www.geosyntec.com

Savannah River Dredging and Dissolved Oxygen Constraints

Engineering With Nature: Designing Navigation Infrastructure for Greater Environmental Sustainability

September 7-8, 2011

Russell Short – Geosyntec Consultants
Jeffrey Green – El Paso Southern LNG
Kwasi Badu-Tweneboah – Geosyntec Consultants

Geosyntec consultants

engineers | scientists | innovators

Discussion topics

- Recently secured maintenance dredging permits for a ship slip and turning basin (18 months vs 5 years)
- Dissolved oxygen constraints contained in the EPA Savannah River Draft TMDL and implications for sustainable operations
- Field investigation to evaluate dissolved oxygen conditions in Savannah River
- Review of potential adverse affects

Recent Maintenance Dredging Permitting Experience

- Submitted 2 permit renewal applications for annual maintenance dredging of ~1.2 M cubic yards on the Savannah River by hydraulic dredge with on site disposal in an upland CDF
- Prepared a Tier II sediment report which confirmed there were no sediment quality issues - samples obtained with a vibracore
- ESA issues – shortnose sturgeon and manatee
- EFH issues – general habitat quality
  - Dissolved oxygen constraints were the most significant permit issue directly related to maintaining berth and navigation infrastructure

Dissolved Oxygen Constraints

- Draft TMDL for Dissolved Oxygen from EPA Region 4
  - Based on South Carolina and Georgia DO standards
- SCDHEC and GEPD were considering imposing a DO threshold of 4 mg/L below which no dredging could occur
- Permit conditions were also to include a “No Dredge” window for June – September because of anticipated DO levels
- No data was available to define natural conditions at permit locations

Potential TMDL DO Targets

- *The initial TMDL target established during the critical period based on **a daily average delta DO of 0.1 mg/L** for Georgia only waters and 0.10 mg/L for waters that are in South Carolina when Harbor waters naturally fall below 5 mg/L.*
- *A 0.1 mg/L Delta DO target for all harbor waters naturally below 5 mg/L. This target would be available if and when South Carolina changes the applicable Delta DO standard from 0.10 mg/L to 0.1 mg/L.*
- *An "**up to 10%**" deficit DO TMDL target established based on a demonstration, acceptable to the States, that resident **aquatic species will not be adversely affected**. Such a target would allow for a delta DO range of greater than 0.1 mg/L up to 0.35 mg/L. Under such a scenario, the TMDL calculator can be used to determine the appropriate NPDES limits.*

Evaluation of Dissolved Oxygen Natural Conditions

- Collected water quality measurements at six locations across the river commencing in the Ship Slip and ending at the Turning Basin
- Field events began in mid-June and occurred at ~2 week intervals
- Recorded data at 5 feet depth intervals beginning at -5 ft and continuing to near bottom
- Measurements were collected with a YSI 600 XLM V2 ODO sensor or a YSI 8290 V2 ODO sensor
- Parameters included: DO, temperature, conductivity

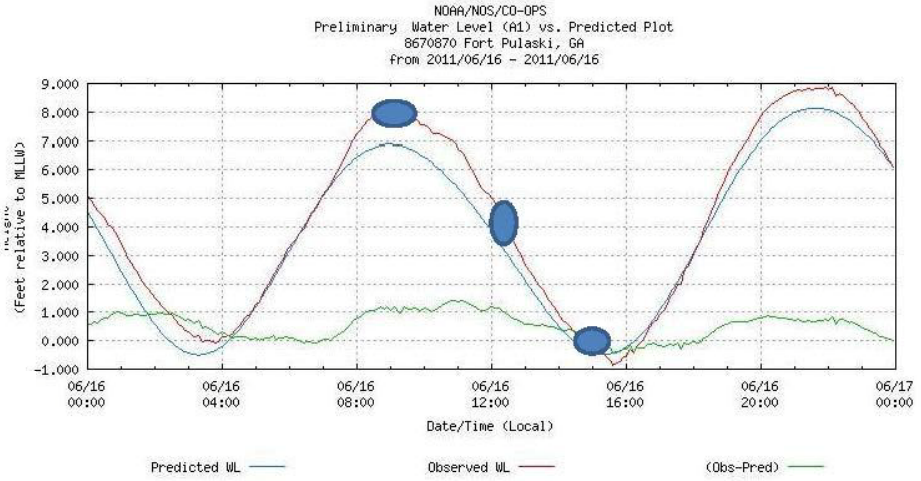
Six Locations

Water Column Measurements

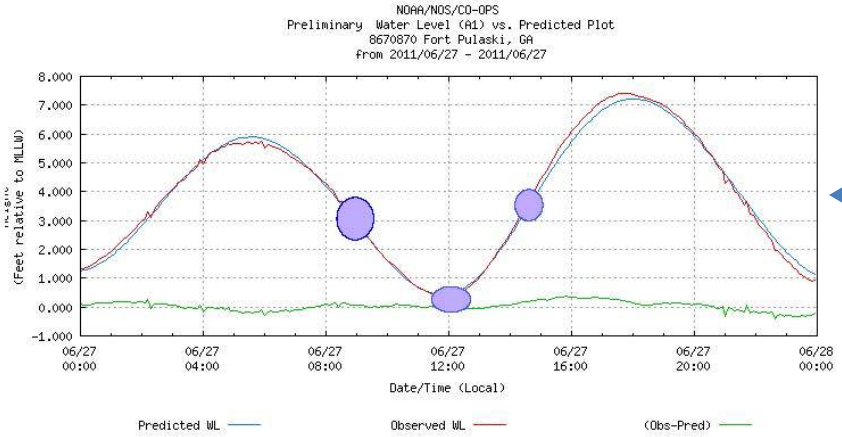
- Three data collection runs were conducted per day
- Each run required around 45 minutes to complete
- Covered various tidal stages
- Each run obtained ~ 47-50 readings each of DO, temperature, and conductivity per data run
- Completed runs on - June 16, June 27, July 13, July 25, August 9, August 26 (not included)
- Data from July 13 was rejected as a result of equipment failure
- Planned dates – September 13 and 28

Typical Tidal Data Collection Sequence.

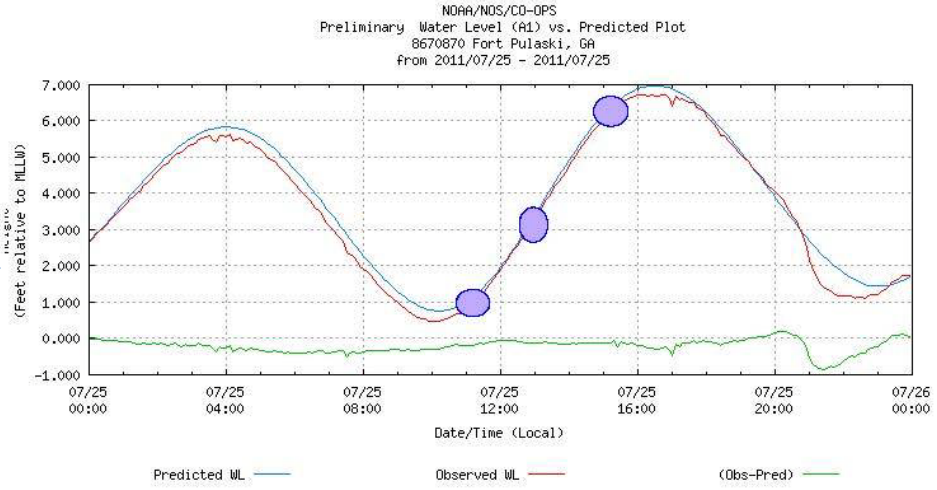
June 16



June 27



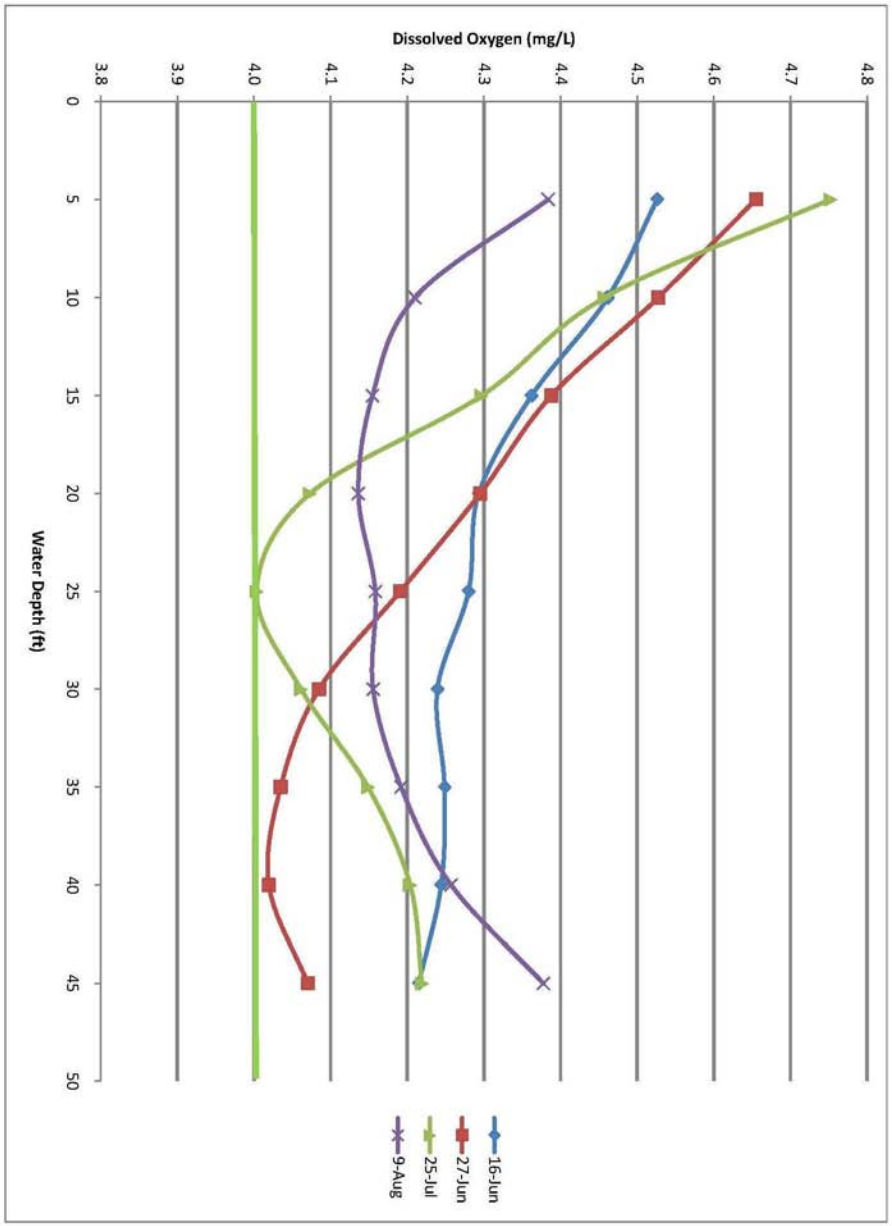
July 25



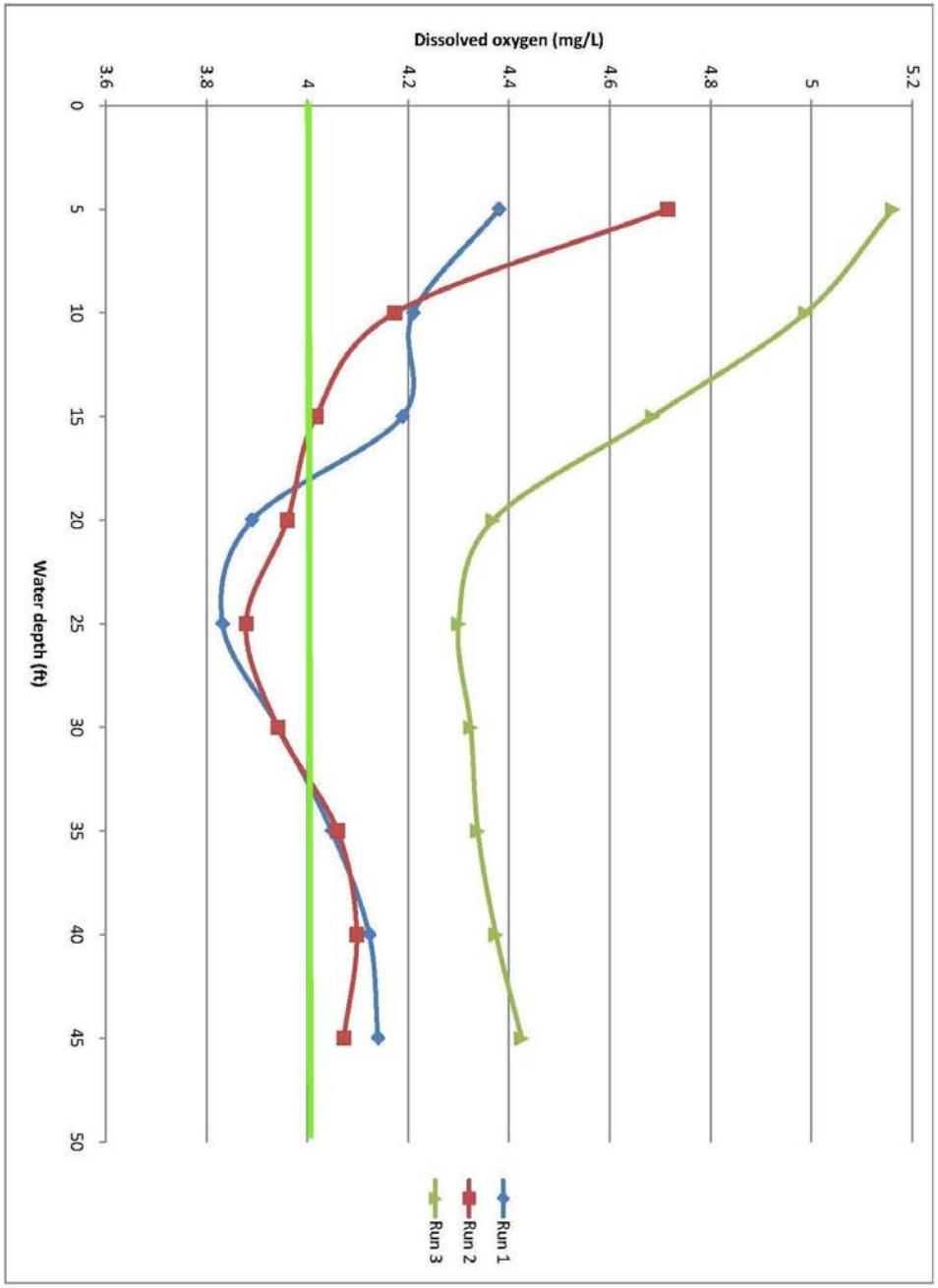
Daily Water Column Average DO

Date	Ave DO (mg/L)	STD	Confidence Interval	α, sample size	Ave Temp (C)	Ave Salinity (psu)
6/16	4.3	0.35	0.1	0.05, 144	29.0	NA
6/27	4.3	0.34	0.1	0.05, 147	29.6	24.6
7/25	4.3	0.43	0.1	0.05, 146	29.5	22.9
8/9	4.2	0.40	0.1	0.05, 144	30.1	19.0

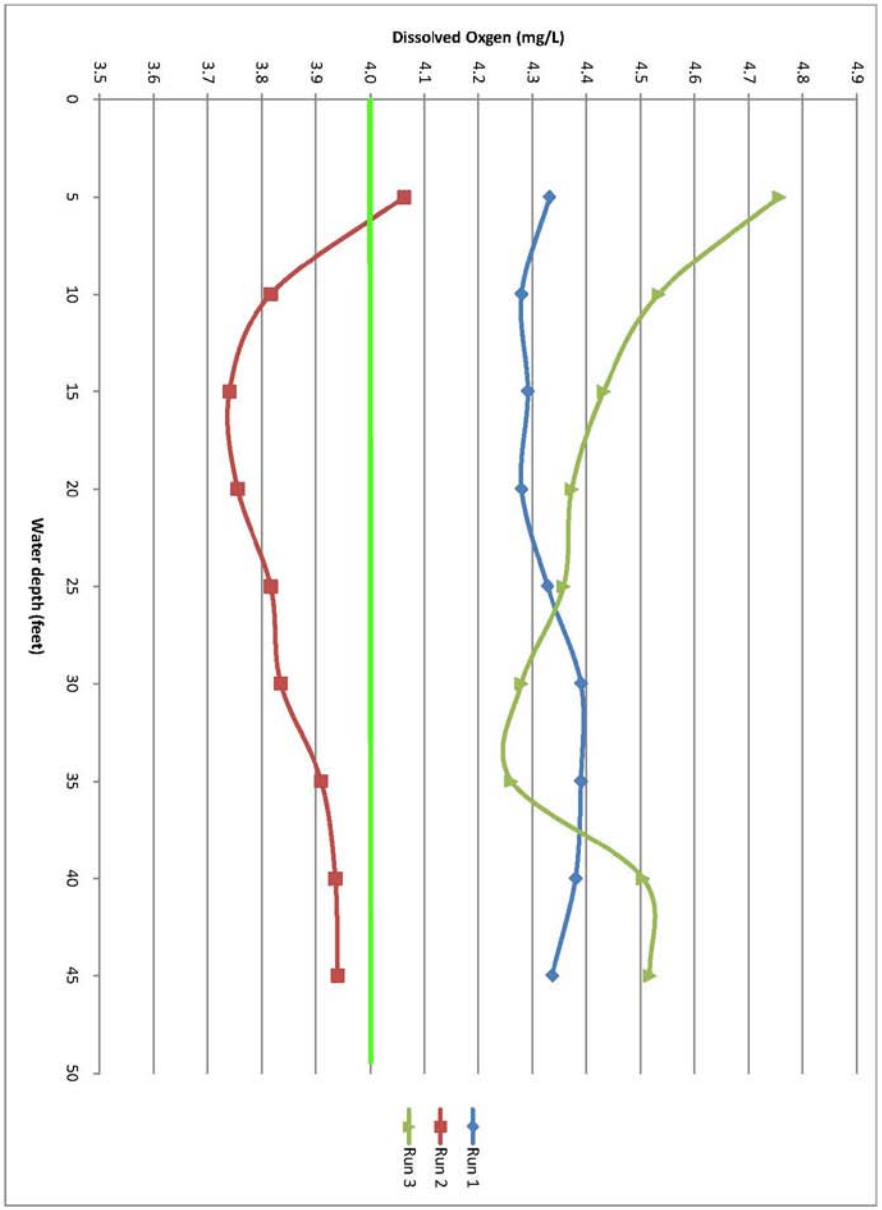
Daily Average DO
Vertical Profiles For Individual Depth Intervals
3 Runs Combined Each Day



July 25
Average DO
Vertical Profiles
3 runs



August 9
Average DO
Vertical Profiles
3 runs



Average DO Concentrations Bottom Waters 3 Runs Combined

		Water Depth (ft)		
		35	40	45
16-Jun	Average DO	4.2	4.2	4.2
	Standard Deviation	0.21	0.16	0.16
	Confidence interval	0.1	0.1	0.1
	Sample size	15	14	12
27-Jun	Average DO	4.0	4.0	4.1
	Standard Deviation	0.16	0.17	0.15
	Confidence interval	0.1	0.1	0.1
	Sample size	15	15	13
25-Jul	Average DO	4.1	4.2	4.2
	Standard Deviation	0.17	0.16	0.18
	Confidence interval	0.1	0.1	0.1
	Sample size	15	14	11
9-Aug	Average DO	4.2	4.3	4.4
	Standard Deviation	0.36	0.36	0.33
	Confidence interval	0.2	0.2	0.2
	Sample size	16	14	8

What Are Adverse Effects As Identified in the Draft TMDL?

- Several laboratory studies have
  - Evaluated gill ventilation rates
  - Assessed predation rates
  - Measured survival
- Studies focus on a variety of organisms and physiological responses at exposure concentrations from 2.0 mg/L to 4 mg/L

Dissolved Oxygen Effects Studies

- Breitburg et al 2003
  - Striped bass larvae LC50 – DO level 2.4 mg/L
- Breitburg et al 1994
  - Naked goby and striped bass predation and gill ventilation rates study- predation lower between 2-3 mg/L
- Jenkins et al 1993
  - Shortnose sturgeon
    - 2.0 mg/L all ages had significance mortality
    - 2.5 mg/L various effects 86%-100% mortality (25-64 days old)
    - 3 mg/L fish > 77 day no adverse affects

Summary

- DO average concentration >4.0 mg/L (June-August 2011)
- Daily average delta DO may not cover “natural conditions”
- Realistically “up to 10%” should be expanded to 0.4 mg/L
- Finally it appears that adverse affects fall below 3.0 mg/L

Options To Reduce DO Limitations On Dredging

- SedCon – hydraulically driven turbo “stirrer” – half a U tube that directs a current along the bottom to keep sediment in suspension
  - http://www.sedcontech.com/
- Bubble curtain – pneumatic barrier system – air is pumped into a distribution system on the bottom and maintains particles in suspension
  - http://www.state.nj.us/transportation/airwater/maritime/pdf/whitepaper.pdf

References

- Breitburg, D., N. Steinberg, S. duBeau, C. Cooksey, E. Houde. 1994. Effects of low dissolved oxygen on predation of estuarine fish larvae. Marine Ecology Progress Series. Vol. 104:235-246.
- Breitburg, D., A. Adamack, K. Rose, S. Kolesar, M. Decker, J. Purcell, J. Keister, and J. Cowan. 2003. The pattern and influence of low dissolved oxygen in the Patuxent River, a seasonally hypoxic estuary. Estuaries. Vol. 26. No. 2A. P 280-297.
- Jenkins, W., T.I. Smith, L. Heyward, and D. Knott. 1993. Tolerance of shortnose sturgeon *Acipenser brevirostrum*, juveniles to different salinity and dissolved oxygen concentrations. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 47:476-484.

Questions