Addendum to

Quality Assurance Project Plan: South Puget Sound Water Quality Study, Phase 2: Dissolved Oxygen

August 2007

Publication Number 07-03-101ADD#1

Publication Information

Addendum

This addendum is available on the Department of Ecology's website at
www.ecy.wa.gov/biblio/0703101ADD#1.html.

Original Publication

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August 19, 2007

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SUBJECT: **ADDENDUM TO THE QUALITY ASSURANCE PROJECT PLAN FOR THE SOUTH PUGET SOUND WATER QUALITY STUDY, PHASE 2: DISSOLVED OXYGEN**

PROJECT CODE: 06-509-01
PUBLICATION NO: 07-03-101ADD#1

The Washington State Department of Ecology (Ecology) began a study of low dissolved oxygen levels in South Puget Sound in August 2006 (Albertson et al., 2007). The purpose of this study is to determine how nitrogen from a variety of sources affects dissolved oxygen levels. The project includes data collection, model development and application, and a final report documenting findings.

This addendum to the Quality Assurance Project Plan summarizes additional field collection necessary to characterize the current velocity fields at key locations within the study domain. The complex morphology of South Puget Sound produces limited circulation in many inlets, and circulation is fundamental to simulating nutrient and dissolved oxygen dynamics. Therefore, this program will provide additional information with which to understand circulation and currents in South Puget Sound.

Experimental Design

Acoustic Doppler Current Profilers (ADCPs) will be used to determine the current vector fields at key locations in Budd, Totten, Eld, Carr, and Case Inlets in summer and fall 2007. Current data will be used both qualitatively and quantitatively. The initial transects will be used to select locations for bottom-mounted deployments based on the heterogeneity or homogeneity of current patterns. The transects also will provide mass fluxes of water with which to compare model output. The bottom-mounted deployments will be used to understand temporal current patterns during the critical, late-summer conditions when dissolved oxygen levels are lowest.

Transects

Transects will focus on three inlets with low dissolved oxygen levels (Budd, Carr, and Case) as well as two inlets that tend to have moderate dissolved oxygen levels (Eld and Totten). Figures 1 and 2 identify locations for the transects, to be completed on a rising tide between July 10 and 13. The time period was selected to provide unidirectional flow and a large tidal exchange during daylight hours to maximize the number of hours available for the surveys.

Table 1 summarizes the high and low tides for the period of interest, and the time available for transects. Expected work areas are listed for each day, but the area targeted may shift due to weather conditions. For example, because of the exposure of Carr Inlet and the water depths, calm wind conditions are needed to maximize usability of the data. The Budd, Totten, and Eld transects tend to be more sheltered and could substitute on a windier day.

Table 2 provides the latitude and longitude for the ends of each transect as well as the maximum depth expected. One transect, Carr1, likely will exceed the capabilities of the bottom-tracking abilities of the ADCP, in which case the spatial patterns and current magnitudes will be available for the top 100 m of the water column only. However, the transect will provide the opportunity to determine the maximum depth achievable by the equipment.

Each transect will consist of a single pass, beginning and ending as near to shore as possible. On each day, two passes will be conducted at least once to provide a quality check on the initial pass and to quantify the potential error. Transects for the double passes are identified in Figures 1 and 2 with a red circle. These were selected as the most important sites in each region for which highly accurate data are needed.

Deployments

Bottom-mounted ADCPs will be deployed at sites selected based on the initial July transects. At each location, units will be deployed in water depths up to 100 m, or to the maximum depth achievable, equipped with acoustic release for retrieval. The units will be retrieved after 30 days, downloaded, and deployed at supplemental sites as needed. Locations will be selected to resolve circulation questions and to provide model input.

Intended Use

The first step in verifying that the hydrodynamic model is functioning is a comparison against water surface elevations at known or estimated tide stations. To supplement that step, the water mass fluxes determined from the initial transects will be compared with model output data as a secondary check on predicted circulation. The transects also will be used qualitatively to determine the two-dimensional complexity of current vectors at the mouths of several inlets. Finally, the transects will be used to select locations for bottom deployments.

The information developed from the bottom deployments will be used for two purposes. First, units likely will be deployed around Hartstene Island to record flow direction and magnitude and to compare with coincident wind data. The ADCP data will help understand how circulation in this portion of South Puget Sound responds to wind patterns. Second, for units deployed in specific inlets, the bottom deployments will be used to understand temporal patterns in current fields.

Quality Objectives

Measurement Quality Objectives

Field measurement objectives are difficult to establish because replicate samples cannot be calculated for ADCP transects or bottom deployments. However, for the transects with a double pass, we will compare the two estimates of mass flux and target a precision, based on the relative standard deviation, of 10%. Pilot studies conducted in June 2007 indicated that the variability is <5% between runs at high volume sites (e.g., Dana Passage). Bias is not an applicable measure. The lowest value of interest is 0.05 m/s.

Representativeness

This study is designed to collect data that adequately represents the current velocity at key locations. Tidal conditions and work hours were selected to provide unidirectional flow to minimize shifting eddies that may occur with changes in tide direction, and areas with well developed eddies were avoided.

Completeness

The completeness target for this field study is 90%. Reasons why all data may not be collected include:

- Severe weather that precludes seagoing vessels from sailing. To mitigate this, Ecology has scheduled backup dates for the transects.

- Malfunctioning equipment. To minimize risk, Ecology will ensure equipment is well maintained and will verify functionality prior to deploying in the field.

Comparability

Only Ecology staff will conduct the ADCP surveys using a single crew to maximize comparability among field days.

Sampling and Measurement Procedures

Appendix A includes field notes for the deployment of ADCPs. We will use Workhorse Sentinel ADCPs, manufactured by Teledyne RD Instruments, operating at a frequency of 300 kHz. The units will record 1.5 minutes of pings that will be ensemble averaged and saved at 6-minute intervals.

Quality Control

At a subset of transects, one on each day, a second return transect will be followed and the results compared to the initial transect. The relative standard deviation of the mass flux cannot be determined in the field. If post-processing indicates a difference >10% that cannot be explained by a change in the tidal velocity between runs, the results will be flagged as estimates.

Data Management Procedures

Current vectors will be downloaded and stored from the proprietary ADCP software using Matlab code written by Ecology to interface with the software. The vector field will be stored in its components in an Access database. Supplemental field information will be recorded in field notebooks.

Audits and Reports

A quality assurance assessment will be conducted prior to using the data for analysis, and the results will be included in the final report for this project.

Data Verification and Validation

Mass fluxes will be verified and validated in accordance with the project Quality Assurance (QA) Project Plan.

Data Analysis and Use

This program will follow the procedures for data analysis and use as outlined in the project QA Project Plan.

Organization

The following responsibilities are in addition to those outlined in the project QA Project Plan:

- Skip Albertson, Marine Monitoring Unit. ADCP field lead and program designer.
- Ken Peer, Marine Monitoring Unit. ADCP field assistant.
- Dale Norton, Statewide Assessments Unit. R/V Skookum skipper.
- Randy Coots, Statewide Assessments Unit. R/V Skookum skipper.
- Greg Pelletier, Modeling and Information Support Unit. Data reviewer and program designer.
- Mindy Roberts, Modeling and Information Support Unit. Data reviewer and program designer.

Project Deliverables and Schedules

Results will be included with the overall project data report, as outlined in the project QA Project Plan. Field work will be conducted between July and October 2007, with the initial transects in July 2007 and in situ deployments from August through October 2007.

References

Albertson, S. L., J. Bos, K. Erickson, C. Maloy, G. Pelletier, and M. Roberts. 2007. South Puget Sound Water Quality Study Phase 2: Dissolved Oxygen, Quality Assurance Project Plan. Washington State Department of Ecology Publication No. 07-03-101.

Attachments: Figure 1
Figure 2
Table 1
Table 2
Appendix A

cc: Skip Albertson, Marine Monitoring Unit, Environmental Assessment Program
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Ryan McEliece, Marine Monitoring Unit, Environmental Assessment Program
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Bill Kammin, Ecology Quality Assurance Officer
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Figures and Tables

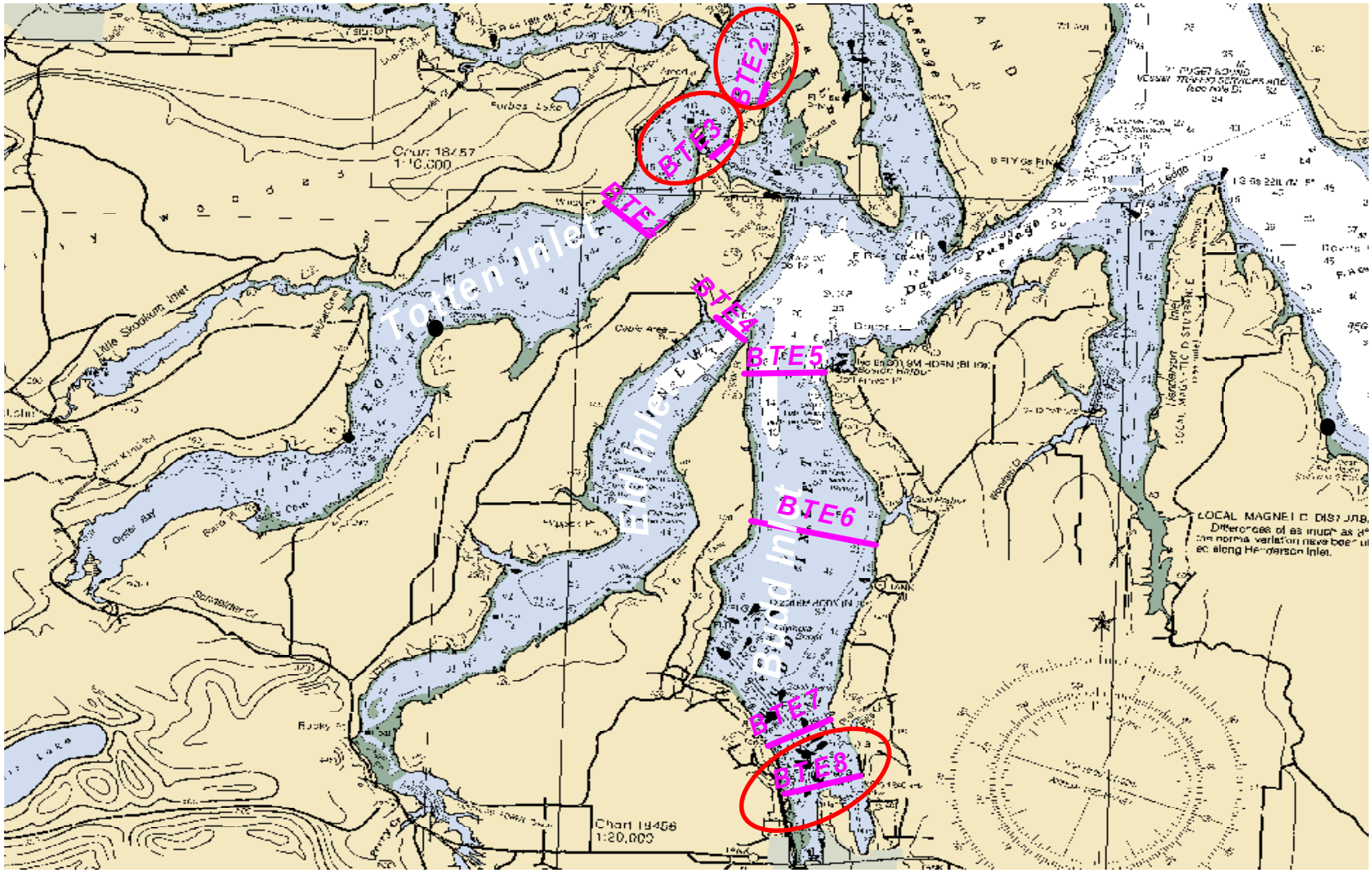

Figure 1. Transect locations in Budd, Totten, and Eld Inlets. Transects circled in red will have double passes.

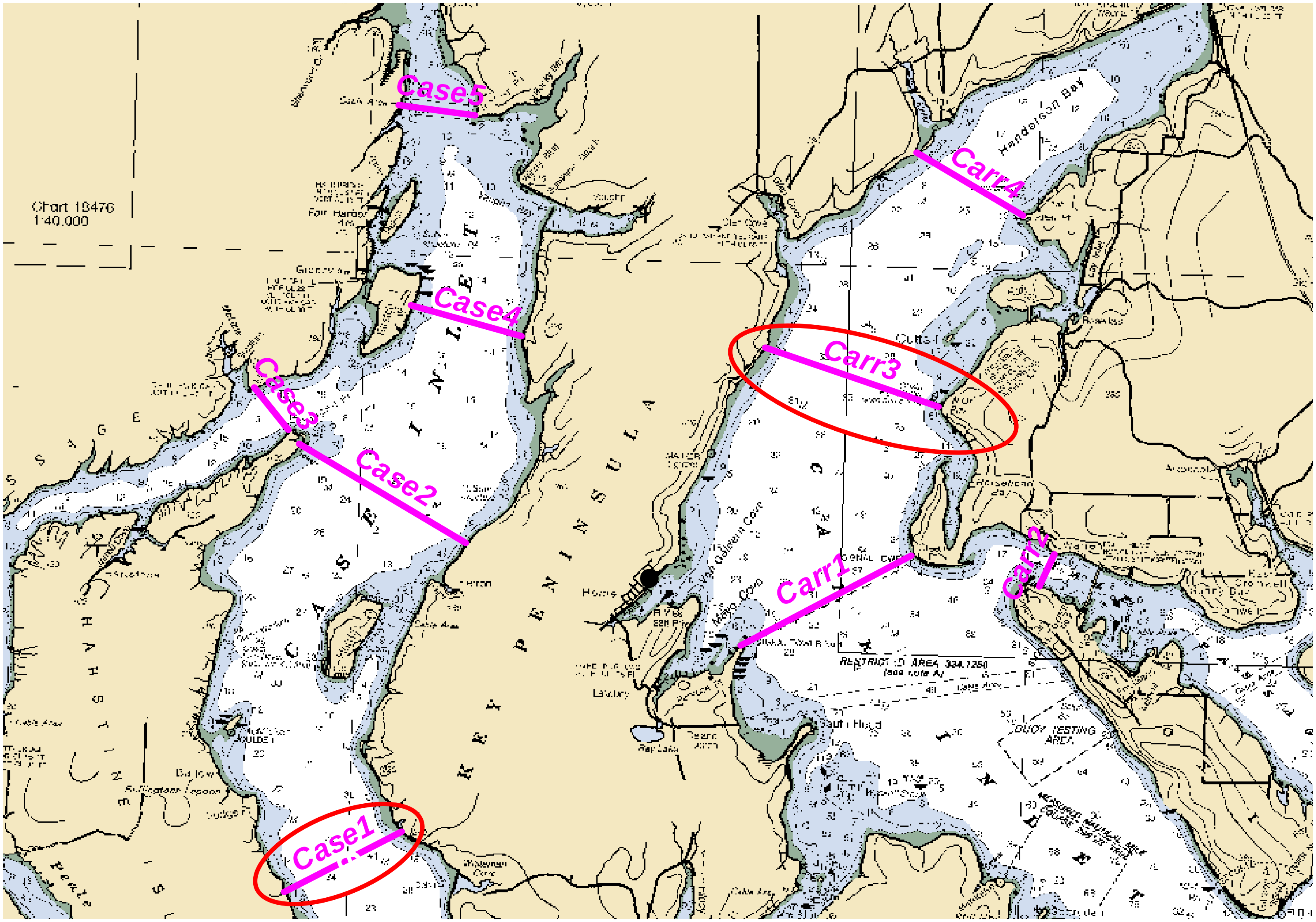

Figure 2. Transect locations in Carr and Case Inlets. Transects circled in red will have double passes.

Table 1. Tide characteristics at Budd Inlet for the transects (source: Tides & Currents v. 2.1)

	July 10, 2007	July 11, 2007	July 12, 2007	July 13, 2007
Low tide	-1.5 ft at 9:05	-2.5 at 9:59	-3.1 at 10:51	-3.4 at 11:35
High tide	+12.8 at 16:34	+14.0 at 17:39	+14.9 at 18:31	+15.5 at 19:16
Estimated work period	10:00 to 15:30	11:00 to 16:30	12:00 to 17:30	12:30 to 17:15
Work area (subject to change due to weather)	Budd, Totten, Eld	Carr	Case	(backup as needed)

Table 2. Transect locations, with latitude and longitude of the west and east ends.

Transect	Location	West Lat	West Long	East Lat	East Long	Max Depth (ft below NAVD88)
BTE1	Mouth of Totten Inlet	47.17130	-122.96199	47.16516	-122.95130	-93
BTE2	North of Hope Island	47.19110	-122.92579	47.19496	-122.92432	-35
BTE3	South of Hope Island	47.18062	-122.93672	47.18364	-122.93248	-47
BTE4	Mouth of Eld Inlet	47.14975	-122.93417	47.14545	-122.92737	-90
BTE5	Mouth of Budd Inlet	47.13909	-122.92692	47.13971	-122.90788	-99
BTE6	Central Budd Inlet	47.11071	-122.92415	47.10694	-122.89428	-52
BTE7	Priest Point Budd Inlet	47.06752	-122.91809	47.07290	-122.90349	-36
BTE8	Southern Budd Inlet	47.05849	-122.91356	47.06224	-122.89601	-36
Carr1	Greer Point Carr Inlet	47.26473	-122.73716	47.28148	-122.69563	-350
Carr2	Hale Passage	47.27658	-122.66371	47.28242	-122.66011	-80
Carr3	South of Cutts Island	47.31815	-122.73353	47.30853	-122.68987	-231
Carr4	Allen Point of Carr Inlet	47.35390	-122.69718	47.34313	-122.67045	-147
Case1	South of McMicken Island	47.21811	-122.84884	47.22969	-122.82007	-250
Case2	North of Herron Island	47.29855	-122.84852	47.28166	-122.80636	-143
Case3	North of Hartstene Island	47.30863	-122.86008	47.30110	-122.85146	-107
Case4	East of Stretch Island	47.32398	-122.82173	47.31903	-122.79422	-93
Case5	Rocky Point of Case Inlet	47.36005	-122.82632	47.35850	-122.80724	-57

Appendix A. ADCP Deployment Field Notes

ADCPs use a face seal because Teledyne RD Instruments at the old box seals failed more. Be careful!

To change the batteries, open the back of the ADCP (away from the heads). Be sure to add desiccant. Don't remove the back until you have identified beam 3 on the casing, so that you can put it back together the same way!

If you flip beam 3 so that it is to your right when you remove the back, mount the battery so that the white ponytail (and often the degauss sticker) are to your left. Feed the white ponytail through the rubber band on the battery pack so that it is taut (and feeds through from the left).

Add the backing plate, washers, and then wing nuts (to hand tight). Attach the desiccant with a rubber band wound around the wing nuts so that it does not get loose and touch the circuit board.

Re-grease the o-ring with Dow Corning 111 valve lubricant and sealant (or equivalent) silicone grease. Be sparing and remove all particles of sand or dirt.

Add the bolts so the nuts face the inside, and the bolt heads project toward the end or ends. Put one washer under the head of each bolt and two under the nut.

Plan your deployment with PlanADCP (see www.rdinstruments.com for details).

Calibrate the ADCP with a degaussed battery set in the open meadow away from cars.

Lazy Susan operator –

1) Brush the heads in order 1-2-3-4.

2) Rotate flat, 360 degrees on primary axis.

3) Rotate pitch/roll – lift by 10 – 20 degrees up on side 3, 360 degrees on primary axis.

4) Rotate roll/pitch – lift by 10-20 degrees up on adjacent side, 360 degrees on primary axis.

5) Final rotation – not as critical. Rotate somewhere between (and not as much), 360 degrees on primary axis.

Program the ADCP and start it now (okay to run it out of the water) if you are going to deploy it tomorrow. That saves the trouble of taking a laptop into the field.