analysis of dissolved oxygen (Winkler) and turbidity.
- routine QC performed weekly.
- more-frequent QC dictated by field supervisors and project managers as warranted by *in situ* instrument readings

24-Hour Snapshot of Water Quality Data



Exceedences

- no exceedences of DO standard during entire project
- only 1 exceedence of turbidity standard during dredging activities – quickly mitigated through use of BMPs
- several exceedences of turbidity standard during backfilling activities – no real problem – due to amount of fine material in backfill material (clean)



Benefits

- actual monitoring of real-time water quality during construction activities
- real time construction management and implementation of BMPs
- acceptance by all project staff and consultants
- acceptance by Ecology
- positive reception with People for Puget Sound
- positive press
- requests for use on other projects

Positive Press

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LOCAL

Wednesday, December 12, 2007
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No Duwamish debacle in Elliott Bay

Work on removal of toxic materials going well

By [ROBERT McCLURE](#)
P-I REPORTER

When scientists a few years ago discovered a female reproductive protein in male fish off Myrtle Edwards Park, well, let's just say that they didn't consider it a good sign. It's as if a male chicken produced egg yolk.

It was happening right where hundreds of millions of gallons of raw sewage and polluted rainwater had gushed out of a massive pipe into Elliott Bay over the years. Scientists wondered: Could hormones in women's urine or birth control pills be at work?

No one really knows.

But now King County has launched a cleanup of toxic goop on the bay bottom. ~~In contrast to a botched cleanup in the Duwamish River in 2003-04, the work in Elliott Bay is going well, county and state officials say.~~

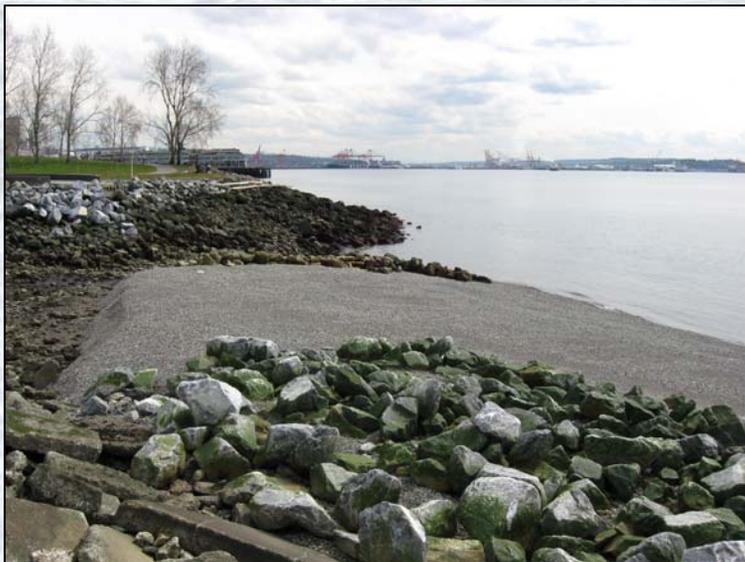


 [zoom](#) PAUL JOSEPH BROWN / P-I

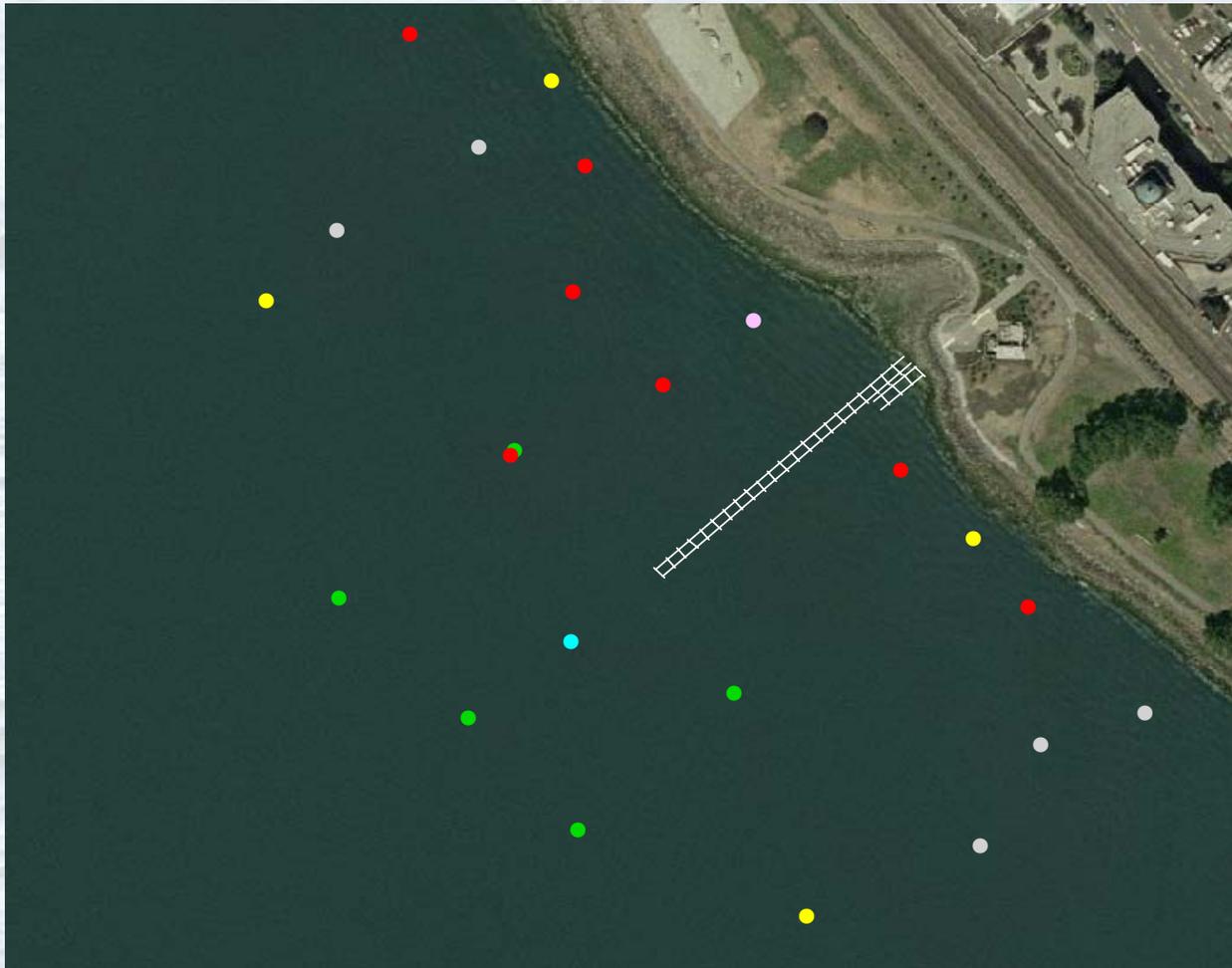
About an acre of sediment is being dredged just off Myrtle Edwards Park as part of efforts to remove contamination from combined sewer outfalls.

<http://anad.tacoda.net/ads/ad12047a-map.cgi/SZ=160X600A/V=2.1S/BRC=24543/BCPG41206.6530>

Site After Remediation



Denny Way Sampling Stations



- A and B Cleanup (0 to 10 cm)
- Biological Opinion (0 to 10 cm)
- Biological Opinion/NPDES (0 to 2 cm)
- Biological Opinion/MNR (0 to 10 cm)
- Biological Opinion/MNR/NPDES (0 to 2 and 0 to 10 cm)
- Biological Opinion/A and B Cleanup (0 to 10 cm)



400 0 400 800 Feet

Buoy Comes Out for a New Adventure



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