RECLAMATION
*Managing Water in the West*

TR-2009-02

# Tracy Fish Collection Facility Primary Channel Velocity Evaluation

## Dates of travel: March 23-27, 2009

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Hydraulic Investigations and Laboratory Services Group
Denver, Colorado

BUREAU OF RECLAMATION
Technical Service Center
Denver, Colorado

TRAVEL REPORT

PRJ-13.00

Code : 86-68460 Date: April 2, 2009

To : Robert Einhellig, Acting Manager
Hydraulic Investigations and Laboratory Services Group (86-68460)

From : Connie DeMoyer, Hydraulic Engineer
Hydraulic Investigations and Laboratory Services Group (86-68460)

Subject : Tracy Fish Collection Facility Primary Channel Velocity Evaluation

1. Travel period: March 23-27, 2009

2. Places or offices visited: Tracy Fish Collection Facility (TFCF), Tracy, CA

3. Purpose of trip: One purpose for the trip was to assist in setting the hydraulic conditions during the salmon whole facility efficiency tests. Another purpose was to determine whether velocity data from the newly installed primary flowmeter can be confidently used during the tests.

4. Synopsis of trip: I traveled to Tracy, CA on Monday, March 23$^{rd}$ and departed on Friday, March 27$^{th}$. During the week, I met with Cathy Karp (86-68290) and her team of researchers regarding the salmon whole facility efficiency tests and assisted in setting hydraulic conditions for two evening fish releases. During the tests, the facility was operated to achieve salmon criteria with a secondary velocity of 3-3.5 ft/s and primary and secondary bypass ratios above 1.0. Using the tidal cycle, the tests were scheduled when the primary channel velocity was approximately 1.1 ft/s for 2 pump operations at Jones Pumping Plant or 1.6 ft/s for 3 pump operations. Hydraulic conditions such as water depths, discharges, velocities, bypass ratios, and velocity control pump operation were recorded during the experiments. Test results will be compiled and released by the principal investigator, Cathy Karp.

While I was at the TFCF, I attended a teleconference on the proposed installation of Hydrolox traveling screens in the secondary channel. Debris capture tests conducted by Brent Mefford (86-68460) and Dane Cheek (86-68460) in March 2009 show that the Hydrolox screens are effective at debris collection. Brent Bridges (TO-411), Cathy Karp (86-68290), and I discussed whether we had the staff, materials, and fish necessary to perform a fish insertion experiment in April or May 2009 with the Hydrolox screens in place. Like the debris capture tests, static screens would be installed on the first louver array in the secondary channel. Results from the salmon whole facility efficiency tests with louvers (collected March 23-31, 2009) could be directly compared to the Hydrolox fish tests if the test methods were the same. The Hydrolox screens are available at the facility, but a barrier of framed netting or perforated plate will need to be fabricated to block the bypass at the end of the second louver array to prevent loss of fish during experiments. Full planning for these tests will begin after regulatory agency personnel are contacted.

Tom Moser, Tracy C&I Mechanic (TO-437), and I discussed the installation locations and output values from the facility flowmeters. Tom installed a RD Instruments ChannelMaster H-ADCP (acoustic Doppler current profiler) in the primary channel in the summer 2008. This permanent flowmeter outputs the mean velocity at the depth at which it was installed (7.2 ft from the channel bottom). Due to tidal fluctuations at the facility, an indexing evaluation is needed to relate the mean velocity at the flowmeter elevation to the actual mean velocity in the channel. Tom is currently looking into options for the indexing evaluation.

Since the salmon whole efficiency test and other experiments are planned before the indexing evaluation, there was uncertainly as to whether the velocity output from the ChannelMaster is representative of the actual mean channel velocity. An OTT Qliner (a portable discharge measurement system) was shipped to the TFCF to compare the primary channel velocities measured by both instruments.

The Qliner consists of an acoustic Doppler current profiler, a boat to hold the current profiler and a Bluetooth transmitter, and a handheld computer with Bluetooth and the data collection software. Five transects were collected at 1Hz for tidal stages that varied between 16.85 ft and 18.36 ft. The transect location was about 55 ft downstream from the trashrack bridge deck near the leading edge of the first primary louver panel. Vertical velocity profiles and water depths were measured at 11 lateral locations across the primary channel at a spacing of 8 ft. A discharge value was calculated from the velocity profiles in the Qliner software by using a section-by-section discharge algorithm. The ChannelMaster is not yet set up to calculate discharge.

Tom downloaded data from the ChannelMaster during the test days. Mean velocity data from the Qliner was compared to the velocity output from the ChannelMaster. Data from the Qliner was also used to document vertical and lateral velocity variations in the channel during low debris, low pumping rate operations. Results from the five primary channel transects are shown below.

### *Discharge Measurement 1 – 3/25/09 from 0913-1013*

Filename: tracy3(1)
Tidal stage: Outgoing tide near high tide.
Tides: High tide 0747, low tide 1411

**Table 1 – Data collected during discharge measurement 1.**

| | Before Test | | After Test | | Average Over Test | |
|---|---|---|---|---|---|---|
| Reading | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) |
| ChannelMaster 1 | 18.64 | 0.955 | 18.10 | 0.944 | | |
| ChannelMaster 2 | 18.63 | 0.895 | 18.09 | 0.972 | | |
| ChannelMaster 3 | 18.63 | 0.952 | 18.09 | 1.015 | | |
| ChannelMaster 4 | 18.62 | 0.884 | 18.09 | 0.945 | | |
| ChannelMaster 5 | 18.62 | 0.949 | 18.08 | 0.900 | | |
| **ChannelMaster average** | 18.63 | 0.93 | 18.09 | 0.95 | **18.36** | **0.94** |
| **ChannelMaster average over entire time period** | | | | | **18.36** | **0.90** |
| **Primary channel depth sensor** | 18.40 | | 17.94 | | **18.17** | |
| **QLiner velocity profiler** | | | | | **17.85** | **0.92** |

Between 0913 and 1013, the mean velocity from the portable QLiner was 0.92 ft/s and the mean velocity from the ChannelMaster was 0.90 ft/s. The permanent flowmeter was 2.2% lower than the portable profiler. The discharge measured using the Qliner was approximately 1,445 $ft^3/s$ during this outgoing tide.

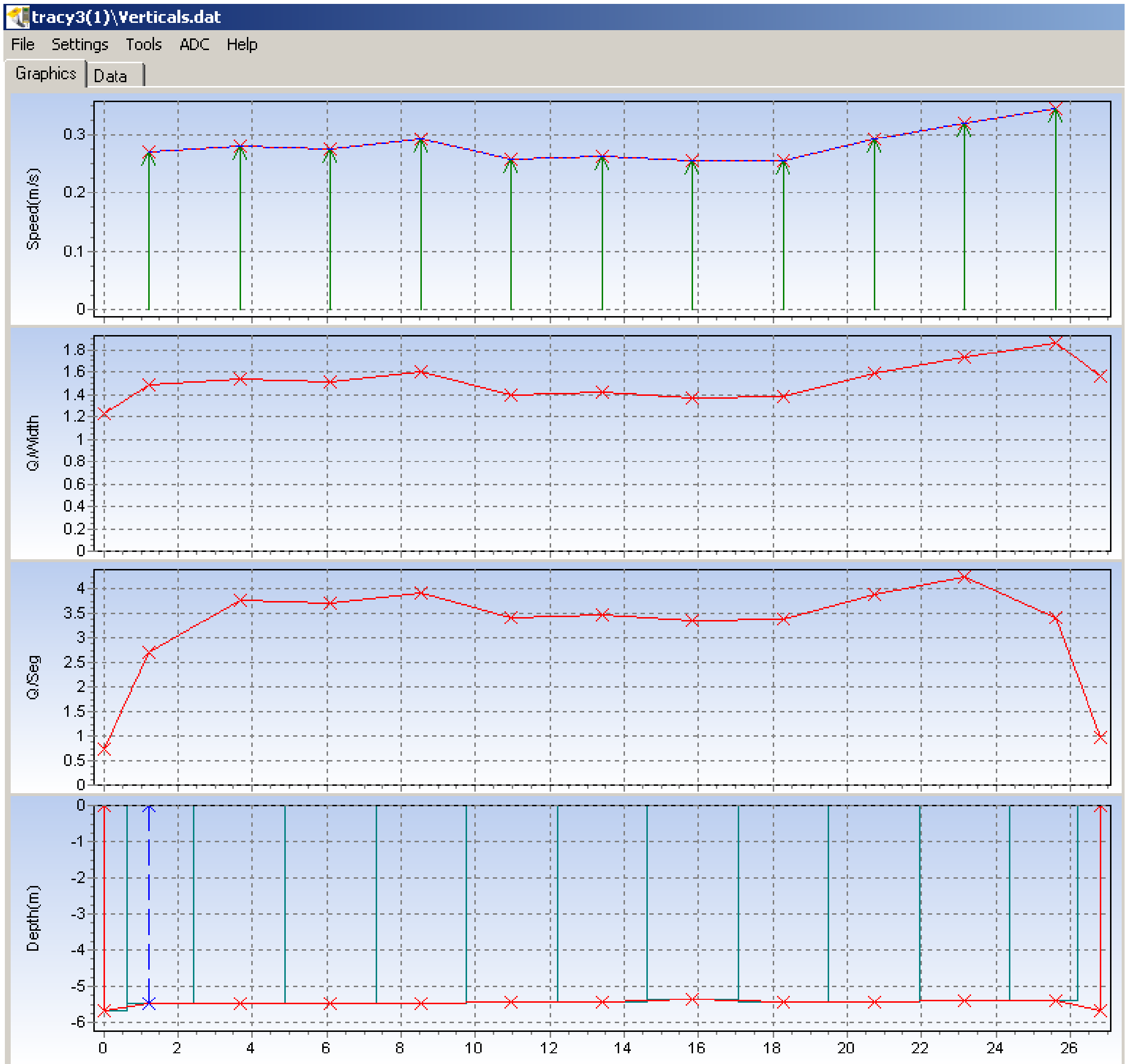


**Figure 1 – Velocity, depth, and discharge in metric units for discharge measurement 1. The transect was measured from left to right looking downstream with vertical 1 on left side and vertical 11 on the right side.**

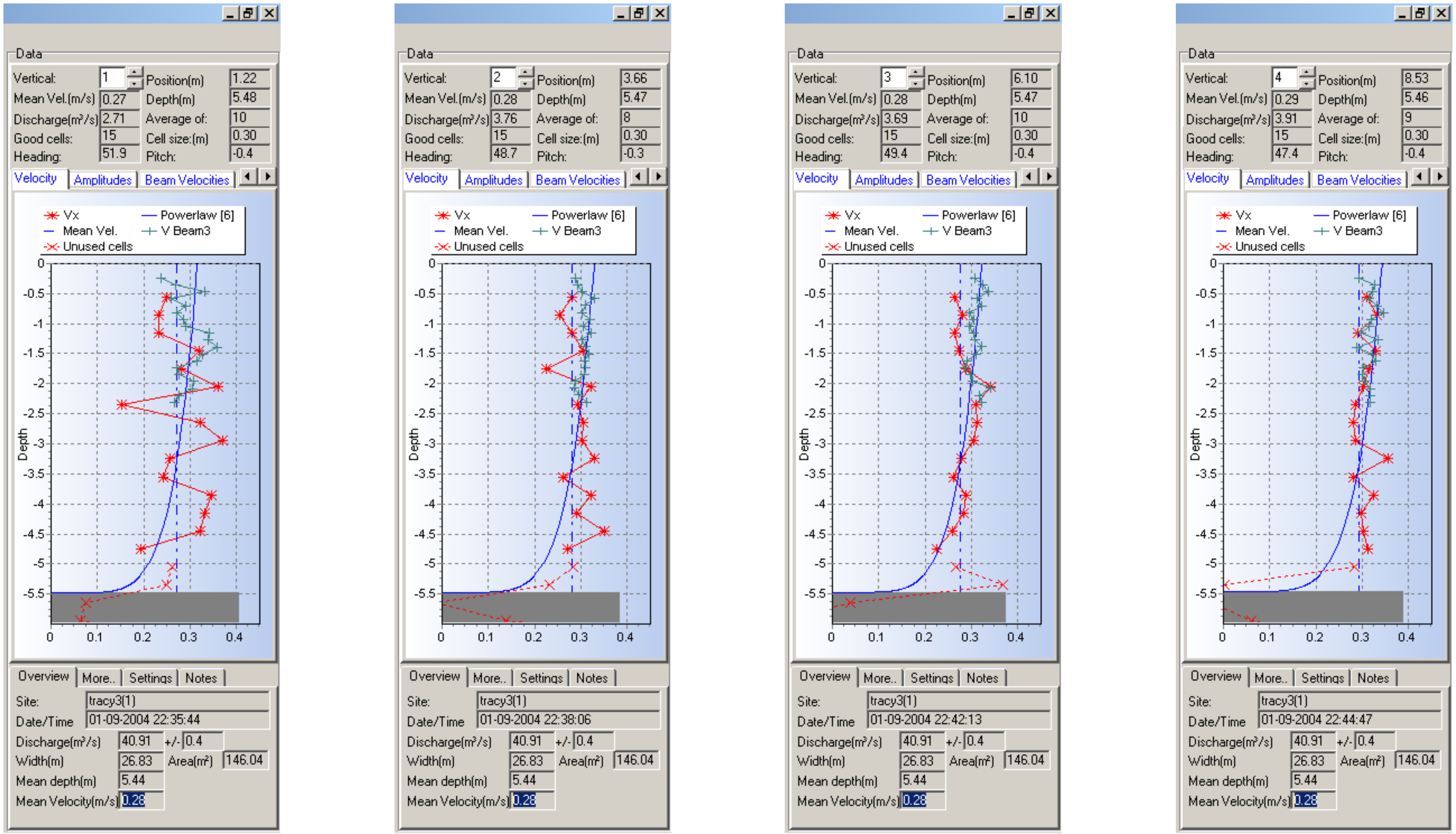


**Figure 2 – Vertical velocity profiles for Verticals 1-4 in discharge measurement 1. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

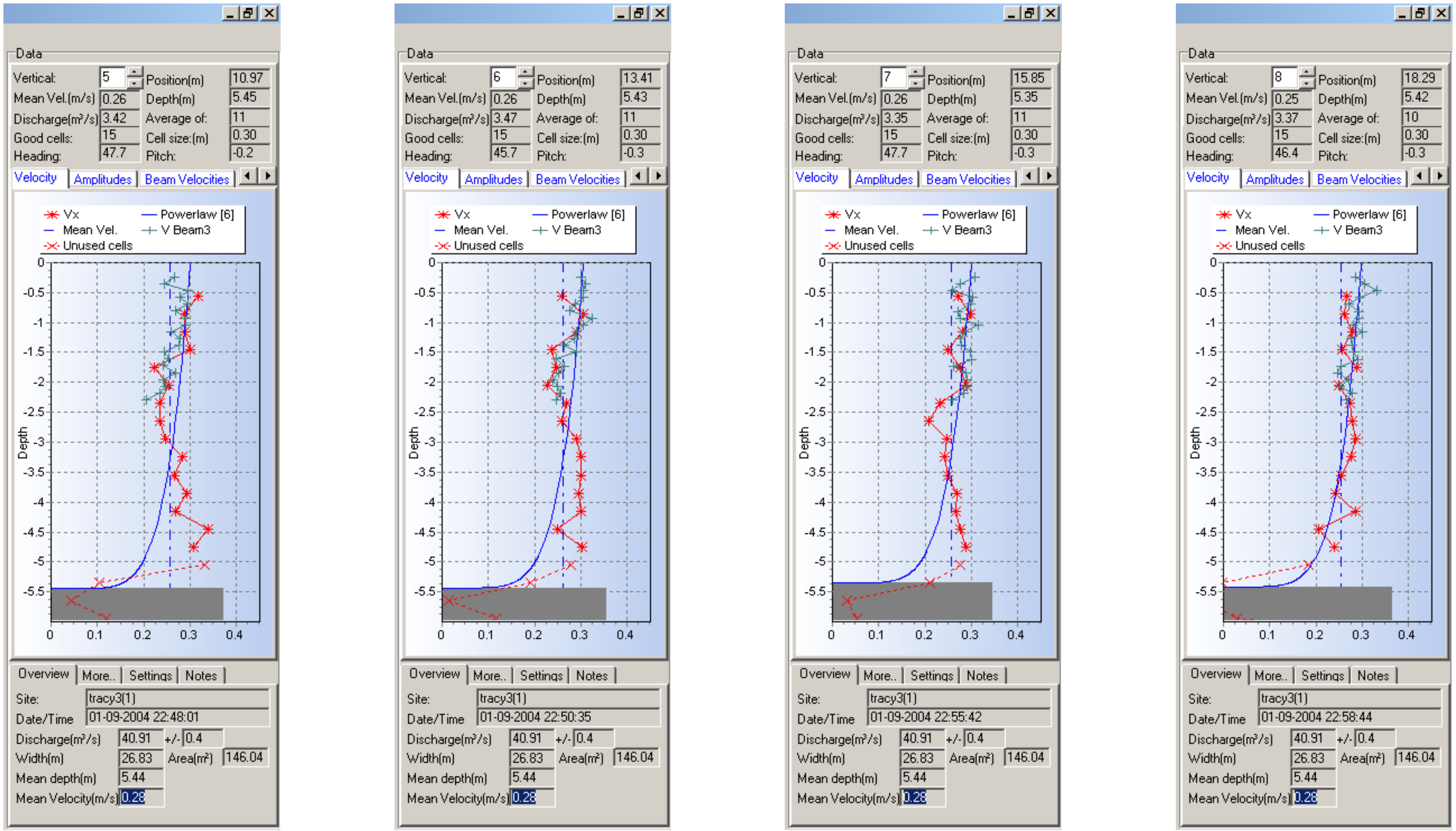


**Figure 3 – Vertical velocity profiles for Verticals 5-8 in discharge measurement 1. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

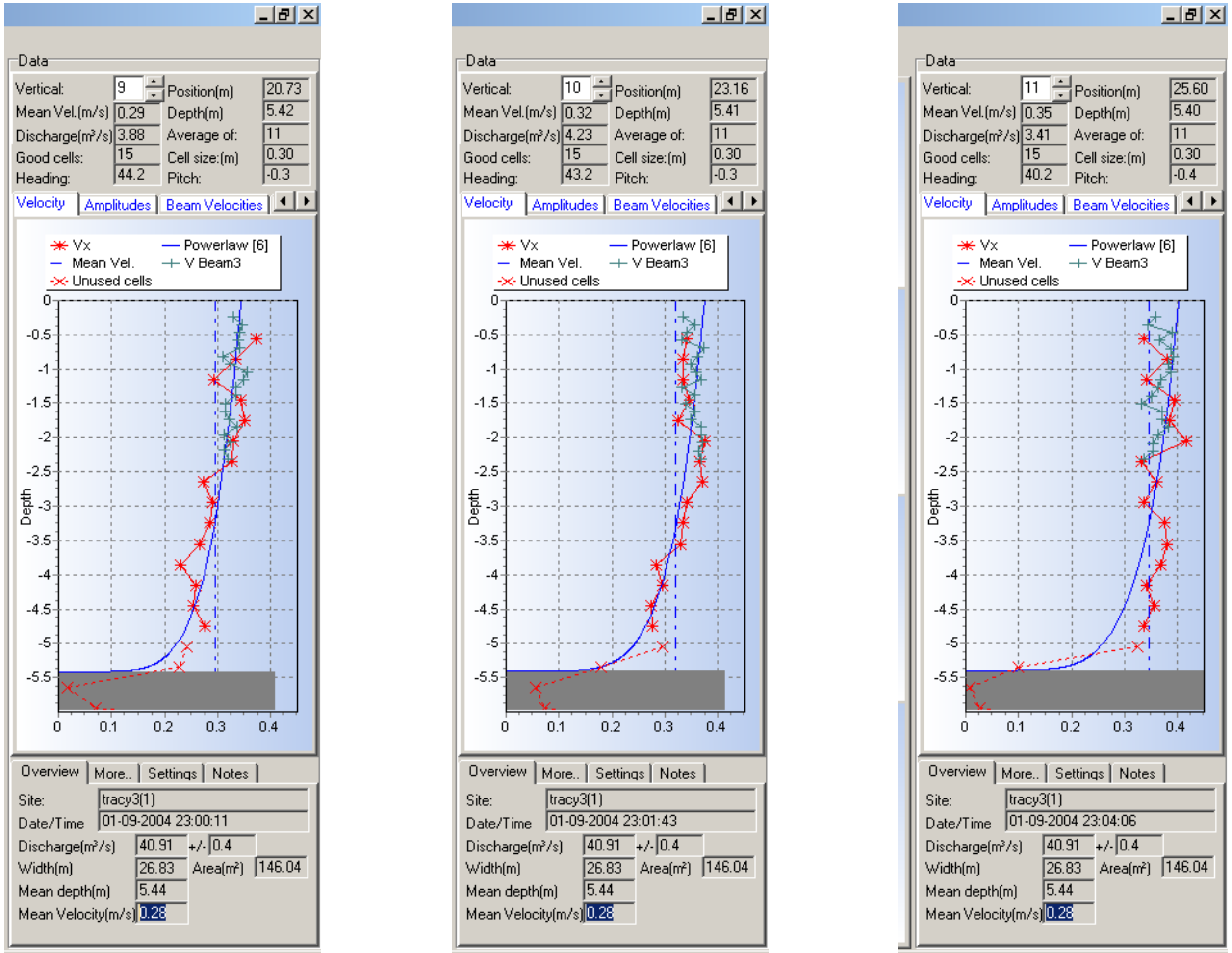


**Figure 4 – Vertical velocity profiles for Verticals 9-11 in discharge measurement 1. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

***Discharge Measurement 2 – 3/25/09 from 1251-1351***

Filename: tracy4
Tidal stage: Outgoing tide near low tide.
Tides: High tide 0747, low tide 1411

**Table 2 – Data collected during discharge measurement 2.**

| | Before Test | | After Test | | Average Over Test | |
|---|---|---|---|---|---|---|
| Reading | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) |
| ChannelMaster 1 | 16.91 | 1.041 | 16.86 | 1.300 | | |
| ChannelMaster 2 | 16.91 | 1.090 | 16.86 | 1.290 | | |
| ChannelMaster 3 | 16.91 | 1.042 | 16.86 | 1.359 | | |
| ChannelMaster 4 | 16.91 | 0.914 | 16.86 | 1.348 | | |
| ChannelMaster 5 | 16.90 | 1.099 | 16.87 | 1.403 | | |
| **ChannelMaster average** | 16.91 | 1.04 | 16.86 | 1.34 | **16.89** | **1.19** |
| **ChannelMaster average over entire time period** | | | | | **16.85** | **1.20** |
| **Primary channel depth sensor** | 16.73 | | 16.67 | | **16.70** | |
| **QLiner velocity profiler** | | | | | **16.34** | **1.21** |

Between 1251 and 1351, the mean velocity from the portable QLiner was 1.21 ft/s and the mean velocity from the ChannelMaster was 1.20 ft/s.  The permanent flowmeter was 0.8% lower than the portable profiler. The discharge measured using the Qliner was approximately 1,731 $ft^3/s$ during this outgoing tide (near low tide).

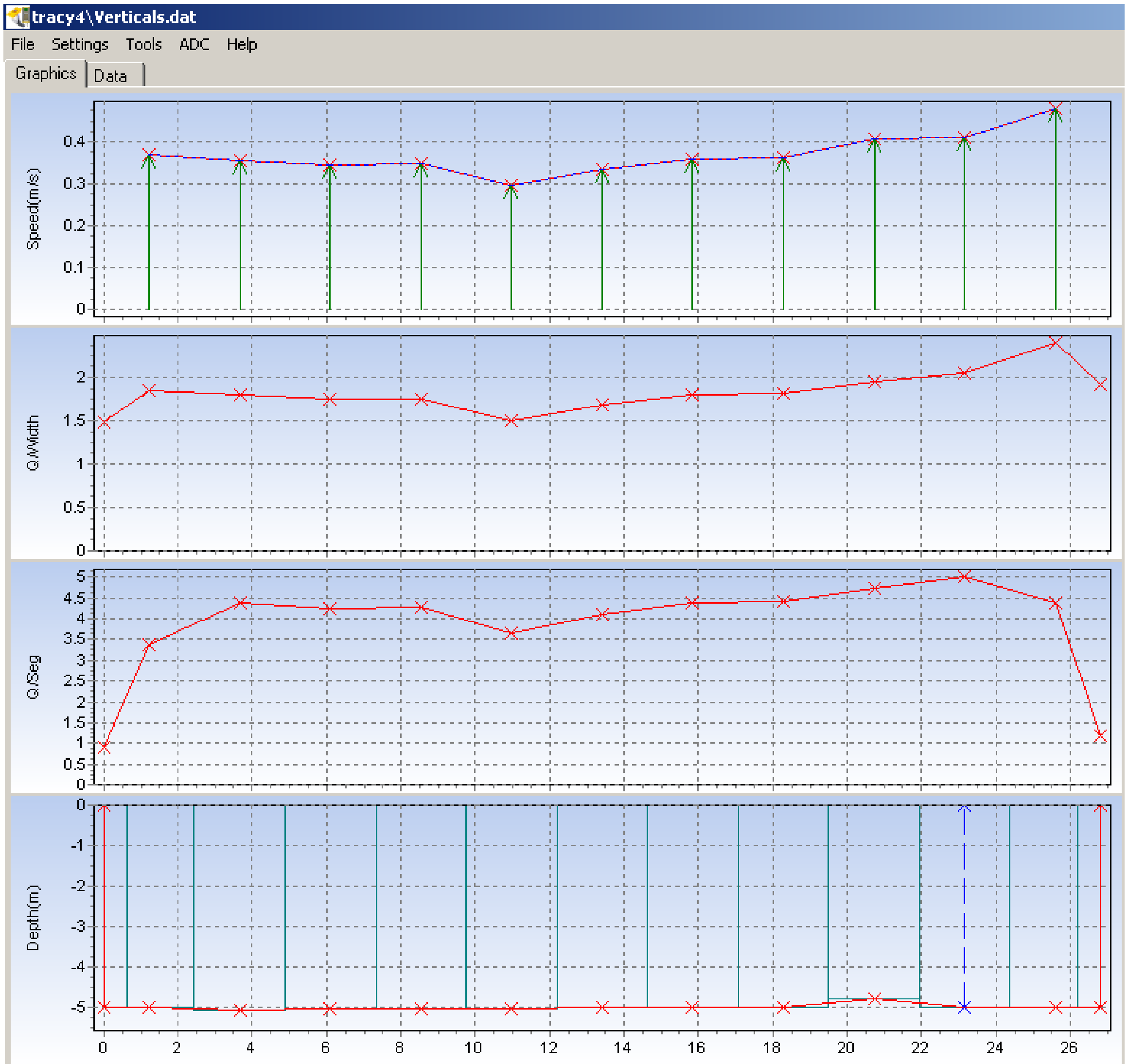


**Figure 5 - Velocity, depth, and discharge in metric units for discharge measurement 2. The transect was measured from left to right looking downstream with vertical 1 on left side and vertical 11 on the right side.**

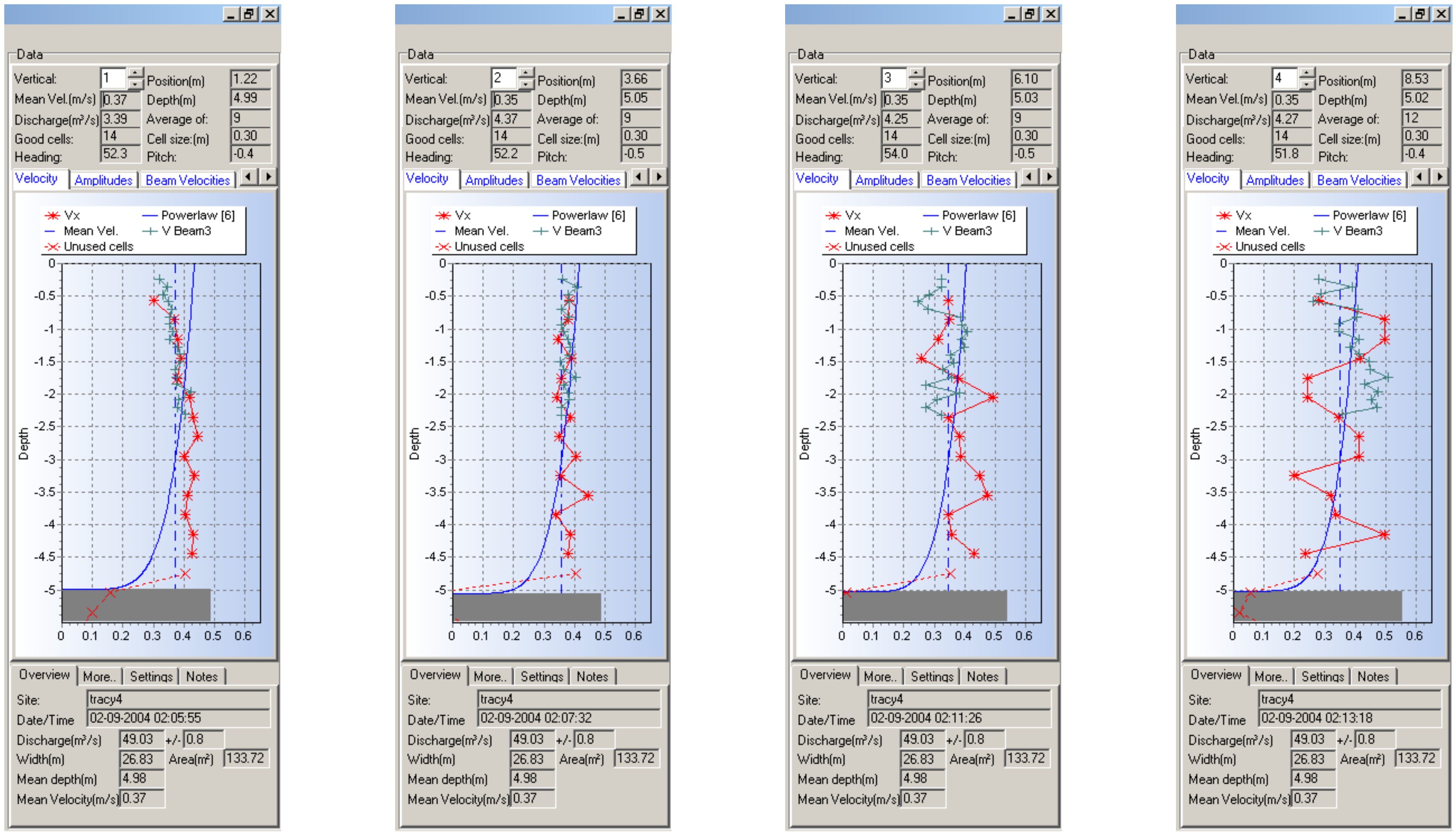


**Figure 6 – Vertical velocity profiles for Verticals 1-4 in discharge measurement 2. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

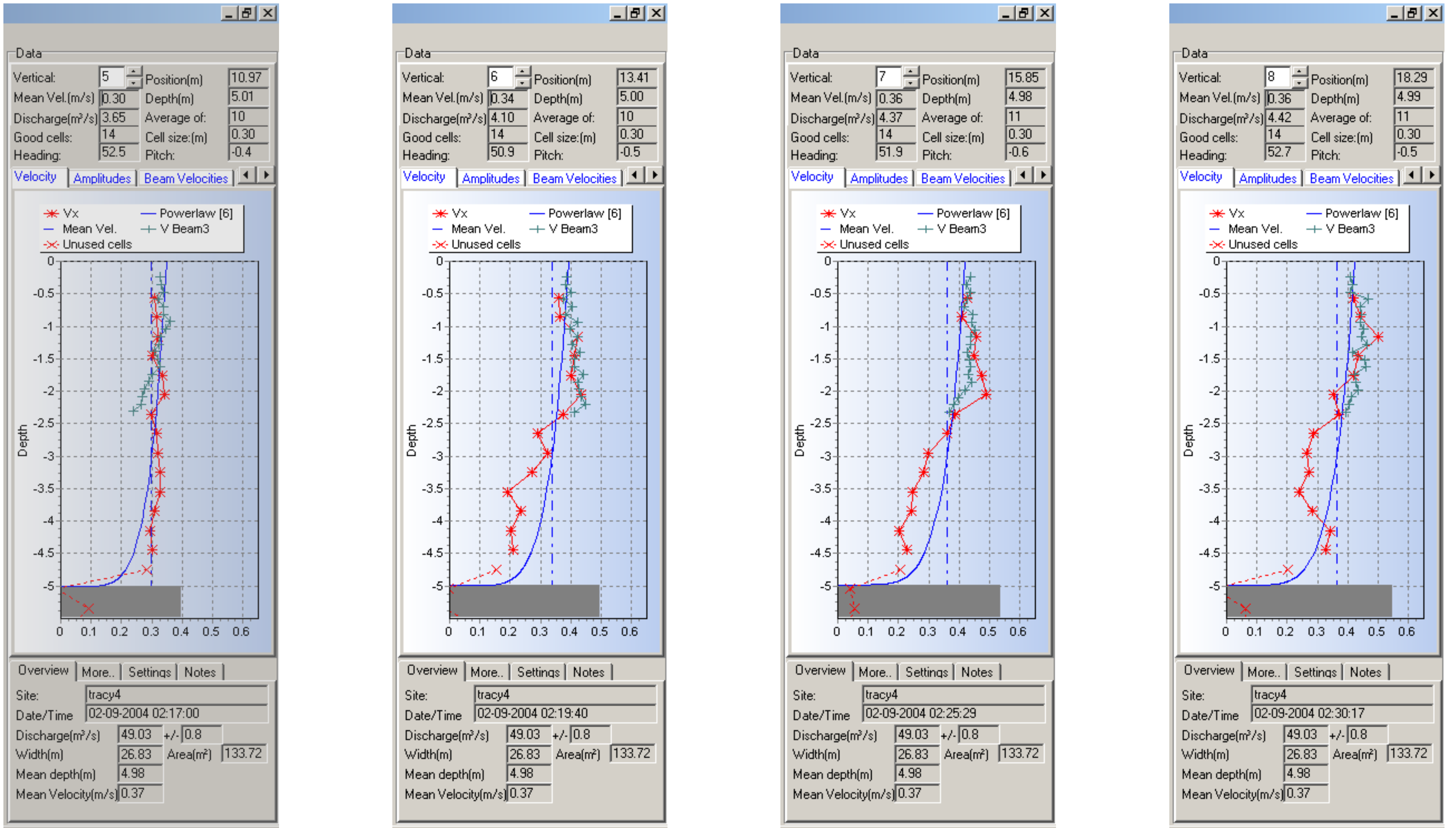


**Figure 7 – Vertical velocity profiles for Verticals 5-8 in discharge measurement 2. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

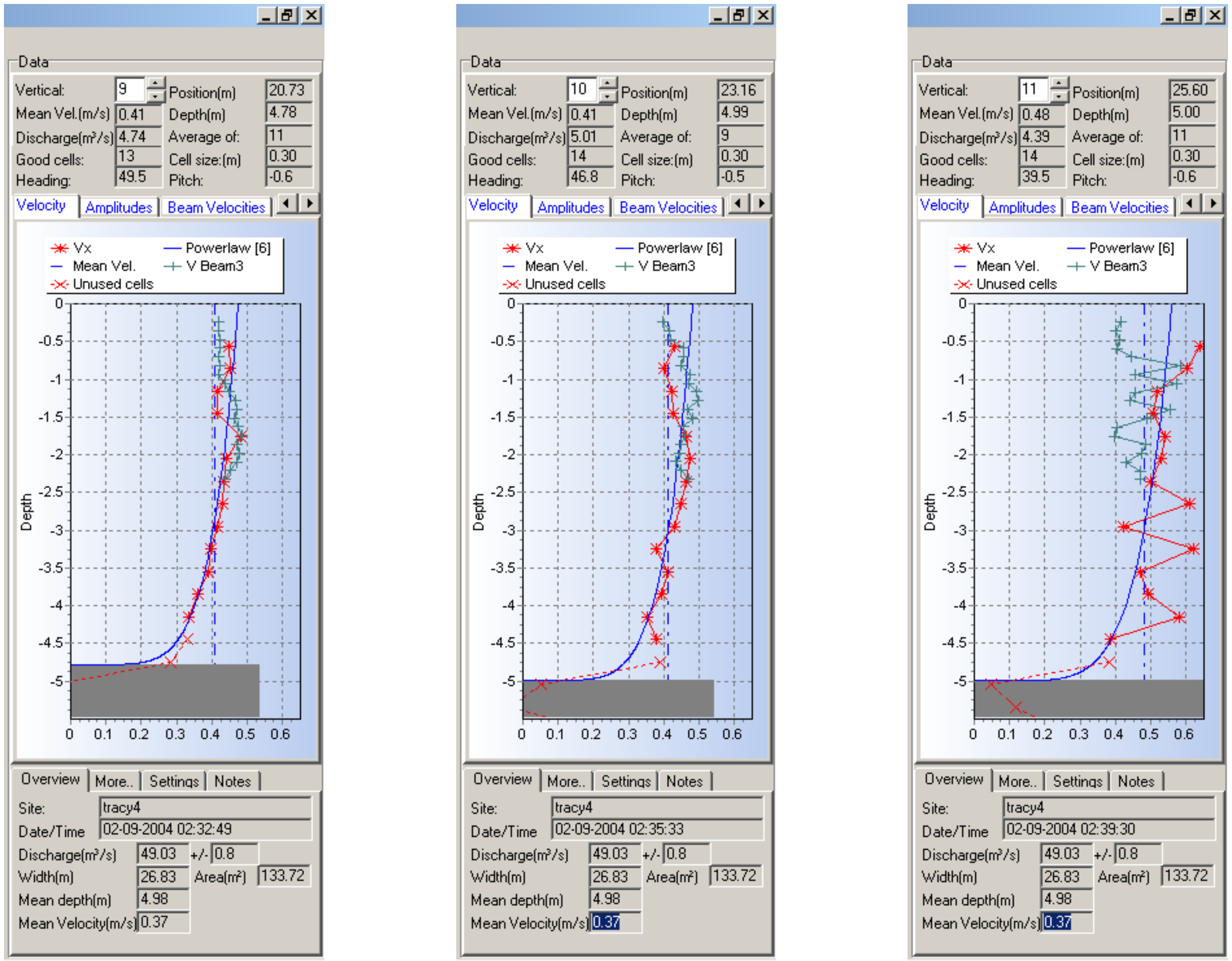


**Figure 8 – Vertical velocity profiles for Verticals 9-11 in discharge measurement 2. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

***Discharge Measurement 3 – 3/26/09 from 1503-1531***

Filename: tracy6
Tidal stage: Incoming tide near low tide.
Tides: High tide 0806, Low tide 1451, High tide 2035

**Table 3 – Data collected during discharge measurement 3.**

| | Before Test | | After Test | | Average Over Test | |
|---|---|---|---|---|---|---|
| Reading | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) |
| ChannelMaster 1 | 17.20 | 1.539 | 17.47 | 1.590 | | |
| ChannelMaster 2 | 17.21 | 1.634 | 17.47 | 1.322 | | |
| ChannelMaster 3 | 17.20 | 1.412 | 17.47 | 1.595 | | |
| ChannelMaster 4 | 17.20 | 1.526 | 17.48 | 1.546 | | |
| ChannelMaster 5 | 17.21 | 1.271 | 17.48 | 1.358 | | |
| **ChannelMaster average** | 17.20 | 1.47 | 17.47 | 1.48 | **17.34** | **1.48** |
| **ChannelMaster average over entire time period** | | | | | **17.34** | **1.48** |
| **Primary channel depth sensor** | 17.01 | | 17.26 | | **17.14** | |
| **QLiner velocity profiler** | | | | | **16.86** | **1.61** |

Between 1503 and 1531, the mean velocity from the portable QLiner was 1.61 ft/s and the mean velocity from the ChannelMaster was 1.48 ft/s.  The permanent flowmeter was 8.1% lower than the portable profiler. The discharge measured using the Qliner was approximately 2,391 $ft^3/s$ during this incoming tide (near low tide).

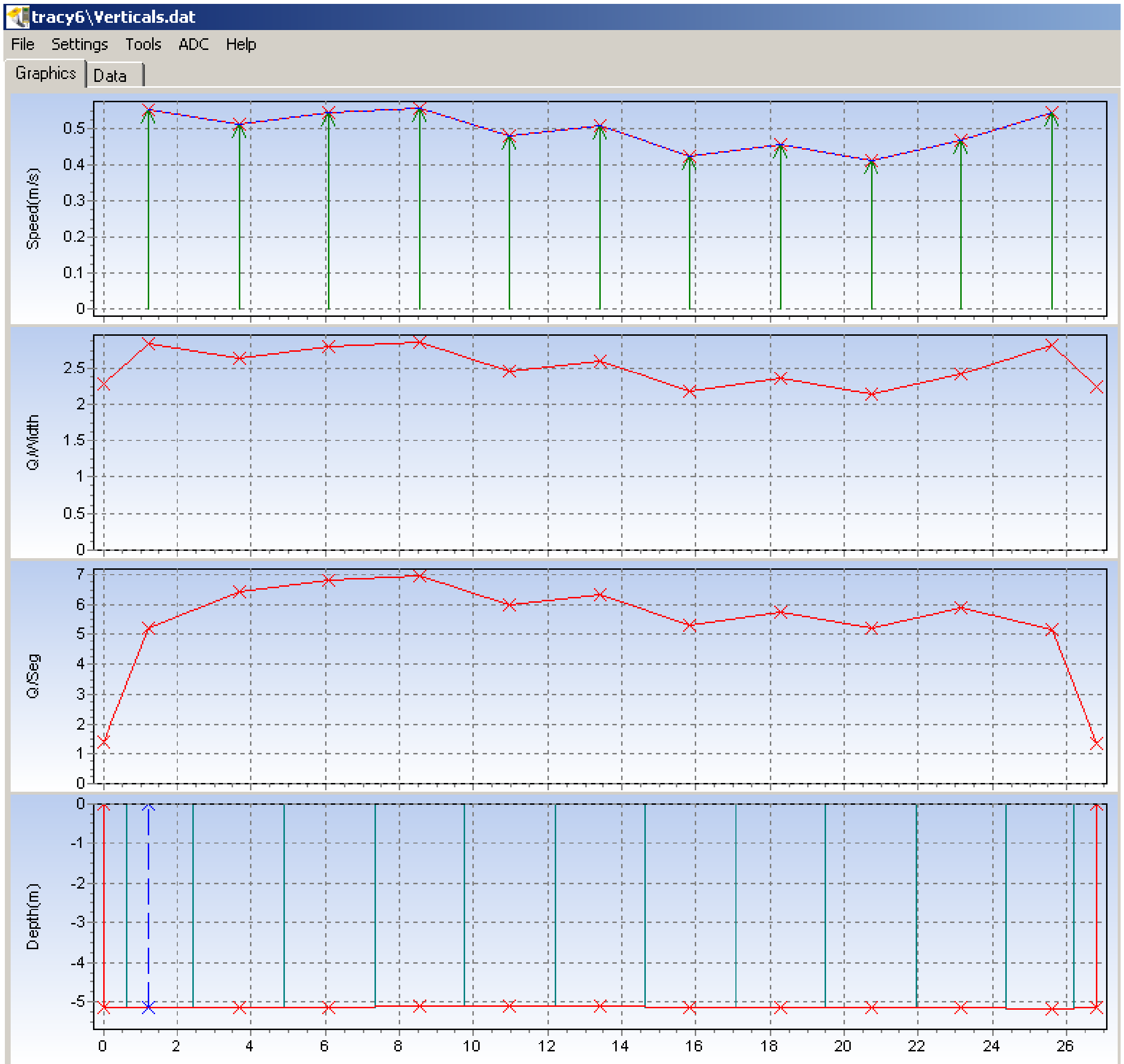


**Figure 9 - Velocity, depth, and discharge in metric units for discharge measurement 3. The transect was measured from left to right looking downstream with vertical 1 on left side and vertical 11 on the right side.**

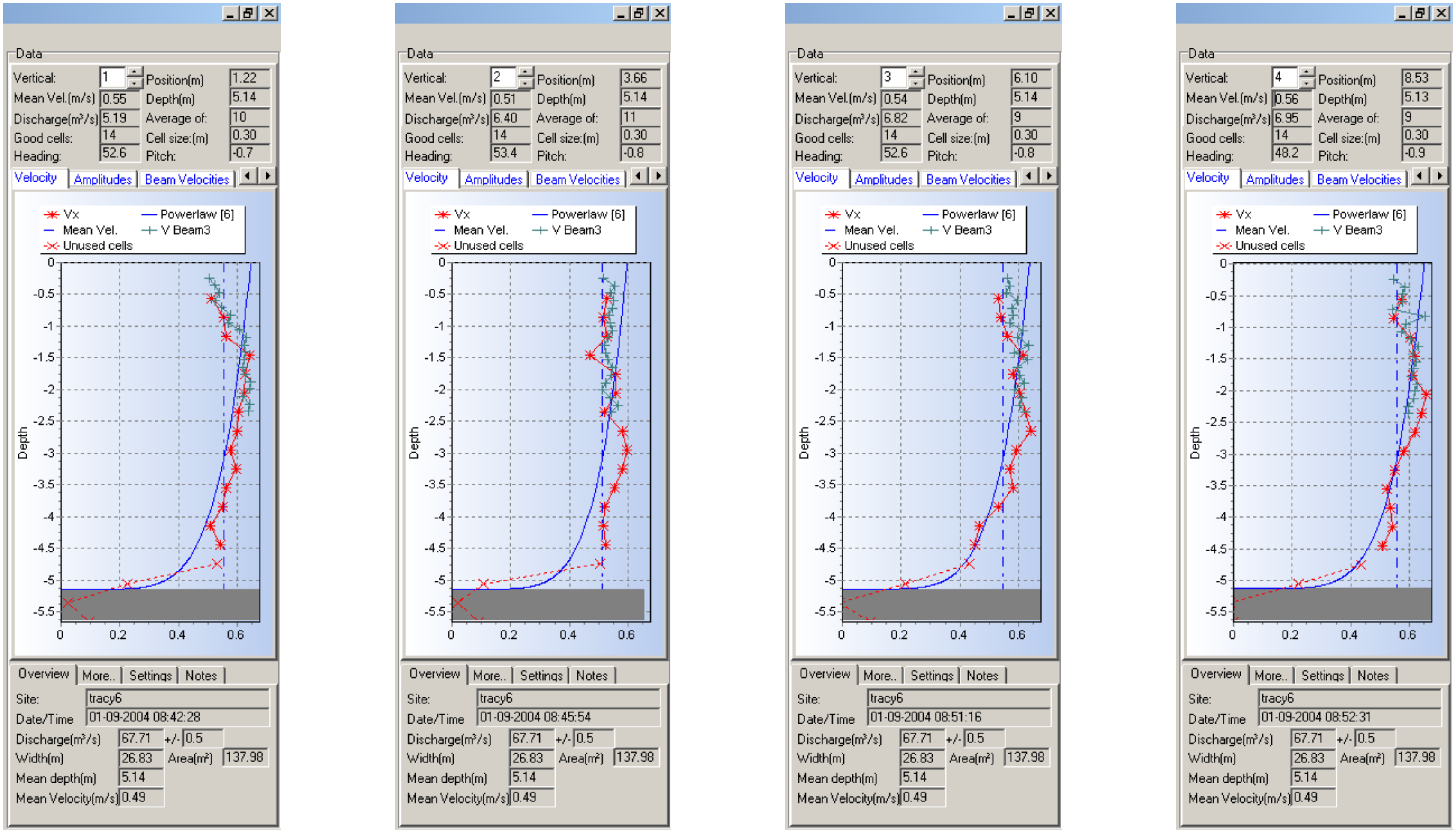


**Figure 10 – Vertical velocity profiles for Verticals 1-4 in discharge measurement 3. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

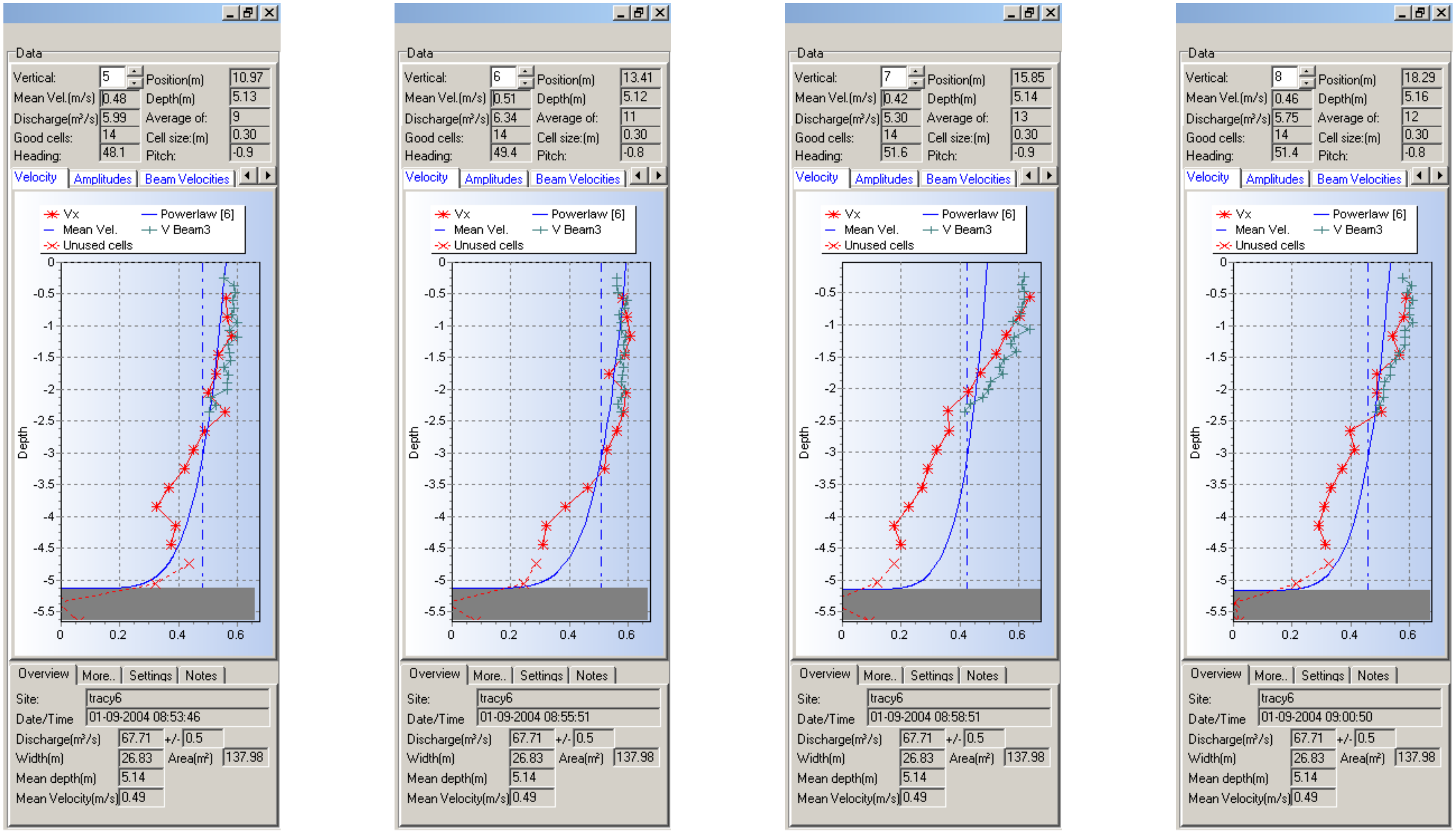


**Figure 11 – Vertical velocity profiles for Verticals 5-8 in discharge measurement 3. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

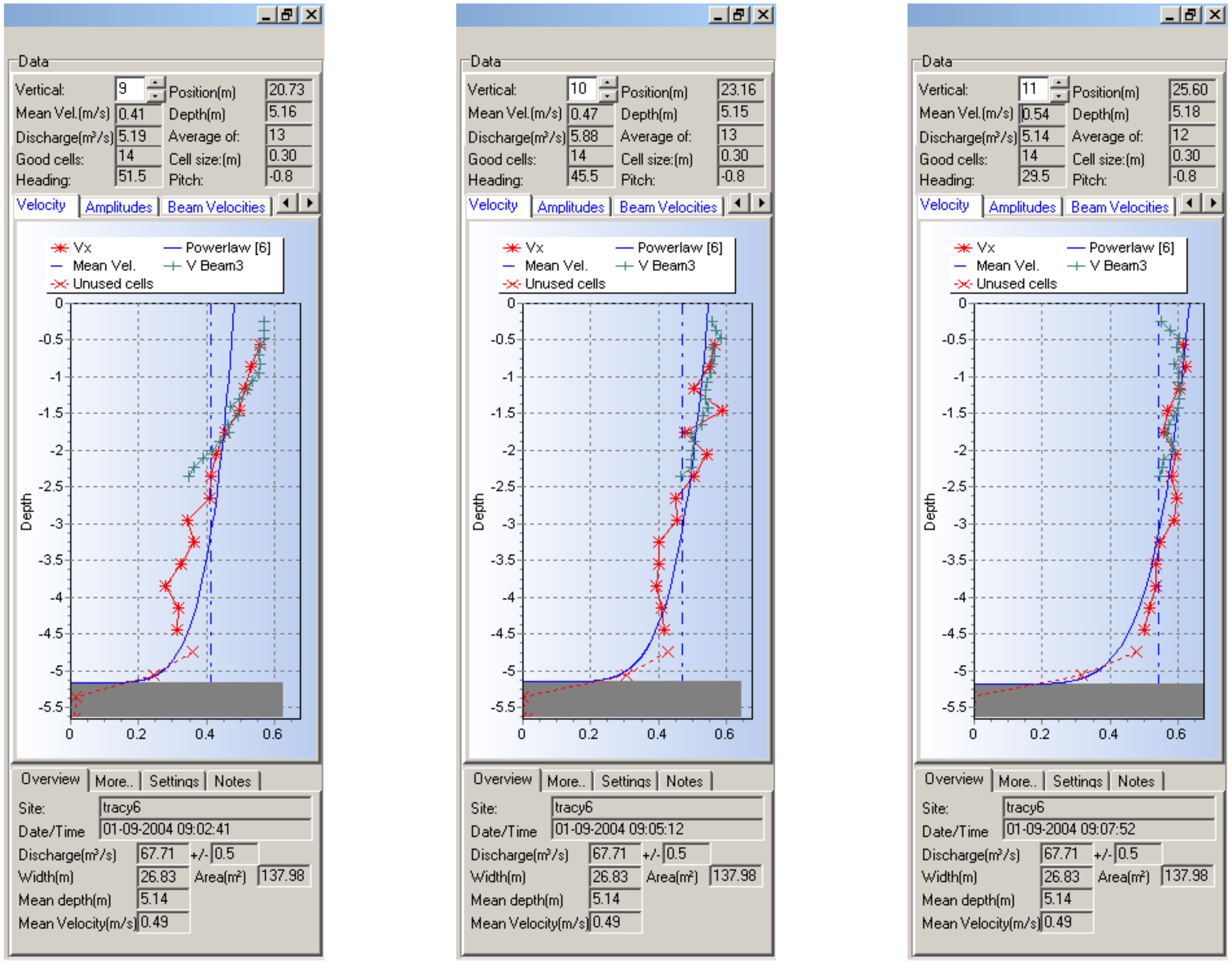


**Figure 12 – Vertical velocity profiles for Verticals 9-11 in discharge measurement 3. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

### *Discharge Measurement 4 – 3/26/09 from 1536-1610*

Filename: tracy7
Tidal stage: Incoming tide.
Tides: High tide 0806, Low tide 1451, High tide 2035

**Table 4 – Data collected during discharge measurement 4.**

| | Before Test | | After Test | | Average Over Test | |
|---|---|---|---|---|---|---|
| Reading | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) |
| ChannelMaster 1 | 17.53 | 1.405 | 17.78 | 1.599 | | |
| ChannelMaster 2 | 17.53 | 1.380 | 17.78 | 1.546 | | |
| ChannelMaster 3 | 17.54 | 1.489 | 17.80 | 1.358 | | |
| ChannelMaster 4 | 17.54 | 1.513 | 17.80 | 1.408 | | |
| ChannelMaster 5 | 17.55 | 1.509 | 17.83 | 1.535 | | |
| **ChannelMaster average** | 17.54 | 1.46 | 17.80 | 1.49 | **17.67** | **1.47** |
| **ChannelMaster average over entire time period** | | | | | **17.67** | **1.44** |
| **Primary channel depth sensor** | 17.35 | | 17.61 | | **17.48** | |
| **QLiner velocity profiler** | | | | | **17.19** | **1.54** |

Between 1536 and 1610, the mean velocity from the portable QLiner was 1.54 ft/s and the mean velocity from the ChannelMaster was 1.44 ft/s. The permanent flowmeter was 6.5% lower than the portable profiler. The discharge measured using the Qliner was approximately 2,315 $ft^3/s$ during this incoming tide.

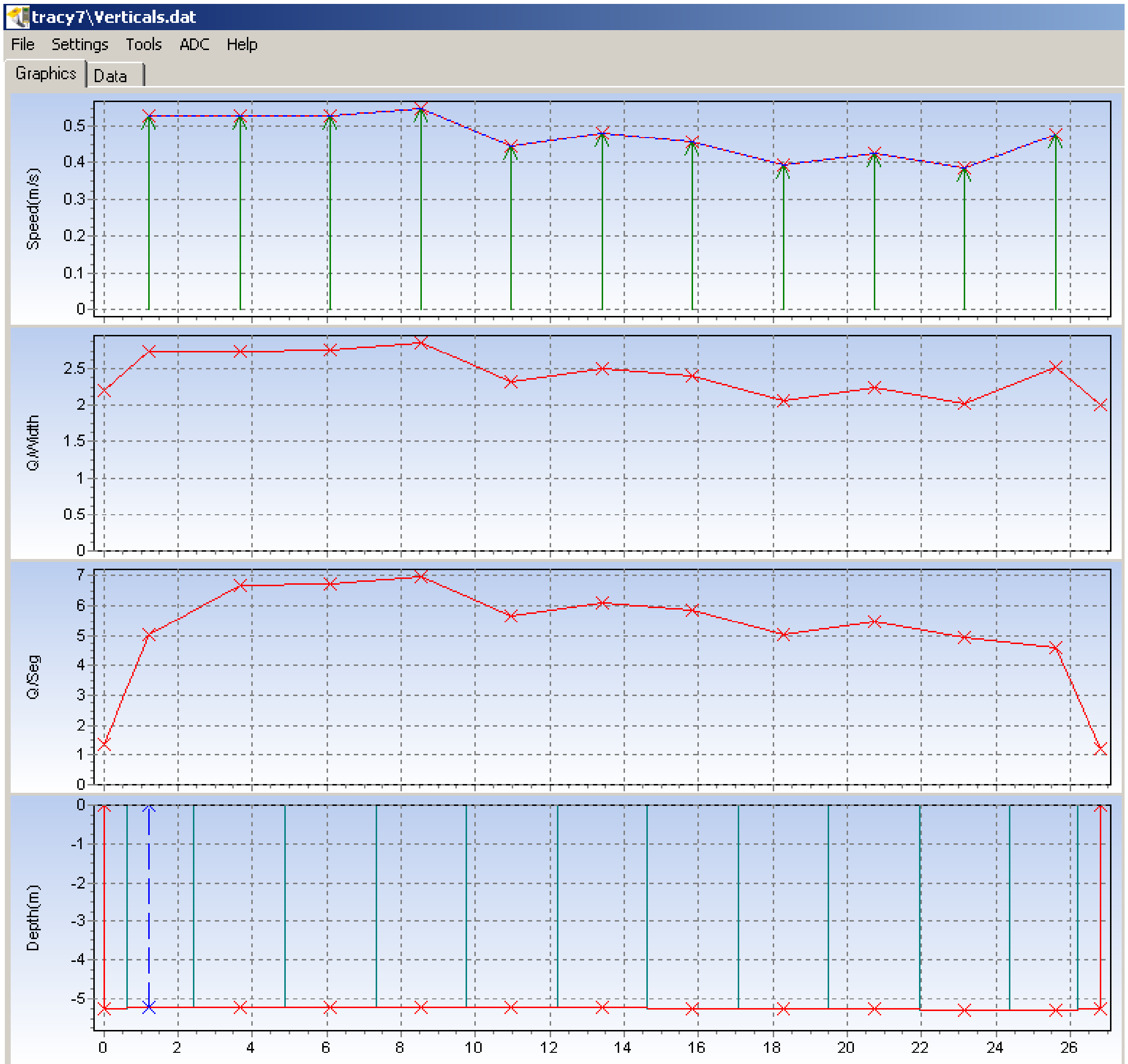


**Figure 13 - Velocity, depth, and discharge in metric units for discharge measurement 4. The transect was measured from left to right looking downstream with vertical 1 on left side and vertical 11 on the right side.**

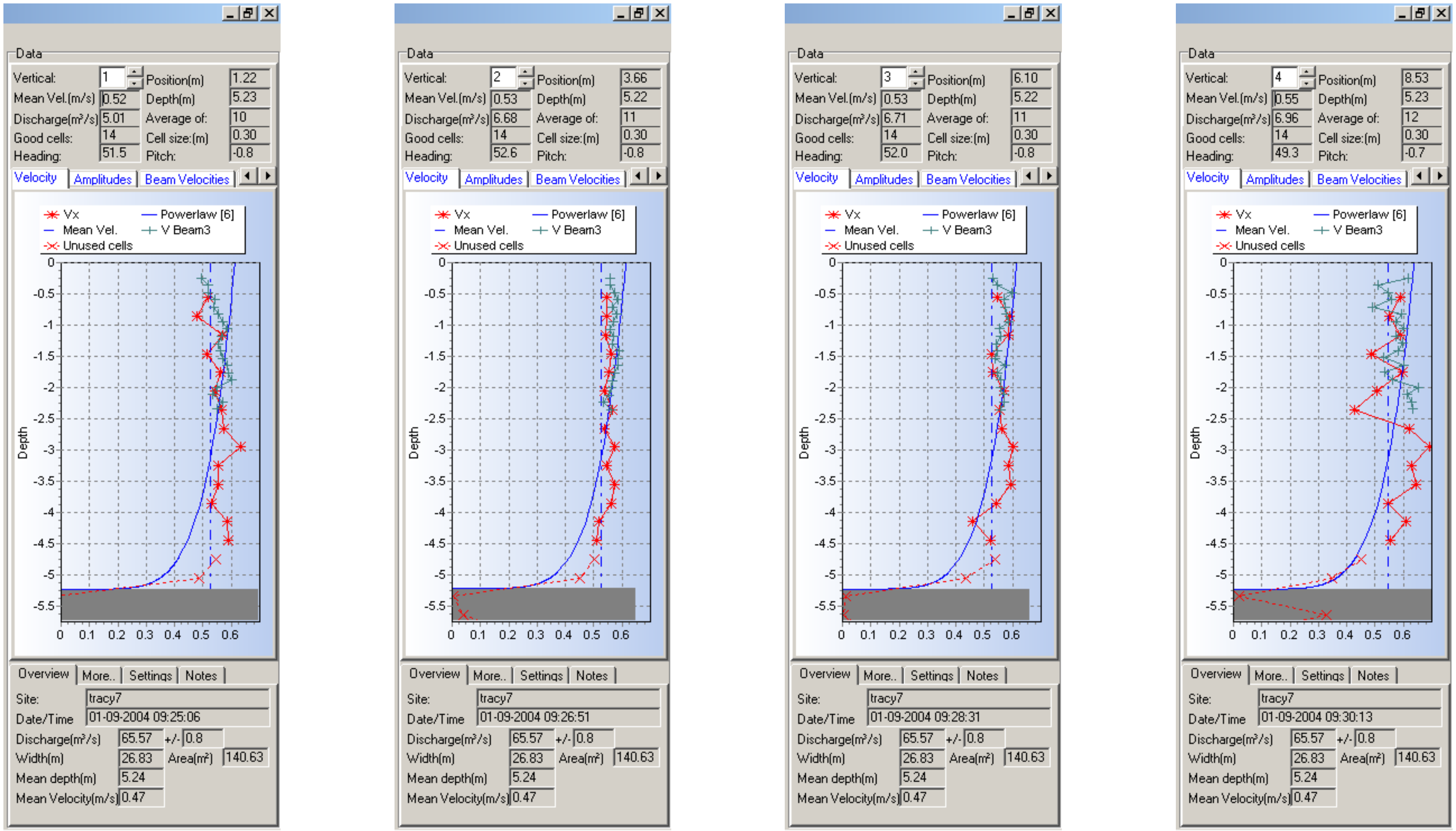


**Figure 14 – Vertical velocity profiles for Verticals 1-4 in discharge measurement 4. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

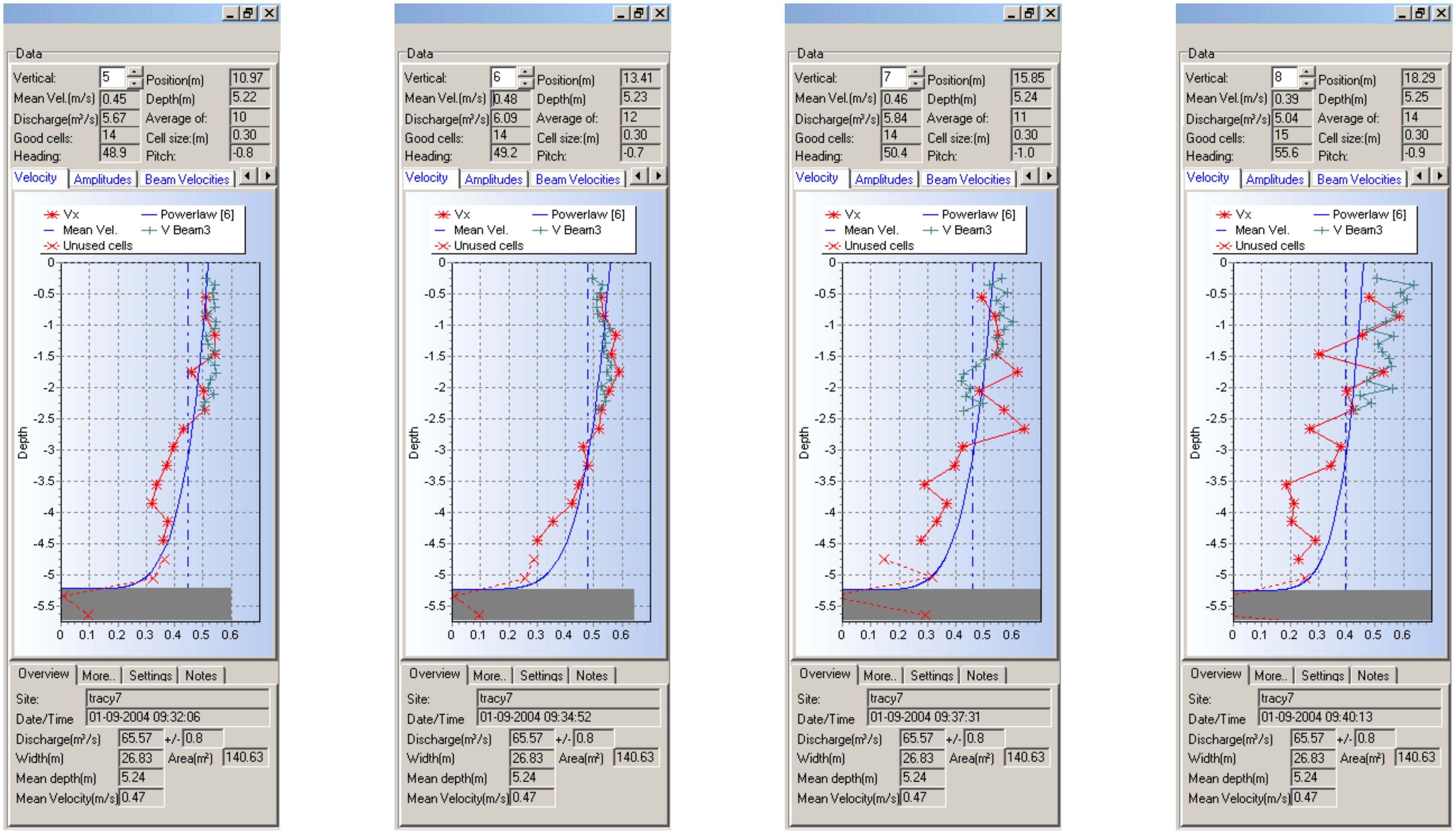


**Figure 15 – Vertical velocity profiles for Verticals 5-8 in discharge measurement 4. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

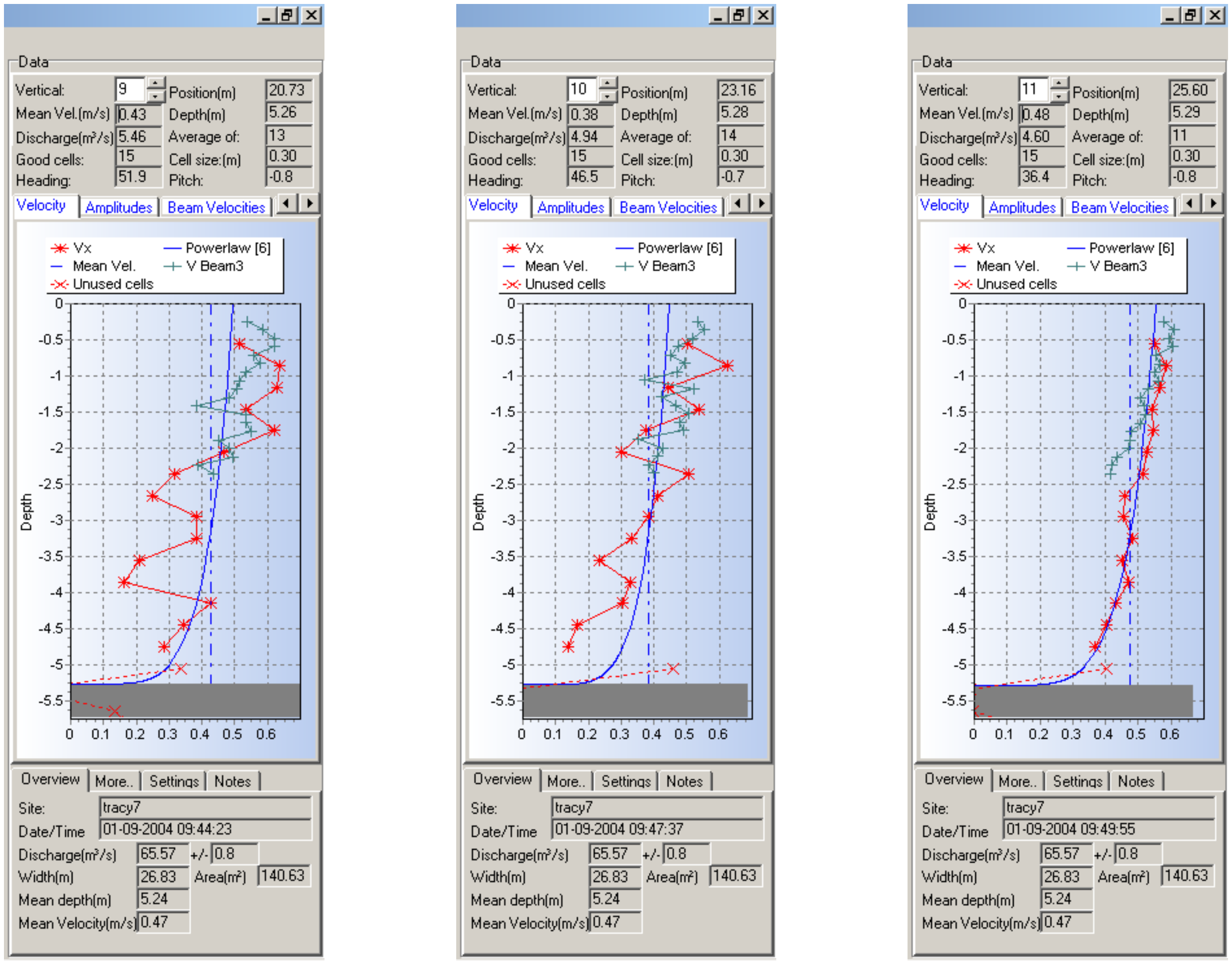


**Figure 16 – Vertical velocity profiles for Verticals 9-11 in discharge measurement 4. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

***Discharge Measurement 5 – 3/26/09 from 1621-1703***

Filename: tracy8
Tidal stage: Incoming tide.
Tides: High tide 0806, Low tide 1451, High tide 2035

**Table 5 – Data collected discharge measurement 5.**

| | Before Test | | After Test | | Average Over Test | |
|---|---|---|---|---|---|---|
| Reading | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) | Depth (ft) | Mean Velocity (ft/s) |
| ChannelMaster 1 | 17.87 | 1.454 | 18.08 | 1.493 | | |
| ChannelMaster 2 | 17.89 | 1.357 | 18.10 | 1.439 | | |
| ChannelMaster 3 | 17.89 | 1.312 | 18.11 | 1.439 | | |
| ChannelMaster 4 | 17.91 | 1.369 | 18.12 | 1.380 | | |
| ChannelMaster 5 | 17.90 | 1.346 | 18.11 | 1.401 | | |
| **ChannelMaster average** | 17.89 | 1.37 | 18.10 | 1.43 | **18.0** | **1.40** |
| **ChannelMaster average over entire time period** | | | | | **17.97** | **1.33** |
| **Primary channel depth sensor** | 17.71 | | 17.81 | | **17.76** | |
| **QLiner velocity profiler** | | | | | **17.49** | **1.38** |

Between 1621 and 1703, the mean velocity from the portable QLiner was 1.38 ft/s and the mean velocity from the ChannelMaster was 1.33 ft/s. The permanent flowmeter was 3.6% lower than the portable profiler. The discharge measured using the Qliner was approximately 2,128 $ft^3/s$ during this incoming tide.

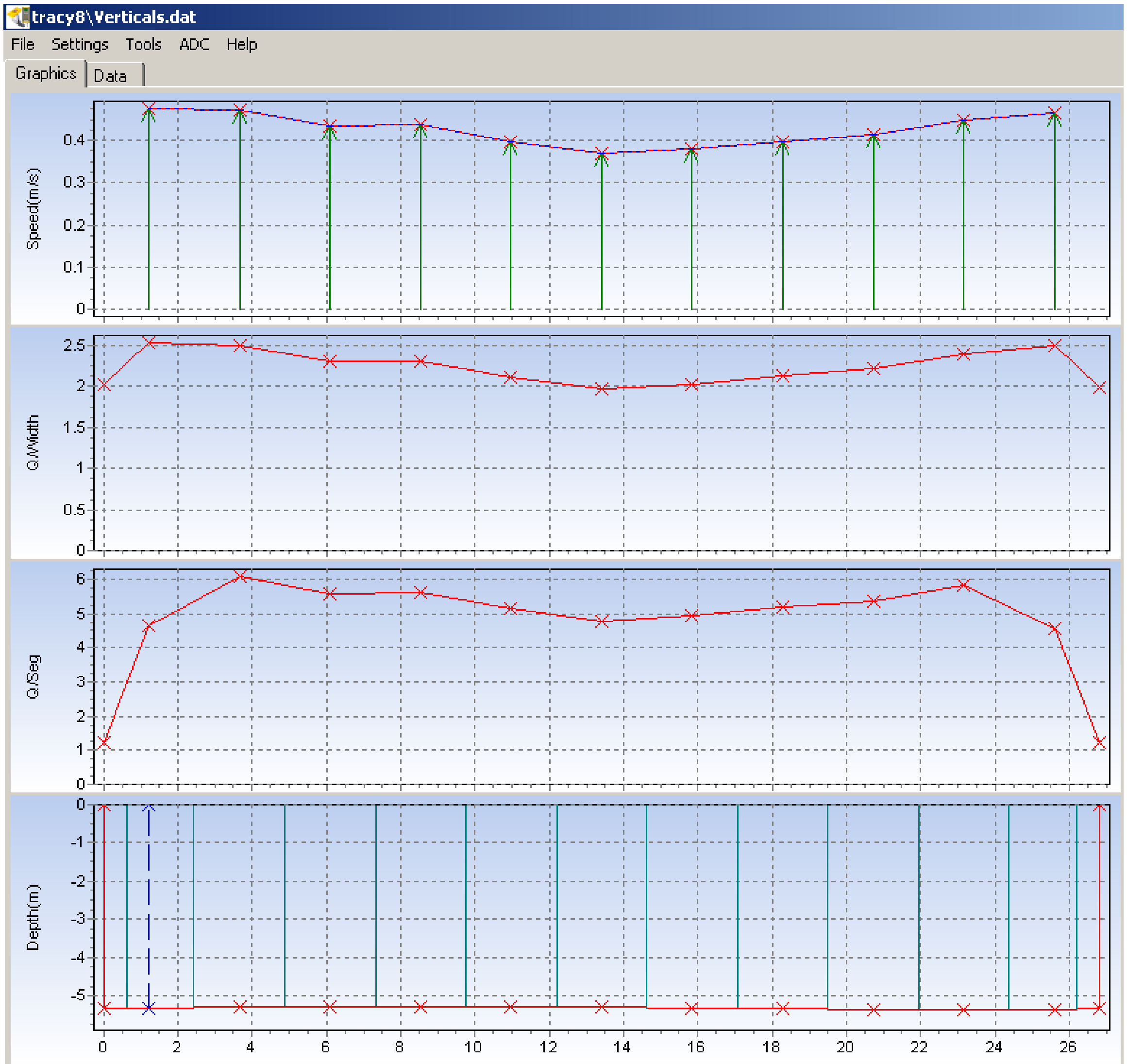


**Figure 17 - Velocity, depth, and discharge in metric units for discharge measurement 5. The transect was measured from left to right looking downstream with vertical 1 on left side and vertical 12 on the right side.**

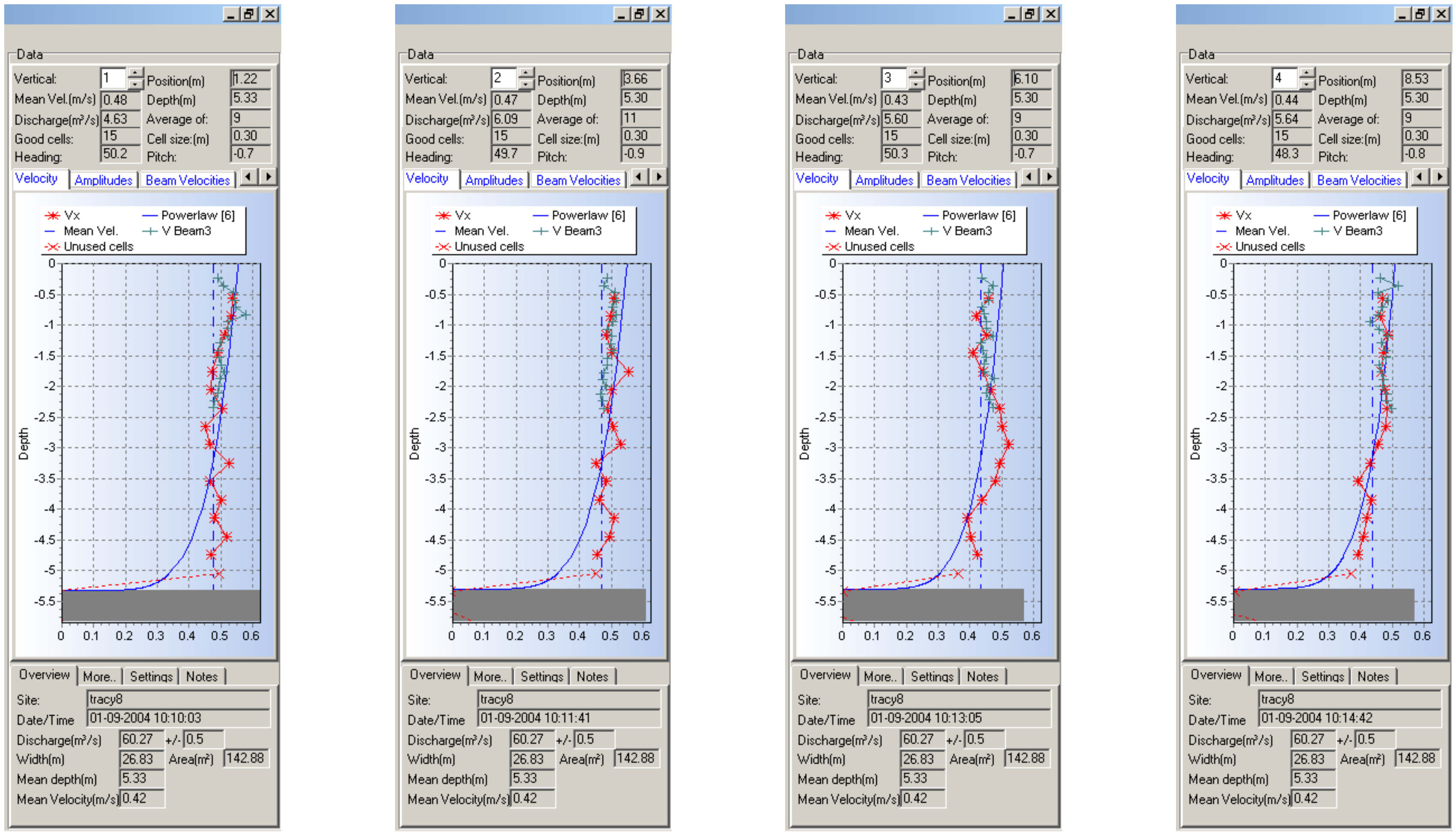


**Figure 18 – Vertical velocity profiles for Verticals 1-4 in discharge measurement 5. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

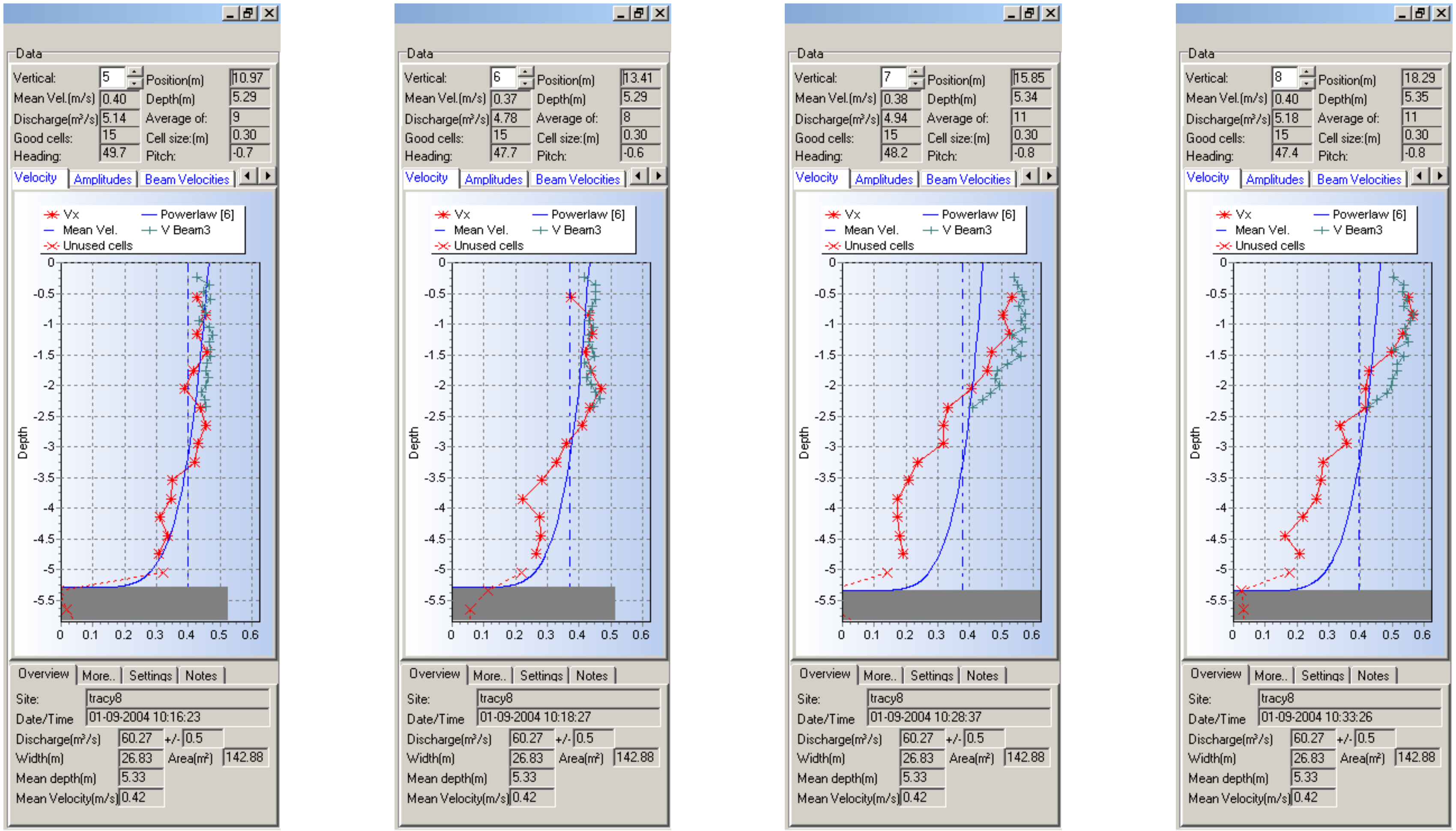


**Figure 19 – Vertical velocity profiles for Verticals 5-8 in discharge measurement 5. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

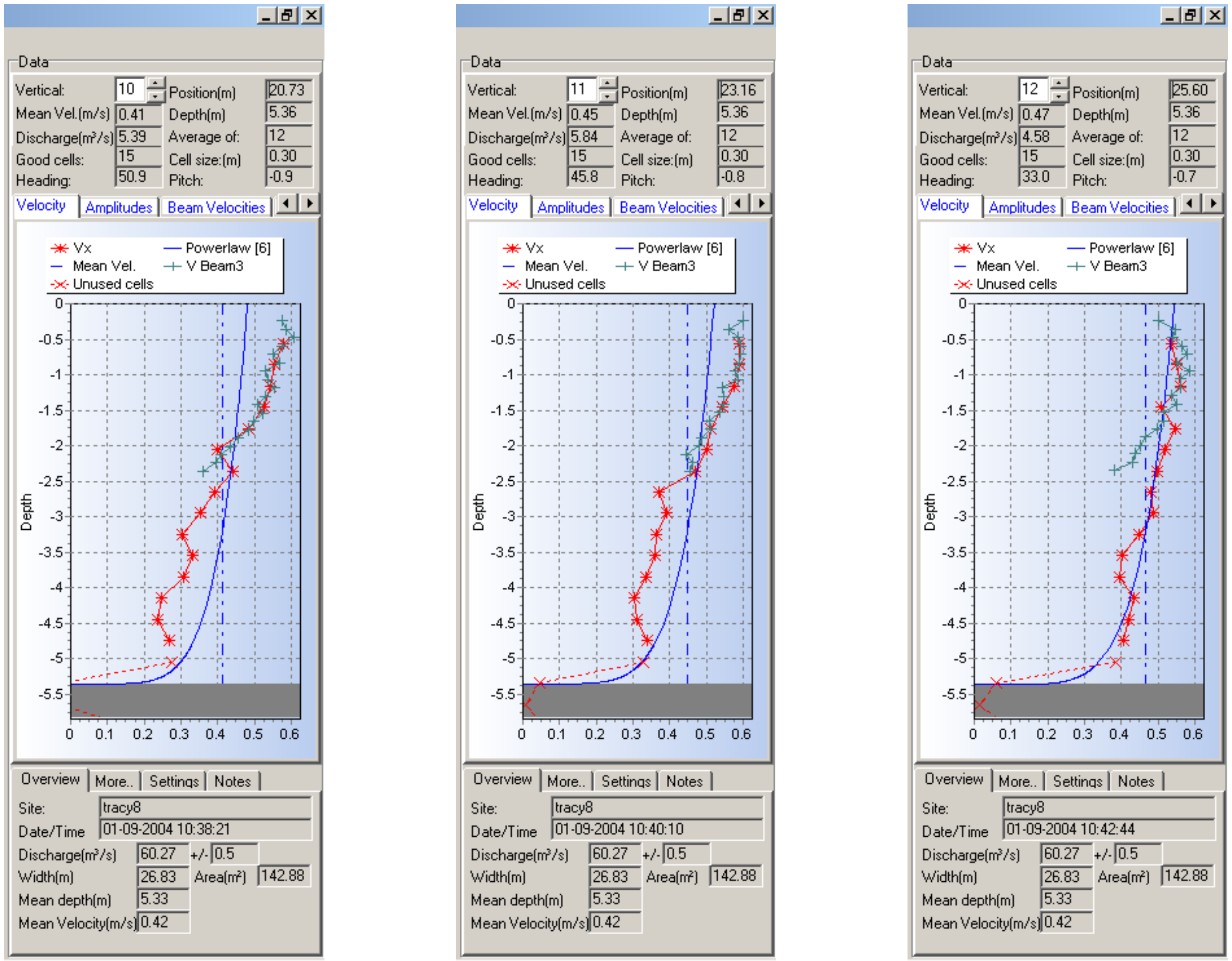


**Figure 20 – Vertical velocity profiles for Verticals 10, 11, and 12 in discharge measurement 5. Information about each profile is shown at the top and average values for the entire transect are shown at the bottom.**

5. Conclusions: Mean velocity values from the ChannelMaster were always lower than the Qliner with differences of 0.8%, 2.2%, 3.5%, 6.5%, and 8.1%. The average difference was 4.2%. Qliner velocity profiles show that the mean velocity tends to be slightly higher near the left edge of the channel. It is possible that the ChannelMaster is not incorporating enough velocity cells on the far left side of the channel toward the louvers. The ChannelMaster's horizontal range should be reevaluated before velocity indexing begins. This comparison between the Qliner and ChannelMaster shows that the permanent facility flowmeter can be used by operators and researchers with some level of confidence until the velocity indexing evaluation is completed.

The lateral skewness in the velocity profiles is far less prominent than was observed in previous tests. In 2003 during 5 pump operations with a typical October debris load, Warren Frizell found that velocity magnitudes on the left side of the channel looking downstream were three times higher than the velocities on the right side of the channel. In these 2009 measurements, mean velocities across the channel were fairly uniform, with slightly lower velocities toward the center of the channel. The lateral uniformity observed during these tests appears to be a result of low debris loads and low pumping rates. Some velocity profiles are more vertically skewed than others, although there is no consistent trend is this data set.

6. Action correspondence initiated or required: Not required.

7. Client feedback received: Not required.

cc: TO-410 (Silva), TO-411 (Bridges), TO-437 (Moser)
86-68290 (Karp)
86-68460 (DeMoyer)

Travelers: Connie DeMoyer, 86-68460

**SIGNATURES AND SURNAMES FOR:**

**Travel to:** Tracy Fish Collection Facility, Tracy, CA

**Date or Dates of Travel:** March 23-27, 2009

**Names and Codes of Travelers:** Connie DeMoyer, 86-68460

**Traveler:**

Connie DeMoyer
Hydraulic Investigations and Laboratory Services Group

4/6/09
Date

**Peer Review by:**

Tracy Vermeyen
Hydraulic Investigations and Laboratory Services Group

4/6/09
Date

**Noted and Dated by:**

Robert Einhellig, Acting Manager
Hydraulic Investigations and Laboratory Services Group

4/8/09
Date