Lessons From OSW Technical Reviews for Hydroacoustics 2007-2009

by Kevin Oberg
Summary of 2007-2009

2009 Hydroacoustics Reviews—Summary

In 2009, OSW Technical Reviews were conducted at 17 WSC’s. The following is an executive summary of significant review comments on hydroacoustics issues. The number of comments may not only indicate the quality of the WSC hydroacoustics program but also be affected by other factors (some subjective) like the skill of the reviewer, philosophy of review, number of reviewers, etc.

COMMON FINDINGS

<table>
<thead>
<tr>
<th>Issue</th>
<th>Category</th>
<th>Freq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration of hydroacoustics into CWA plan related to CWA plan issues</td>
<td>General</td>
<td>10</td>
</tr>
<tr>
<td>Water temperature not being measured/recorded</td>
<td>General</td>
<td>10</td>
</tr>
<tr>
<td>Problems with electronic data storage (no plan, inconsistent use, etc)</td>
<td>General</td>
<td>7</td>
</tr>
<tr>
<td>Beam checks (bucket tests) not being done or are suspect</td>
<td>FlowTracker</td>
<td>6</td>
</tr>
<tr>
<td>Training needed (generally ADCP/AODC attend webinar)</td>
<td>General</td>
<td>6</td>
</tr>
<tr>
<td>Evaluation of extrapolations that are not validated</td>
<td>ADCP</td>
<td>5</td>
</tr>
<tr>
<td>Use DatView software for viewing FlowTracker Onsite</td>
<td>FlowTracker</td>
<td>5</td>
</tr>
<tr>
<td>Firmware/software in use has not been updated to OSW recommended</td>
<td>General</td>
<td>5</td>
</tr>
<tr>
<td>Measurements should be reviewed/checked (by trained personnel, etc)</td>
<td>General</td>
<td>5</td>
</tr>
<tr>
<td>ADVM beam checks not being done/recorded</td>
<td>Index-Velocity</td>
<td>5</td>
</tr>
<tr>
<td>Problems with index velocity ratings</td>
<td>Index-Velocity</td>
<td>5</td>
</tr>
<tr>
<td>Moving bed tests not being done or incorrectly done</td>
<td>ADCP</td>
<td>4</td>
</tr>
<tr>
<td>Improper velocity observation depths (0.2, 0.6, 0.8)</td>
<td>FlowTracker</td>
<td>4</td>
</tr>
<tr>
<td>Improper Qm section locate—better measuring section/instrumentation</td>
<td>General</td>
<td>4</td>
</tr>
<tr>
<td>Loop methodology/or/OC program not used or problems with loop tests</td>
<td>ADCP</td>
<td>3</td>
</tr>
<tr>
<td>Problems with compass calibrations/evaluations</td>
<td>ADCP</td>
<td>3</td>
</tr>
<tr>
<td>Proper use of WSC/Office appoint Hydroacoustics specialist/Coordinators</td>
<td>General</td>
<td>3</td>
</tr>
<tr>
<td>Suggest WSC/Office appoint Hydroacoustics specialist/Coordinator</td>
<td>General</td>
<td>3</td>
</tr>
<tr>
<td>ADVM-QA parameters not being output/stored/archived</td>
<td>Index-Velocity</td>
<td>3</td>
</tr>
<tr>
<td>Diagnostic tests not being done</td>
<td>ADCP</td>
<td>2</td>
</tr>
<tr>
<td>Duration of individual transects should be at least 3 minutes</td>
<td>ADCP</td>
<td>1</td>
</tr>
<tr>
<td>High boat speed (rule of thumb: boat speed = water speed)</td>
<td>ADCP</td>
<td>1</td>
</tr>
<tr>
<td>Need to use SMSA or misuse of SMBA</td>
<td>ADCP</td>
<td>1</td>
</tr>
<tr>
<td>Need better measurement techniques</td>
<td>General</td>
<td>1</td>
</tr>
<tr>
<td>Stage area note not validated (documented)</td>
<td>Index-Velocity</td>
<td>1</td>
</tr>
<tr>
<td>Measure edge distances using laser range finder or suitable tools</td>
<td>ADCP</td>
<td>1</td>
</tr>
<tr>
<td>Syncing ADCP/ADVM measurements/Sampling time for QM data</td>
<td>Index-Velocity</td>
<td>1</td>
</tr>
</tbody>
</table>

FlowTracker Comments:

- All personnel using hydroacoustics equipment are encouraged to review relevant OSW Technical Memorandums (TM) (2004.04, 2006.02) that document various field and office techniques. In particular, the reason for conducting routine QA procedures (i.e., acoustic Doppler velocimeter [ADV] Bucket Tests) could be more clearly understood, which would allow for better interpretation of these tests.

- The DatView software (available at http://hydroacoustics.usgs.gov/) was not widely used in the WSC to review FlowTracker discharge measurements. Although the use of DatView is not required, it is very useful and OSW strongly encourages its use.

- One office was still missing depth velocity measurements between 1.5 and 2.5 ft. when using FlowTrackers—OSW TM 2004.04 states that 2.5-3 depth velocity measurements are required in this depth range, and the hydrographer is not allowed to switch to cup meters to avoid this requirement.

FlowTracker Comments:

- General comments:
  - Hydrographers need to collect an independent water temperature check when conducting low Backscatter measurements. The majority of measurements reviewed did not have an independent water temperature measurement.
  - ADCP Measurements:
    - When making StreamPro measurements, OSW strongly recommends that each individual transect have a 3-minute minimum duration. In several instances, transects were less than 3 minutes.
    - Invest in tethered boat hydroacoustics when finances enable it. You will increase efficiency during high flows and enable staff to get around to more sites quicker and limit time on bridge (safety). This would particularly help the Bureau of Reclamation in catching more high-flow measurements in light of personnel limitations during flood operations and the pending retirement of key personnel.
    - WinRiver 10.06 is still being used to collect discharge measurements. Strongly encourage all offices to utilize WinRiver II when making discharge measurements. The cause of the problem when performing/recording compass calibrations in WinRiver II should be discussed with OSW (Mike Bechtle) and a suitable solution found so that WinRiver 10.06 is no longer necessary.
  - FlowTracker Comments:
    - All personnel using hydroacoustics equipment are encouraged to review relevant OSW Technical Memorandums (TM) (2004.04, 2006.02) that document various field and office techniques. In particular, the reason for conducting routine QA procedures (i.e., acoustic Doppler velocimeter [ADV] Bucket Tests) could be more clearly understood, which would allow for better interpretation of these tests.
    - The DatView software (available at http://hydroacoustics.usgs.gov/) was not widely used in the WSC to review FlowTracker discharge measurements. Although the use of DatView is not required, it is very useful and OSW strongly encourages its use.
    - One office was still missing depth velocity measurements between 1.5 and 2.5 ft. when using FlowTrackers—OSW TM 2004.04 states that 2.5-3 depth velocity measurements are required in this depth range, and the hydrographer is not allowed to switch to cup meters to avoid this requirement.
  - Index-Velocity Comments:
    - When establishing operating index velocity stations, avoid using vendor supplied methods for computing discharge. Instead, use USGS methods and computer discharge in ADAPS.
Sources of OSW Guidance

- Techniques and Methods for Moving Boat ADCP Discharge Measurements
- Technical Memos
- Web pages/Mailing list/Forums
General Issues
General Issues

- QA Plan Issues
- Electronic data storage
- Water temperature
- Qm section/instrument
- Qms need reviewed
- Training
- Better Qm technique
- Firmware/software
- HA Specialist

QA Plan/QA Issues

- WSC has not adequately addressed the use of hydroacoustics in their QA plan, either by having a hydroacoustics component or integrating into their plan.

- WSC has not implemented other QA Practices Recommended by OSW:
  - Annual instrument checks? (T&M / 2009.05) CA
    WSC report is a good example.
  - Beam angle tests (distance tests) (T&M / 2009.05)
Does WSC have Data Archival Plan?
Is it Used Consistently?

Common problems
- No policy
- Inconsistent usage
- Inconsistent file naming
- Everyone doesn’t have access to archive

Example 1 – Directory Structure

```
    data
     | WY2003
     | 03378500
    /   measurements
     | 542.20021117.aquacale
     | 543.20021231.adep
     | 544.20030121.flowtracker
     | Harmony001r.000
     | Harmony001w.000
     | Harmony001n.000
     | Harmony001d.000
     | 766.021231151218.txt
     | compc766.021231151218.txt
     | and others
```

OSW Tech Memo 2005.08
Policy and Guidance for Archiving Electronic Discharge Measurement Data
Archiving Electronic Qm’s (2005.08)

- Each measurement should have its own directory containing all files collected or created as part of the measurement.
- Naming convention must include some combination of measurement dates, water years, and/or instrument types.
- Recommended that data be archived within 2 days of returning from field.

**Example 1 – Directory Structure**

```
data
    WY2003
    03378300
    measurements
      542.20021117.aquacale
      543.20021231.adcp
      544.20030121.flowtracker
        Harmony001r.000
        Harmony001w.000
        Harmony001n.000
        Harmony001d.000
        766.021231151218.txt
        compcal766.021231151218.txt
        and others
        03378300.wad
        03378300.ctl
        03378300.dis
        03378300.sum
        03378300.dat
      542.txt
```
Temperature Sensors & Hydroacoustic Instruments

- An accurate water temperature is important for accurate velocities
  - An error of 9° F will cause approximately a 2% error in velocity

- Every measurement made with hydroacoustic equipment needs an independent measure of water temperature for QA (T&M / 2009.05)

- Policy for Flowtrackers not articulated in OSW technical memo (an oversight).
Equilibration Time

- Allow time for instrument (FlowTracker, ADCP) to equilibrate to water temperature. This is especially important if you are moving between temperature extremes. (Hot truck → Cooler stream)
Measurement Location and Technique
Location Location Location!

- Cannot be emphasized enough!
Use of bank-operated cableway is encouraged whenever feasible as it results in better Qm’s

Wading with StreamPro / ADCP is discouraged
Guidance for Wading Measurements

- **Do NOT Wade with StreamPro’s or other shallow water ADCPs!**
  - ADCP beams may impinge on the hydrographer or sample the flow disturbance caused by the hydrographer.
  - It is difficult to wade across channel while keeping the StreamPro motion smooth and steady.
Recognize Limitations
Cannot Use Acoustics Everywhere!

Use the Right Tool for the Job!
OSW recommends review of discharge measurements by another trained hydrographer as a good QA practice.

Recommended in training classes and T&M.

Question: Should acoustic Qms be subject to more review than current meter Qms?

Answer: Need to develop guidelines for this (OSW and WSCs).
Training

- Training is required for using ADCPs for Qm’s \(2002.02 / T&M\) but not point-velocity meters.

- Most review comments had to do with keeping current with OSW policies, etc. and encouraging attendance at refresher training classes. Often paired with comments about a Hydroacoustics specialist.
Current Software and Firmware

- Users should be using currently recommended software and firmware
- Hydroacoustics Web pages
- More on this later in the presentation
Current Software and Firmware

- Use of WinRiver II 2.04 or greater
  - Have WSC’s upgraded to 2.04?
  - Strongly encourage use of USB-to-serial converters

- Use of SxS
  - Not well tested by OSW. If used, WSC’s should do comparison measurements to validate (with BT and/or GPS and ADCP)
  - We’d like to know of comparison Qm’s with SxS
ADCP Measurement Issues
ADCP Discharge Measurements

![Bar chart showing discharge measurements over years 2007, 2008, and 2009. The categories include Moving bed tests, Loop method/IC, 3 minutes Duration, Extrapolation, Measure edges, Configuration, Compass calibrations, Diagnostic tests, High boat speed, and SMBA.](chart.png)
Moving Bed Issues
New Policies in T & M Report

- Every moving-boat Qm must have a moving bed test (MBT)
- Guidance for stationary MBT’s
  (T&M / 2009.05)

<table>
<thead>
<tr>
<th>Deployment</th>
<th>Duration of SMBT</th>
<th>MBT Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tethered boat</td>
<td>5 minutes</td>
<td>1%</td>
</tr>
<tr>
<td>Anchored boat</td>
<td>5 minutes</td>
<td>1%</td>
</tr>
<tr>
<td>Boat with DGPS</td>
<td>5 minutes</td>
<td>1%</td>
</tr>
<tr>
<td>All other</td>
<td>10 minutes</td>
<td>2%</td>
</tr>
</tbody>
</table>
New Policies in T & M Report

- When a moving bed condition is present, preferred method for data collection is:
  - GPS (if available and accurate)
  - Loop MBT and LC program (conditions permit)
  - Multiple stationary MBT’s with SMBA program
  - Mid-section method
Loop Moving Bed Tests and Corrections

(SIR / 2003.04 / T&M)
Loop Method Issues

- Loop method not being used
  - No MBT at all
  - SxS approach being used
  - (SIR / 2003.04 / T&M)

- LC program needs to be used (available at hydroacoustics.usgs.gov) instead of ‘hand’ computations

- Cannot use loop method with StreamPro ADCPs that do not have a compass
Compass Calibration and Loops

- Compass calibration for Rio Grande has calibration and evaluation steps. Both need to be done. Take 75-80 s.

- In order to make use of the loop method, the ADCP compass must be able to maintain an accurate heading! (ie no large source of magnetism).
Proper Extrapolation Methods
Evaluate Extrapolation

- What method should be used here?
- Qm’s are often not reviewed for appropriate method
- Look for wind shear and other effects in profiles
Power Curve Limitations

Unidirectional Flow

Bi-directional Flow

Distance from the bed (Z), feet

Velocity cross product (f-value), ft²/s²

Hydro Acoustics USGS
Edge Estimates

- Edge distances must be MEASURED (T&M / 2002.02)
  - Laser rangefinder
  - Tagline

<table>
<thead>
<tr>
<th>Station Number: 05651640</th>
<th>Station Name: Fox River at Montgomery, IL</th>
<th>Date: 07/06/2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Party: KA00000</td>
<td>Mean Velocity: 1.300 ft/s</td>
<td></td>
</tr>
<tr>
<td>Boat/Motor:</td>
<td>Discharge: 1.340 ft/s</td>
<td></td>
</tr>
<tr>
<td>Gage Height: 11.74 ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G.H.Change: 0.00 ft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area Method: Arg. Course</th>
<th>ADCP Depth: 0.270 ft</th>
<th>Index Vel: 0.00 ft/s</th>
<th>Rating No: 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nav. Method: Bottom Track</td>
<td>Shore Eq: 0.10</td>
<td>Adj Mean Vel: 0.00 ft/s</td>
<td>Gm Rating: G</td>
</tr>
<tr>
<td>Mag/Var Method: None (0.0)</td>
<td>Bottom Est. Power: 0.166%</td>
<td>Rated Area: 0.000 ft²</td>
<td>Diff: -4.40%</td>
</tr>
<tr>
<td>Depth Sounder Net Used</td>
<td>Top Est. Power: 0.166%</td>
<td>Control: 4-0 Line</td>
<td>Control: Unspecified</td>
</tr>
</tbody>
</table>

Performed Diag. Test: NO
Performed Moving Bed Test: NO
Performed Compass Test: NO
Meas. Location: 1500 ft DS of gage

<table>
<thead>
<tr>
<th>Tr.#</th>
<th>Edge Distance</th>
<th>#Ens.</th>
<th>Discharge</th>
<th>Time</th>
<th>Mean Vel.</th>
<th>% Bad</th>
</tr>
</thead>
<tbody>
<tr>
<td>004</td>
<td>L</td>
<td>552</td>
<td>234</td>
<td>12.49</td>
<td>0.41</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>552</td>
<td>234</td>
<td>12.56</td>
<td>1.88</td>
<td>1</td>
</tr>
<tr>
<td>005</td>
<td>L</td>
<td>393</td>
<td>237</td>
<td>12.56</td>
<td>0.54</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>393</td>
<td>237</td>
<td>13.01</td>
<td>0.49</td>
<td>1</td>
</tr>
<tr>
<td>006</td>
<td>L</td>
<td>331</td>
<td>235</td>
<td>13.06</td>
<td>0.53</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>331</td>
<td>235</td>
<td>13.10</td>
<td>1.90</td>
<td>0</td>
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<tr>
<td>Mean</td>
<td>L</td>
<td>418</td>
<td>235</td>
<td>00:21</td>
<td>0.52</td>
<td>2</td>
</tr>
<tr>
<td>SDev</td>
<td>L</td>
<td>94</td>
<td>0.088</td>
<td>0.03</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>94</td>
<td>0.089</td>
<td>0.03</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>R/M</td>
<td>L</td>
<td>52.9</td>
<td>1.2</td>
<td>0.00</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>52.9</td>
<td>1.2</td>
<td>0.00</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Measurement made as a part of a series of ADCP test measurements
Concurrent Price AA current meter Qm’s made this day
Proper Configuration

Example: Indiscriminate Use of Water Mode 12

- Mode 5/11 (often need to try both)
  - Low instrument noise
  - Small bins
  - Limited application

- Mode 12
  - High-ping rate
  - Small bins
  - Potential errors in dynamic conditions

- Mode 1
  - Robust mode
  - Highest instrument noise
  - Limited bin sizes

Dynamic Conditions

Too fast, too deep, too turbulent
Wizard Configuration Secondary Depth

- If not zero, will attempt to configure depth cell size to get at least 3 good cells in this depth
- **Only** use when you **MUST** profile in this depth
- Recommend first leaving at zero, then verify the minimum profile depth (2 cells) in the summary page is acceptable
- Entering an unnecessary secondary may result in smaller depth cells and increase measurement noise
StreamPro Issues

- Make sure that stationary moving bed tests are being done
- Encourage use of Stationary Moving Bed Analyzer (SMBA) software for determining if moving bed condition exists and to correct the discharge
Other ADCP Qm Issues

- ADCP Qm’s not locked (2003.04)
- Diagnostic tests need to be run prior to each Qm or minimum of 1/day (T&M / 2009.05)
- ADCP depth not being measured. Can be significant bias (2-3%) in small streams and should be carefully measured from water surface to center of transducers.
- Compliance with number of transects policy
  - 4 or 8 transect means
  - Do not want odd-numbers of transects
  - (2002.02)
FlowTracker
Flowtracker Issues

Bar chart showing issues over years:
- Beam checks:
  - 2007: Approximately 3
  - 2008: Approximately 4
  - 2009: Approximately 5
- Use of DatView:
  - 2007: Approximately 3
  - 2008: Approximately 2
  - 2009: Approximately 4
- Velocity obs. depths:
  - 2007: Approximately 1
  - 2008: Approximately 2
  - 2009: Approximately 3
ADVChecks not Run Prior to Field Trip

OSW Technical Memo (2007.01)
SonTek/YSI FlowTracker firmware version 3.10 and software version 2.11 upgrades and additional policy on the use of FlowTrackers for discharge measurements
Flowtracker Issues

- Compliance with OSW Technical Memo 2007.01
  - Velocity sampling (1-, 2-, and 3-point methods)
  - Is current firmware/software being used?
Flowtracker Issues

- Use of DatView
  - For questionable measurements or where SonTek software highlights a possible issue.
  - Issues highlighted by SonTek software should be explained or discussed on the measurement note.
FlowTracker Measurement Errors

Most FlowTracker measurement problems are the result of:

- **Poor site selection**
- **Boundary issues** (avoid placing sample volume with 2” of any boundary)
- Poor instrument orientation
- Low signal-to-noise ratio
Index Velocity Issues
Index Velocity Ratings

- Sometimes, the rating “analysis” is no more than adding a trend line to the data.
- Documentation is required that clearly identifies the logic used, analysis results, and the final rating selected (with hydrologic reasoning). Reviewers should not have to second guess a hydrographer’s choice for a rating.
Index Velocity Ratings

- Lots of “house-keeping” issues
  - Documentation
  - Consistency
  - Carryover of info from year to year

- Ratings not being maintained/updated

- Inconsistent use of ‘rated’ section (stage-area)
Beam Checks

- Are they being done?
  - Stored in recorder? Site visits? Not overwritten?
  - Archived according to WSC plan?
- Are they being analyzed?
Recording And Analyzing QA Data

- QA data are often not retrieved, reviewed, and archived (internal data, beam checks, etc.)
- QA data should be stored in the velocity data archive for the site
- Data are often not analyzed. Can be used to detect changes or issues with the site / instrument
Recording And Analyzing QA Data

From an Index-Velocity ‘expert’: “Many times the instrument orientation (beams are measuring different flow regimes) and configurations are improper, i.e. cell begin is too close and/or cell end is too far and averaging intervals are usually too short.”
Are Velocity Components Reviewed?

- Problem identified as Beam 2 issue
Index Velocity Issues

- Not making use of multi-cell data
- Is ADVM setup info in station description?
- Are the following parameters being transmitted?
  - Vel X, SNR, Cell end, Vel Y, temperature
- ADVM / Qm times not synchronized
Index Velocity Issues

- Record index velocity at 1-minute intervals during Qm’s
- Is averaging interval appropriate for site?
Location of Index Sites

Tomoka River SL 1

Mean Channel Velocity vs. Index Velocity

\[ y = 1.3828x + 0.2717 \]

\[ R^2 = 0.6874 \]
Emerging Issues
WinRiver II Versions

- Last OSW recommended version is 2.04, but latest TRDI release is 2.07
- No changes between 2.04 and 2.07 that affect Q for moving boat measurements
- Most significant change is improve stability in SxS
- Users can stay with 2.04 unless they have a need to use the SxS feature (mid-section method), StreamPro firmware 31.07 or newer (new extended range and/or compass), or RiverRay
- If you upgrade to 2.07 you will have configuration issues with StreamPros using firmware prior to 31.07 (configures for 30 bins, when 20 max in old firmware)
**StreamPro Firmware**

- Many changes, will soon have the 6th version in 14 months

<table>
<thead>
<tr>
<th>StreamPro Firmware</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.05 and earlier</td>
<td>Depth measurements biased low</td>
</tr>
<tr>
<td>31.06</td>
<td>Fixed depth bias, improved BT</td>
</tr>
<tr>
<td>31.07</td>
<td>Added support for compass, increased range, Btchanges</td>
</tr>
<tr>
<td>31.08</td>
<td>BT change, fixed time stamp issue. Found initialization issue with WRII 2.07</td>
</tr>
<tr>
<td>31.09</td>
<td>Fixed initialization issue with WRII 2.07. TRDI had issues with some StreamPros becoming unresponsive during upgrade. Pulled by TRDI</td>
</tr>
<tr>
<td>31.10</td>
<td>Out soon. Fixes minor depth and BT issues and 31.09 upgrade issue</td>
</tr>
</tbody>
</table>
Software and Firmware

- OSW is considering only mandating a change in software/firmware when a known issue is fixed that significantly affects total discharge. Otherwise, keeping an updated page that contains the available software and firmware for instruments along with any known issues.
- With the increased instrument types and software, OSW can not do complete and thorough testing of the software or firmware in all conditions. No matter how much testing we attempt do complete some issues are not discovered until the software/instrument are much more widely used.
- OSW will continue testing as thoroughly as possible
SonTek ADCPs

- Only a few delivered to USGS
- Source of bias for low-velocity measurements identified and corrected
- OSW testing has not been completed
New TRDI Profiler – RiverRay

- Flat face Phased array - 600 kHz
- Sold with tethered boat, Bluetooth
- Evaluations in progress
Reminder

Question: “Can we collect data with the SonTek M9 (or some other instrument)?”

- If an instrument has not been tested fully by OSW and no formal technical guidance (i.e. memo) has been published, WSC’s are responsible for their own QA. Please consult with OSW first.

- It is always a good idea to do a check measurement(s) with any newly-purchased instrument (Flowtracker, Rio Grande, etc.)
2009 ADCP Issues
2008 ADCP Issues

- Moving bed tests
- Loop method / LC
- Extrapolation
- Diagnostic tests
- 3 minutes Duration
- High boat speed
- Compass calibrations
- Measure edges
- SMBA
- Configuration