A STANDARD OPERATING PROCEDURES

A.1 STANDARD OPERATING PROCEDURE FOR THE FIELD COLLECTION OF GRAB SAMPLES

STANDARD OPERATING PROCEDURE

FOR THE

FIELD COLLECTION OF GRAB SAMPLES

Bureau of Laboratory Services

Philadelphia Water Department

Signatures and Dates

Lab Analysts ________________________

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Supervisor ________________________

QA Supervisor ________________________

Revised January 2009
Timothy McMahon, Biologist Trainee

1.0 Identification of test method

1.1. The purpose of this SOP is to establish a uniform procedure for collecting grab samples from Philadelphia's surface waters. The procedure is based on standard method 1060.

2.0 Applicable matrix or matrices

2.1. This SOP applies to surface waters.

3.0 Method detection limit

3.1. N/A

4.0 Scope and application, including components to be analyzed

4.1. This SOP describes procedures and requirements for collecting water grab samples, recording the necessary field data and transmitting the collected samples to laboratory facilities for analysis. This includes requirements regarding sample handling, field notes, and chain-of-custody records, along with requirements for quality assurance and quality control (QA/QC). Record keeping is briefly discussed.

5.0 Summary of the test method

5.1. Samples of surface waters are collected in appropriate bottles for the required analytes. The necessary field data is recorded from a multi-parameter sonde placed in-situ. Once collected, the sample is poured off into the correct bottles, as prepared by BLS, for specific analytes, and preserved, if necessary. The samples are then packed into a cooler with ice and transported to BLS for analysis and turned over to the central receiving unit (CRU) with the correct chain-of-custody record. Field-staff file field sheets and input field data into the LIMS system.

6.0 Definitions

6.1. Discrete Grab Sample - A sample that is taken at a selected location, depth and time.

6.2. Multi-Parameter Sonde – A multi-meter that reads instantaneous pH, specific conductivity, temperature, turbidity, and dissolved oxygen when placed in a body of water.

7.0 Interferences

7.1. Contaminants introduced into the sample containers through careless handling, or by using "dirty" preservatives can bias the true values of the sample.

8.0 Safety

8.1. Gathering of water samples may result in exposure to sewage and bacteriologically contaminated water. Field personnel must wear suitable hand protection during the collection and handling of samples and take care to minimize exposure to surface waters. Anti-bacterial wipes should be used after contact with waters.

8.2. Adequate medical protection against risk of infectious disease (tetanus, polio, pertussis, diphtheria and hepatitis A/B) is recommended.

8.3. While working in the field, the field crew must carry a complete first-aid kit that provides materials for disinfection and protection of any skin cuts or abrasions. Personnel will promptly attend to any such cuts or abrasions, and seek medical attention if appropriate, and any such instances will be recorded in the field log, including time and location of incident and description of first-aid treatment applied.

8.4. Field personnel must wear sturdy boots with adequate ankle support. If personnel need to enter a stream, correctly fitting hip- or chest-waders with felt bottoms that have been inspected for water-tightness must be worn, and care taken to avoid slipping.

8.5. When working in cold weather, the field crew must take extra precautions for warmth and keep chemical hand-warmers in the vehicle. Having extra dry clothes is recommended as well.

8.6. If using concentrated acid to acidify samples, sampler must wear safety glasses and latex gloves.

9.0 Equipment and supplies

9.1. Sample bottles or containers prepared and preserved in accordance with BLS protocols (see Table 1, section 23.0) and concentrated H_2SO_4 as preservative if collecting TKN^- samples.
9.2. 0.45 µm pore-size screw-tip filters and 60 mL syringes (if sampling dissolved metals)
9.3. Insulated coolers for sample transport
9.4. Ice
9.5. Chain-of-custody forms
9.6. BLS field sheets (attached in section 23.0)
9.7. Multi-parameter field sonde (usually YSI 6920 sonde, but can also use YSI 6600 or 600XLM sondes, or YSI 85D/YSI 60 portable meters) with check standards (see section 10.0)
9.8. Hip- or chest-waders with felt bottoms, to allow personnel to wade into stream.
9.9. First aid kit
9.10. Latex gloves

10.0 Reagents and standards

10.1. **Where catalog numbers are given, equivalent products may be used. Any chemical or reagent without a manufacturer's expiration date is valid for up to ten years of receipt.**
10.1.1. Conductivity check standards, 100 and 500 µmhos/cm (100 µmhos/cm – Ricca Chemical, cat. No 2237-1; 500 µmhos/cm – Ricca Chemical, cat. No 2241-1)
10.1.2. pH check standards at 6.86 and 7.40 (pH 7.40 – Ricca Chemical, cat. No 1565-5; pH 6.86 – Ricca Chemical, cat. No 1540-1)
10.1.3. Turbidity check standard (either Milli-Q DI water (0.0-NTU) or prepared 9.0-NTU check std, diluted from 1000-NTU stock solution) (1000-NTU solution- Ricca Chemical, cat. No 8825-16)
10.1.4. Concentrated sulfuric acid, to acidify necessary samples.

11.0 Sample collection, preservation, shipment and storage

11.1. For sample collection, shipment and storage, see section 14.0
11.2. For sample preservation, see Table 1 in section 23.0

12.0 Quality control

12.1. Field sonde must be calibrated prior to sampling in the field.
12.2. Field sonde must be checked with check standards before sampling and recorded in the appropriate section on the field sheet.
12.3. After ten samples are taken, field sonde must be checked with check standards and recorded in the appropriate section on the field sheet.
12.4. After sampling, field sonde must be checked with check standards and recorded in the appropriate section on the field sheet.

13.0 Calibration and standardization

13.1. For calibration information, see appropriate SOP for the field meter being used.

14.0 Procedure

14.1. Drop the field sonde into the stream near to where sample will be drawn from. Sample must be taken from a representative and well-mixed area of the stream, generally mid-channel and mid-depth, where the flow is swift enough that solids do not settle out.
14.2. To gather a water sample, dip the sample bottle into the flow stream being careful not to draw in bottom sediments or detritus. Do not include large non-homogeneous particles in the sample.

14.3. Face the sampling bottle upstream to avoid contamination.

14.4. Once the sample bottle has been filled, cap it. Pour off samples into appropriate containers with labels that contain date, time, location, and analyte. Labels are provided by CRU. Sampler must fill out information legibly and accurately with waterproof ink. Add preservative if necessary (label adequately any bottle containing concentrated acid as corrosive) and place sample in a cooler with ice. Preservative must be added within 15 minutes of sample collection. Take care to minimize risk of contamination by handling samples as little as possible and by as few people as possible.

14.4.1. Do not touch the inner portion of sample bottles and caps with bare or gloved hands.

14.4.2. Sample bottles must be kept in a clean environment away from dust, dirt, fumes, and grime. Vehicle cleanliness is important to eliminating contamination problems.

14.4.3. Samples must never be allowed to stand in the sun and must remain cool.

14.5. For dissolved metals, sample filtration must occur on site.

14.5.1. Season syringe with 60 mL of well mixed sample and discard.

14.5.2. Fill syringe with 60 mL of sample.

14.5.3. Attach filter head to syringe and filter.

14.5.4. Use first 5 mL of filtrate to rinse dissolved metals container and discard.

14.5.5. Collect appropriate aliquot of sample into the dissolved metals container.

14.6. Record field notes on BLS field sheet with appropriate date, time, and location. Each location sampled must have a field sheet. Field notes will also include:

14.6.1. Sampling team initials

14.6.2. Weather conditions

14.6.3. General observations regarding flow, water clarity, odors at sampling sites

14.6.4. Modifications to established procedures

14.6.5. Readings from field sonde (pH, temperature, specific conductivity, dissolved oxygen, and turbidity). Record readings once sonde values have stabilized. Be careful that sonde is reading a representative sample of the stream (if detritus and sediment is disturbed by wading into the stream, place sonde upstream of the murky area).

14.7. The field sampling crew will initiate a chain-of-custody form for all samples. Chain-of-custody forms will include information on project name, date and time of sample collection, sample description, sample location, which analysis is required on each sample, method of sample preservation used at the time of sample collection, and date and time of sample custody transfer. Chain-of-custody forms are provided by BLS.

14.8. Return samples to the Central Receiving Unit at BLS immediately upon return and relinquish them with the chain-of-custody form.

14.9. Add field data to LIMS system.

15.0 Calculations – N/A

16.0 Method performance

16.1. Quality control data can be found on the sample field sheet.

17.0 Pollution Prevention

17.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation.

17.2. For information about pollution prevention that may be applicable to laboratories and research institutions, consult “Less is Better: Laboratory Chemical Management for Waste

Reduction", available from the QA Department or from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington D.C. 20036, (202)872-4477.

18.0 Data assessment and acceptance criteria for quality control measures

18.1. Calibration – Calibration criteria are listed in the SOP for the multi-meters used (Standard Operating Procedure For YSI 60 Portable Meter, Standard Operating Procedure For YSI 85 Portable Meter, & Standard Operating Procedure For YSI Sondes Models 600XLM, 6600, 6820, And 6920 To Monitor Water Quality In Streams)

19.0 Corrective actions for out of control data

19.1. Calibration check – If calibration check fails, recalibrate field sonde for whichever parameter failed the check.

20.0 Contingencies for handling out of control or unacceptable data

20.1. If a parameter on the field sonde fails a calibration check, the data points recorded since the last valid calibration check must be flagged. A "failed check standard" flag must be noted both on field sheets and in the LIMS system.

21.0 Waste management

21.1. All check standards for this procedure used in the field must be collected in a waste container and brought back to BLS, where they can be poured down the drain with sufficient water for dilution.

22.0 References

22.1. Standard Methods for the Examination of Water and Wastewater, 1995. American Public Health Association, American Water Works Association, American Environmental Federation, 20th Edition. Eaton, A.D., Clesceri, L.S., and A.E. Greenberg, Eds.

23.0 Tables, diagrams, flowcharts, and validation data

Table 1
Recommended sample containers and sample preservation

Parameter	Container	Sample Container Size	Preservation
Total Suspended Solids	Polyethylene or Glass	500 ml	
Carbonaceous and Biochemical Oxygen Demand	Polyethylene or Glass	500 ml	
Fecal Coliform,	Sterilized Polyethylene or Glass	250 ml	(Add $Na_2S_2O_7$)(1)
Ammonia	Polyethylene or Glass	500 ml	Add H_2SO_4 until pH <2
Nitrate + Nitrite	Polyethylene or Glass	100 ml	Add H_2SO_4 until pH <2
Ortho-Phosphate	Polyethylene or Glass	50 ml	Filter on site or within 6 hours
Phosphorus	Polyethylene or Glass	50 ml	Add H_2SO_4 until pH <2
Metals (Total Recoverable and/or Dissolved)	Polyethylene	250 ml	
E. coli	Polyethylene or Glass	500 ml	Add $Na_2S_2O_3$ (0.008%)
Alkalinity	Polyethylene or Glass	500 ml	
Fluoride	Polyethylene	500 ml	
Osmotic pressure	Polyethylene	120 ml	
Total Dissolved Solids	Polyethylene	500 ml	
Turbidity	Polyethylene	100 ml	
TKN	Polyethylene or Glass	500 ml	Add H_2SO_4 until pH <2
Chlorophyll	Amber Glass Only	1000ml	
Phenols	Glass only	500 ml	Add H_2SO_4 until pH <2

A.2 STANDARD OPERATING PROCEDURE FOR CONTINUOUS WATER QUALITY MONITORING WITH YSI MODEL 6600 AND 600XLM SONDES

(For more information, please contact PWD Bureau of Laboratory Services 1500 E. Hunting Park Ave, Philadelphia 19124)

A.3 STANDARD OPERATING PROCEDURE FOR WET WEATHER SAMPLING USING THE ISCO 6712 AND ISCO 720 LEVEL MODULE

STANDARD OPERATING PROCEDURE

FOR

WET WEATHER SAMPLING USING THE ISCO 6712 AND ISCO 720 LEVEL MODULE

Bureau of Laboratory Services

Philadelphia Water Department

Signatures and Dates

Lab Analysts ________________________

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Supervisor ________________________

QA Supervisor ________________________

Revised January 2009
Timothy McMahon, Biologist Trainee

1.0 Identification of test method

1.1. The purpose of this SOP is to establish a uniform procedure for sampling wet weather events from Philadelphia surface waters using the ISCO 6712 unit with the ISCO 720 level module. The procedure is based on the Standard Method 1060 for the collection and preservation of samples and the manufacturer recommendations.

2.0 Applicable matrix or matrices

2.1. This SOP applies to surface waters.

3.0 Method detection limit

3.1. N/A

4.0 Scope and application, including components to be analyzed

4.1. This SOP describes procedures and requirements for auto-sampling during wet weather events using the ISCO 6712 unit with the ISCO 720 level module, recording the necessary field data, transmitting the collected samples to laboratory facilities for analysis, and transferring data collected by the ISCO unit to a lab computer for analysis. This includes requirements regarding sample handling, field notes, and chain-of-custody records, along with requirements for quality assurance and quality control (QA/QC). The results of these analyses, along with the water level data logged by the ISCO unit, allow the Philadelphia Water Department to monitor effects of storm water runoff.

5.0 Summary of the test method

5.1. The ISCO autosampler unit is set up at the desired site before a rain event and programmed to begin sampling when the stream level increases by 0.1 ft (unless the stream normally has a daily variation larger than 0.1 ft, in which case the trigger level is set accordingly). The goal is to capture a view of the entire rain event so the unit is programmed to sample at desired intervals, determined by the sampler, based on the event's forecasted length and intensity. A grab sample is collected and field readings recorded before the rain event, as a baseline. During the rain event, the ISCO sampler is maintained by retrieving level data, removing full samplers and replacing with empty bottles, if necessary. Samples are returned to BLS and composited in CRU. Analyses requested are based on Philadelphia Water Department's Office of Watersheds requirements. A chain-of-custody form is completed when the samples are relinquished. The ISCO unit is allowed to run for several days after the rain event without sampling in order to collect level data as the stream returns to base flow. Level data from the ISCO unit is transferred to a lab computer and analyzed.

6.0 Definitions

6.1. Autosampler Enclosure – Fiberglass or metal enclosure with a locking lid which protects ISCO units from water and vandalism.

6.2. Baseline – The values of a given set of parameters before precipitation begins and against which the wet weather event values are measured.

6.3. Composite Sample – A representative water or wastewater sample made up of individual smaller samples taken at periodic intervals.

6.4. Discrete Grab Sample – A sample that is taken at a selected location, depth and time.

6.5. ISCO 6712 – Portable, programmable auto-sampler used to collect samples remotely during wet weather events.

6.6. ISCO 720 Level Module – Attachment to ISCO 6712 that measures stream depth with a level probe.

6.7. Multi-Parameter Sonde – A multi-meter that reads instantaneous pH, specific conductivity, temperature, turbidity, and dissolved oxygen when placed in a body of water.

6.8. RTD 581 Data Logger – The data logger which plugs into the ISCO 6712 unit in the field and quickly downloads the data collected since the program was started.
6.9. Wet Weather Event – A period of precipitation during which stream flows increase due to runoff and then return to base flow

7.0 Interferences

7.1. Contaminants introduced into the sample containers through careless handling, or by using "dirty" preservatives can bias the true values of the sample.
7.2. An improperly set-up ISCO sampler can fail to collect samples or to collect the necessary amount of sample.

8.0 Safety

8.1. Gathering of water samples may result in exposure to sewage and bacteriologically contaminated water. Field personnel must wear suitable hand protection during the collection and handling of samples and take care to minimize exposure to surface waters. Anti-bacterial wipes should be used after contact with waters.
8.2. Adequate medical protection against risk of infectious disease (tetanus, polio, pertussis, diphtheria and hepatitis A/B) is recommended.
8.3. While working in the field, the field crew must carry a complete first-aid kit that provides materials for disinfection and protection of any skin cuts or abrasions. Personnel will promptly attend to any such cuts or abrasions, and seek medical attention if appropriate, and any such instances will be recorded in the field log, including time and location of incident and description of first-aid treatment applied.
8.4. Field personnel must wear sturdy boots with adequate ankle support. If personnel need to enter a stream, correctly fitting hip- or chest-waders with felt bottoms that have been inspected for water-tightness must be worn, and care taken to avoid slipping.
8.5. When working in cold weather, the field crew must take extra precautions for warmth and keep chemical hand-warmers in the vehicle. Having extra dry clothes is recommended as well.
8.6. If using concentrated acid to acidify samples, sampler must wear safety glasses and latex gloves.
8.7. Field personnel must be aware of depth of streams and strength of current, especially during rain events, and use appropriate precautions. Entering a stream during a rain event is discouraged.
8.8. ISCO units are powered by deep cycle batteries, which are similar to car batteries. When attaching leads from the ISCO unit, work gloves must be worn.
8.9. The pump in the ISCO 6712 has a safety mechanism which does not allow the pump to run when the pump band is open. Do not tamper with this safety mechanism. The pump rollers can cause severe injury. Disconnect power from the sampler before replacing pump tubing.

9.0 Equipment and supplies

9.1. ISCO 6712 sampler, including base containing 24 1-liter polypropylene wedge shaped cage-bottles (ISCO part #68-6700-087) with new plastic sampling bags (ISCO part #68-6700-096) (including caps)
9.2. Fully charged deep cycle marine battery or 12 volt car battery with clip attachment
9.3. ISCO 720 Module (ISCO part #60-9004-030)
9.4. Fiberglass autosampler enclosure with necessary padlocks to secure the lid
9.5. 25 ft cable and level probe (ISCO part #60-3224-002)
9.6. 25 ft extension cable (if needed)
9.7. Pump head tubing for ISCO unit (ISCO part #68-6700-045)
9.8. Discharge tubing for sampler arm (ISCO part #60-9003-260)

9.9. precut length (site-specific, determined in advance) of vinyl suction tubing (ISCO part #68-1680-059)
9.10. Rapid Transfer Device (RTD) 581 data logger (ISCO part #60-9004-027)
9.11. Strainer (stainless steel), 7 mm pore size, for autosampler intake (ISCO part #69-2903-138)
9.12. Multi-parameter field sonde (usually YSI 6920 sonde, but can also use YSI 6600 or 600XLM sondes, or YSI 85D/YSI 60 portable meters) with check standards (see section 10.0)
9.13. Tool box (pliers, wrench, tape measure, screw drivers, tubing cutter, ratchet)
9.14. Wooden base for ISCO unit
9.15. PVC pipe for running sampler tubing and level probe down to the stream
9.16. Steel spikes/rebar/metal U-clamps (2-3 per site) to secure pipe in stream-bed, bank or to stone structure
9.17. Sample bottles or containers prepared and preserved in accordance with BLS protocols and concentrated H_2SO_4 as preservative if collecting TKN^- samples.
9.18. 0.45 µm pore-size screw-tip filters and 60 mL syringes (if sampling dissolved metals)
9.19. Insulated coolers for sample transport
9.20. Ice for ISCO unit and sample transport
9.21. 1000 ml graduated cylinder for check of ISCO sample volumes
9.22. BLS field sheets
9.23. Chain-of-custody forms
9.24. Keys to the ISCO housing units
9.25. Sledge hammer
9.26. Sawz-all
9.27. Hammer drill
9.28. Electric drill with drill bits
9.29. Various nuts, bolts, and washers needed to secure ISCO enclosure to base and stream bank
9.30. Angle irons
9.31. Hip- or chest-waders with felt bottoms, to allow personnel to wade into stream.
9.32. Latex Gloves
9.33. First aid kit

10.0 Reagents and standards

10.1. **Where catalog numbers are given, equivalent products may be used. Any chemical or reagent without a manufacturer's expiration date is valid for up to ten years of receipt.**
10.1.1. Conductivity check standards, 100 and 500 µmhos/cm (100 µmhos/cm – Ricca Chemical, cat. No 2237-1; 500 µmhos/cm – Ricca Chemical, cat. No 2241-1)
10.1.2. pH check standards at 6.86 and 7.40 (pH 7.40 – Ricca Chemical, cat. No 1565-5; pH 6.86 – Ricca Chemical, cat. No 1540-1)
10.1.3. Turbidity check standard (either Milli-Q DI water (0.0-NTU) or prepared 9.0-NTU check std, diluted from 1000-NTU stock solution) (1000-NTU solution- Ricca Chemical, cat. No 8825-16)
10.1.4. Concentrated sulfuric acid, to acidify necessary samples.

11.0 Sample collection, preservation, shipment and storage

11.1. For sample collection, shipment and storage, see section 14.0
11.2. For sample preservation, see Table 1 in section 23.0

12.0 Quality control

12.1. Field sonde must be calibrated prior to baseline grab sampling (conducted before and after wet weather event)

12.2. Field sonde must be checked with check standards before baseline grab sampling and recorded in the appropriate section on the field sheet.

12.3. After baseline grab sampling, field sonde must be checked with check standards and recorded in the appropriate section on the field sheet.

13.0 Calibration and standardization

13.1. For calibration information, see appropriate SOP for the field meter being used.

14.0 Procedure

14.1. Preparation for wet weather event (at lab)

14.1.1. Install new internal ISCO sampler pump head tubing and sampler arm tubing according to manufacturer's instructions.

14.1.2. Turn on ISCO unit in the lab and attach level probe. Insure level probe is reading a steady depth for several hours. The level does not need to be 0.000 ft, as the probe will be zeroed in the field. If level probe reading is erratic, replace with a different probe and check for stable reading.

14.1.3. Install new plastic bags in the sample cages and arrange sample cages according to numbering on ISCO base. Numbering on the cages should match the numbering on the outside of the base. Each base is given a number (1,2,3…) and cages are numbered from 1-24. The cages in base 1 will be denoted as (1.1, 1.2, 1.3…1.24).

14.2. Setting up ISCO unit at sampling site

14.2.1. Set up the ISCO unit at the site the day before the storm, if possible. A baseline grab sample will be taken at this time, also. If installing an ISCO at a new site, secure wooden base to stream bank by driving angle irons into a flat area of the stream bank with sledgehammer and bolting the base in place. Bolt the fiberglass enclosure to the wooden base and check that locks are functional and open with the correct key. Using metal spikes or metal U-clamps, secure two lengths of PVC pipe to stream bank between ISCO enclosure and stream bed. The level probe and sampler tubing will run through these pipes in order to hold them in place during heavy flow and to protect them against vandalism.

14.2.2. Place ISCO unit in the enclosure on top of the correct base for that site, making sure that all sample bottles are in correct numbered locations and caps are removed.

14.2.3. Attach tubing (pre-cut to the correct length for that site) and level module probe cable to ISCO unit.

14.2.4. Attach battery to ISCO unit using battery clips and turn on the unit.

14.2.5. Feed sampler tubing, with stainless steel strainer attached to the end, through one of the PVC pipes until it hits the streambed. Pull tubing back until strainer is positioned in main stream flow, off the streambed. Cut tubing to correct length if necessary.

14.2.6. Remove cap from dessicant assembly attached to ISCO 720 module.

14.2.7. Fill the center of the ISCO base with ice.

14.3. Programming ISCO unit

14.3.1. When programming the ISCO unit to sample, the sampling schedule and volumes will be based on both the weather forecast and the analyses requested by the Office of Watersheds. 4-5 samples should fall on the rising limb of the rain event and 3-4 samples should fall on the descending limb, unless instructed otherwise. The weather forecast should be monitored in the days leading up to the event and the sample timing should be based on when most precipitation is forecasted to occur.

14.3.2. The ISCO menus are navigated by using the arrow keys and the enter button. For a full graphic depiction of menus and options, see the ISCO 6712 manual.

14.3.3. Before programming the ISCO to sample, first check the date and time and correct if necessary.

14.3.3.1. From the main menu, choose "other functions"→ "maintenance" → "set clock"

14.3.3.2. Set date and time with keypad, using 24-hr time and DD-MON-YY format for the date.

14.3.4. While the ISCO has several "standard programs" available, an "extended program" is used to sample wet weather events to allow more control over the sampling schedule. The program used is a "20-minute 2-part program" and the parameters will be adjusted based on the storm.

14.3.5. From the main menu screen, select "Program." The ISCO will now scroll through all of the set parameters for the current program, which can be altered by using the arrow and enter keys, and the numerical keypad. The parameters which must be tailored for each event are: Site description (the assigned names used for each site and for the LIMS system), units selected (for tubing length), submerged probe (level-only or flow-sensitive probe), current level, data interval (how often the ISCO logs a level reading), number and volume of bottles, length of suction line (the tubing which the ISCO uses to draw a sample from the stream), number of rinses and retries in case of failure, type of program, bottle assignments (if a two part program: the number of bottles which are assigned to parts A & B), the pacing, distribution, volume, depth at which to trigger the program, and any scheduled pauses for each program. For example, a standard program for a wet weather event is:

14.3.5.1. 20-minute 2-part program

14.3.5.2. Site description: BYBE150

14.3.5.3. Units selected: ft

14.3.5.4. Submerged Probe: level only

14.3.5.5. 15 minute data interval

14.3.5.6. 24, 1000mL bottles

14.3.5.7. 15 ft suction line

14.3.5.8. 0 rinses, 0 retries

14.3.5.9. Bottle Assignments: 1-15 to "A", 16-24 to "B"

14.3.5.10. "A" pacing: Time, every 0 hours, 30 minutes

14.3.5.11. "A" distribution: 3 bottles/sample

14.3.5.12. "A" volume: 1000 mL samples

14.3.5.13. "A" enable: level > 2.65 ft

14.3.5.14. "B" pacing: Time, every 2 hours, 0 minutes

14.3.5.15. "B" distribution: 3 bottles/sample

14.3.5.16. "B" volume: 1000 mL samples

14.3.5.17. "B" enable: When "A" is done

14.3.5.18. "B" enable: 30 minute delay to start of sampling

This program will trigger the ISCO to fill three 1000 mL bottles when the level probe reads a depth of 2.65 ft. The ISCO will then sample at 30 minute intervals, filling three 1000 mL bottles at each sample. After the first 5 samples (15 bottles) are finished (after 2 hours), the ISCO will switch to part "B". It will wait 30 minutes and then fill three 1000 mL bottles. The ISCO will then sample at 2 hour intervals, filling three 1000 mL bottles at each sample. After the 30 minute delay, the final 9 bottles will be full after 4 hours. The ISCO will not sample after that point, but will continue logging level readings every fifteen minutes.

14.3.6. While scrolling through the program parameters, the level probe reading must be set to zero (before putting the probe in the stream).

14.3.6.1. Set the level probe reading to 0.000 ft by highlighting the current level and pressing the enter key. The screen will prompt the user to enter the current level. Enter 0.000 ft by using the keypad once the current reading is stable. Put the probe in the stream and let the level reading stabilize. The level at which the ISCO is set to start sampling is based on this initial level. In most streams, the trigger level is set to 0.1 ft (1.2 inches) more than the baseline level. In a stream with a regular daily fluctuation (tidal or due to wastewater discharge upstream), the trigger level must be set slightly higher so the ISCO does not trigger before the wet weather event.

14.3.7. Once the program parameters are set, the ISCO will ask if it should start the program. Choose “yes” and the ISCO will start sampling once the trigger level is reached.

14.3.8. Once the program is running, the pump must be checked to insure it pumps the correct amount per sample.

14.3.8.1. Disconnect the pump tube from the bulkhead fitting and place the end of the tube over the 1000 mL graduated cylinder.

14.3.8.2. Press the red button on the keypad to access the menu.

14.3.8.3. Scroll to “calibrate volume” and follow prompts. Type in the desired sample volume (the volume the ISCO is going to sample while running the program) and press enter. The ISCO will run through the sample collection process.

14.3.8.4. When the full volume is delivered, type in the amount in the graduated cylinder. The ISCO will adjust the pump settings. Repeat this process until the pump delivers the desired amount.

14.3.8.5. Reconnect the pump tube to the bulkhead fitting.

14.3.9. The ISCO is now ready to sample.

14.4. Collect a grab sample at the site for the analyses requested by the Office of Watersheds using the procedure outlined in “Standard Operating Procedure for the Field Collection of Grab Samples”. This sample functions as a baseline sample against which the wet weather samples are compared.

14.5. Maintenance of the ISCO unit during a wet weather event

14.5.1. Depending on when the wet weather event starts, the ISCO will need periodic visits to ensure proper collection of samples. The following procedures should be followed when visiting an ISCO unit.

14.5.1.1. Take new sampler base with 24 1-liter bottles (with caps) to the sampler. Fill the center hole with ice.

14.5.1.2. Unlock the enclosure and observe the sampler display to determine if sampling is completed or if the program is still running.

14.5.1.3. If the sampler has finished the original program, follow these steps:

14.5.1.3.1. Place the RTD into the back of the sampler and download stored data. The yellow light on the RTD will be lit to indicate the device is receiving power, and the green light will blink as the data reports are collected. The green light stops blinking when the transfer is successfully completed. A constant red light indicates that the RTD memory is full and a blinking red light indicates a transfer error. In the case of full memory, use another RTD. In the case of transfer error, unplug the RTD and wait briefly before trying again. Use another RTD if there is another transfer error.

14.5.1.3.2. Check and record the reports summary for sample start times and for the last sample collected time.

14.5.1.3.3. Remove base and cap all filled bottles. Replace with a new base of empty bottles. Drain any excess water from the first base and fill center hole with ice for transport to BLS.

14.5.1.3.4. Depending on the weather forecast, reprogram the ISCO to continue sampling as desired. If no more samples are desired, set trigger level to 28.00 ft. The ISCO will continue logging level values without sampling.

14.5.1.3.5. Take field readings for DO, pH, conductivity, and temperature with a multi-parameter sonde and fill out field sheets.

14.5.1.3.6. Fill out chain of custody forms.

14.5.1.3.7. Close and lock the enclosure and proceed to next destination.

14.5.1.4. If the sampler has not finished the original program, follow these steps:

14.5.1.4.1. Check display for the number of samples already collected and when the next sample will be collected. Depending on the number of samples taken and time of day, it might be better to let the sampler continue with the original program before replacing bottles.

14.5.1.4.2. If the next sample will be sampled soon, wait for the ISCO to take the next sample.

14.5.1.4.3. Take field readings for DO, pH, conductivity and temperature with the multi-parameter sonde when the next sample is taken.

14.5.1.4.4. Manually stop the sampler and follow above procedure for collecting stored sample and level data with the RTD.

14.5.1.4.5. Replace the filled sample base with a new base and cap all filled sample bottles. Drain first base of any excess water and fill center hole with ice for transport to BLS.

14.5.1.4.6. Depending on the weather forecast, reprogram the ISCO to continue sampling as desired. If no more samples are desired, set trigger level to 28.00 ft. The ISCO will continue logging level values without sampling.

14.5.1.4.7. Fill out chain of custody forms.

14.5.1.4.8. Close and lock the enclosure and proceed to next destination.

14.6. Compositing of the ISCO sample bottles at CRU

14.6.1. Each sample collected by the ISCO unit is contained in three bottles, for a total volume of 3 liters, as per the programming schedule. Upon arrival at BLS, the samples must be composited and poured off to specific analyte bottles. CRU has the composite sample bottles (4 liter collection bottles) labeled for each site. A full 24-bottle base will need 8 composite bottles and each one will indicate which ISCO bottles need to be poured into it. For example, a composite bottle will be labeled “1.1-1.3” and bottles 1.1, 1.2, and 1.3 must be poured into that bottle. The samples from the ISCO must be inverted to suspend particulate matter that may have settled out and then the full volume poured into the composite bottle. Do this for all of the samples in the collected ISCO bases.

14.6.2. Each composite bottle must be inverted to suspend any particulate matter that may have settled out and then poured off into appropriate analysis bottles provided by CRU. The analysis bottles must be labeled with the date and time the sample was taken. This information is retrieved in the field from the ISCO program summary.

14.6.3. A completed chain of custody form must be signed and dated by both the sampler and CRU. Each ISCO site will have its own chain of custody, and any grab samples must be on a separate chain of custody. An example of the format used on a chain of custody for a wet weather event:

(2) SAMPLE LOCATION (CODE)	COLLECTION DATE	COLLECTION TIME	SAMPLE DESCRIPTION	SAMPLE PROGRAM CODE	GRAB COMP # Hrs C
TACO250	1/13/04	13:50	Bottles 1.1 - 1.3	Wet Weather	C
TACO 250	1/13/04	14:50	Bottles 1.4 - 1.6	Wet Weather	C

14.7. Maintenance of ISCO unit after wet weather event until eventual shut down

14.7.1. When no more samples are desired, the ISCO should be left running with the trigger level changed to 28.00 ft. The ISCO will continue logging level data without sampling.

14.7.2. 3-4 days after the end of a wet weather event, when the stream has returned to base flow levels, collect level data (using the RTD) and another baseline grab sample. Collect field data using a multi-parameter sonde and fill out a field sheet. At this time, the ISCO can be turned off. Replace dessicant assembly cap. Bring the battery, sample tubing, and level probe back to BLS. Discard sample tubing. Recharge the battery.

14.8. Retrieval and formatting of data from ISCO unit

14.8.1. Connect the RTD power cord into one of the serial ports on the computer, and plug the power cord into an electrical outlet. Connect the RTD data logger to the power cord and click on the FLOWLINK 4.1 software icon. Click on the Isco.exe file to launch the application.

14.8.2. Click the RTD icon on the screen to transfer the ISCO data from the datalogger into the FLOWLINK folder.

14.8.3. Once the data has been successfully transferred, click on the site folder to show all site locations and data.

14.8.4. Click once on the (+) sign next to the site name to show the most recent level data file. Click on the level file to display the graph of the level readings. Switch between the graph and the raw data by clicking on the "Graph/Table" icon in the menu bar.

14.8.5. Right click on either the graph or table values and choose "Properties". Click the "Time Scale" tab and adjust the "Date", "Time", and "Timespan" boxes to adjust displayed data as desired.

14.8.6. Click on the "File" menu and select "Export". Select the desired folder to export data to and click "Export".

14.8.6.1. Exported data is saved as a ".csv" file; open the .csv in excel and save as an ".xls" file.

14.8.7. Click on the "Site Setup" box to show the "Reports" box. Click on the "Reports" box to view the ISCO program settings used and the details of the sampling times. Save this report data in the appropriate file folder.

15.0 Calculations

15.1. N/A

16.0 Method Performance

16.1. Quality control data can be found on the sample field sheets.

17.0 Pollution Prevention

17.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation.

17.2. For information about pollution prevention that may be applicable to laboratories and research institutions, consult "Less is Better: Laboratory Chemical Management for Waste Reduction", available from the QA Department or from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington D.C. 20036, (202)872-4477.

18.0 Data assessment and acceptance criteria for quality control measures

18.1. Calibration – Calibration criteria are listed in the SOP for the multi-meters used (Standard Operating Procedure for YSI 60 Portable Meter, Standard Operating Procedure for YSI 85 Portable Meter, & Standard Operating Procedure for YSI Sondes Models 600XLM, 6600, 6820, And 6920 To Monitor Water Quality In Streams)

19.0 Corrective actions for out of control data

19.1. Calibration check – If calibration check fails, recalibrate field sonde for whichever parameter failed the check.

20.0 Contingencies for handling out of control or unacceptable data

20.1. If a parameter on the field sonde fails a calibration check, the data points recorded since the last valid calibration check must be flagged. A "failed check standard" flag must be noted both on field sheets and in the LIMS system.

21.0 Waste management

21.1. All check standards for this procedure used in the field must be collected in a waste container and brought back to BLS, where they can be poured down the drain with sufficient water for dilution.

22.0 References

22.1. Teledyne Isco. 6712 Portable Samplers Installation and Operation Guide. 2008.

22.2. Teledyne Isco. 720 Submerged Probe Module Installation and Operation Guide. 2007.

DO Acceptance:

The large number of measurements made by the continuous sampling equipment serves to characterize DO throughout the diurnal cycle under a range of flow conditions. The equipment produces 96 observations of DO every 24 hours, but cost and quality control are more challenging compared to discrete sampling. A variety of procedures are followed before, during, and immediately after deployment to help ensure quality and identify problems that may affect DO data quality. These procedures are outlined in detail in the main body of "YSI 6600 Sondes to Monitor Water Quality in Streams" and are summarized below.

- Pre-deployment and post-deployment laboratory validation checks are performed on all parameters. The probes are tested in solutions of known concentrations as established by standard laboratory testing procedures. Instruments are deployed and data is initially accepted if probe measurements are within a certain tolerance of the standards.

- Field personnel fill out standardized forms to note conditions and events that may have an effect on data quality. Examples include debris or sediment obstructing the probe, debris obstructing free flow of water around the instrument, or instrument failure such as a battery failure.

- Beginning in the fall of 2001, field measurements are taken of DO, pH, and specific conductance at deployment and retrieval. Measurements are taken as close to the probe locations as possible, and the data is added to the pre- and post-deployment validation checks when determining whether data is initially accepted.

- BLS personnel prepare time series plots and make preliminary determinations of whether data fall within reasonable ranges and patterns. BLS staff recommends acceptance of data at this point provided they pass the criteria discussed above.

These four items represent initial screens for poor quality data; they identify instances where probes do not accurately measure conditions in the immediate vicinity of the instrument. However, suspended sediment, debris, and biofouling can all affect the microenvironment in the immediate vicinity of the instrument, causing data to be collected that does not represent overall conditions in the water column. For this reason, additional procedures are needed to distinguish data that is sufficiently representative to be included in analyses from data that is not representative.

Table 2.2.1 summarizes a system that assigns points to data based on the presence of characteristics that are indicative of reliable data. Data analysis suggests that conditions that lead to unreliable data are present primarily during and after wet weather and depend on the intensity of the runoff event. For this reason, the continuous data is biased toward dry weather conditions although they do represent some wet weather events.

Table B.1 Criteria Applied to Determine Sonde DO Data Reliability

CRITERIA (Accept data with 5 or more points.)	**CHARACTERISTICS OF HIGHER RELIABILITY DATA**	⟷	**CHARACTERISTICS OF LOWER RELIABILITY DATA**
VALIDATION CHECKS	The data pass all field and laboratory validation checks within 1.0 mg/L. PROCEED TO NEXT STEP.	Does not apply.	The data do not pass one or more validation checks. REJECT THE DATA.
PROBE FAILURE	The data never drop to zero for two or more days. PROCEED TO NEXT STEP.	The data drop to zero for two days or more, but recover later in the deployment. PROCEED TO NEXT STEP.	The data drop abruptly to zero and remain there for the duration of the deployment. REJECT THE DATA.
SITE CONDITIONS	Field notes do not document any conditions that may cause instrument failure. (+2 POINTS)	Field notes indicate light to moderate obstruction by debris, sediment, and/or biofouling. (+1 POINT)	Field notes indicate moderate to extensive obstruction by debris, sediment, and/or biofouling. (+0 POINTS)
NOISE	The data pattern is smooth, without sudden and erratic changes. (+2 POINTS)	Data are slightly to moderately noisy, but the underlying pattern is readily apparent. (+1 POINT)	The data are extremely noisy. (+0 POINTS)
IF diurnal pattern is evident…	The diurnal pattern is relatively constant in dry weather and has an amplitude of less than 4 mg/L. (+2 POINTS)	The diurnal amplitude is less than 4 mg/L, but it changes over the course of the deployment by a factor of 2 or more. This may indicate algae accumulation. (+1 POINT)	The diurnal amplitude is greater than 4 mg/L. (+0 points)
IF redundant observations are available…	Both sets of data are similar and display characteristics of high quality data. (+2 POINTS for one data set; discard the other).	Only one data set displays multiple characteristics of low quality data. (+1 POINTS for the higher quality data set; discard the other).	Both data sets display multiple characteristics of low quality data. (+0 POINTS)

Explanation of acceptance/rejection:

The primary objective in this part of the update is to identify which data is usable and which is not. The most important comment that can be made is that we are not trying to reject data that doesn't seem to fit the "usual" pattern (diurnal). Instead we are trying to reject data that seems to have been caused by mechanical failure. Therefore it is important to realize exactly what is usable and what is useless. The first place to look for this is in the original excel file that supplied the data. Check the charts that are in the file and look for any red comments about mechanical failure. If this is the case, then the data should be rejected in those regions. The Excel file "PP_Acceptance_Criteria.xls" has a series of worksheets which help decide if the data should be rejected or not. Looking at the plot, decide on an appropriate number of sections that are needed. For example, if there seems to be a section of questionable data between 2 sections of good data, you would need 3 sections. Make a copy of one of the templates depending on the sections required and rename the sheet for the respective deployment. Complete the sheet to help gauge if the data should be rejected or not.

How to select which regions to reject:

- Open the database:**"Pennypack.mdb"**.
- Open the sheet called **"RejectedDates"**.
- For each region you wish to reject, enter the deployment, start dtime to reject and end dtime to stop rejecting.
- For single point rejections, enter the same dtime for start and stop.
- For multiple rejection ranges for the same deployment, use the same deployment number and add a new record with more rejection times.
- Update the **"PP_Acceptance_Criteria"** worksheet. Add a new worksheet for each new deployment using the template sheets in the front. For 2 rejection regions use Template2, for 3 use Temp3 etc.
- Fill in the proper point values as was described above.

DO Flagging:

Program 5 – "update do flag optimized.vb" - Module inside database

- This program takes the rejected date ranges and flags the PP_Sonde table accordingly.
- Run the module, if there are any errors, read the comments in the program. You may comment out the **fillw1** query.
- Export the table **"PP_Sonde"** with the export query. Output is **"Export_PP_Sonde.csv"**.
- Rerun the program DOPlots.sas. Output will be several graphics files.
- Check the graphs for consistency.

Table C.1 Sample Information for Potentially Contaminated Samples, 2007

Sample ID	Water Body	Sample type	Parameter	Units	Site	Date-Time	Value	wet48	wet72
DW020425-0076	Pennypack	grab	PO4	mg/L	PP1380	25APR02:09:05:00	1.538	0	0
DW020425-0076	Pennypack	grab	TP	mg/L	PP1380	25APR02:09:05:00	1.526	0	0
DW020905-0058	Pennypack	grab	PO4	mg/L	PP1150	05SEP02:07:30:00	0.969	0	0
DW020905-0058	Pennypack	grab	TP	mg/L	PP1150	05SEP02:07:30:00	0.8593	0	0
DW020905-0053	Pennypack	grab	PO4	mg/L	PP1380	05SEP02:07:45:00	1.18	0	0
DW020905-0053	Pennypack	grab	TP	mg/L	PP1380	05SEP02:07:45:00	1.067	0	0
DW020905-0060	Pennypack	grab	PO4	mg/L	PP970 PP985	05SEP02:08:25:00	1.031	0	0
DW020905-0060	Pennypack	grab	TP	mg/L	PP970 PP985	05SEP02:08:25:00	0.8928	0	0
DW020905-0055	Pennypack	grab	PO4	mg/L	PP1680	05SEP02:08:45:00	1.016	0	0
DW020905-0055	Pennypack	grab	TP	mg/L	PP1680	05SEP02:08:45:00	0.9481	0	0
DW020905-0061	Pennypack	grab	PO4	mg/L	PP690	05SEP02:08:50:00	0.667	0	0
DW020905-0061	Pennypack	grab	TP	mg/L	PP690	05SEP02:08:50:00	0.6429	0	0
DW020905-0064	Pennypack	grab	PO4	mg/L	PP180	05SEP02:10:03:00	0.453	0	0
DW020905-0064	Pennypack	grab	TP	mg/L	PP180	05SEP02:10:03:00	0.4373	0	0
DW020912-0061	Pennypack	grab	PO4	mg/L	PP970 PP985	12SEP02:07:15:00	1.314	0	0
DW020912-0061	Pennypack	grab	TP	mg/L	PP970 PP985	12SEP02:07:15:00	1.248	0	0
DW020912-0069	Pennypack	grab	PO4	mg/L	PP1380	12SEP02:07:45:00	1.184	0	0
DW020912-0069	Pennypack	grab	TP	mg/L	PP1380	12SEP02:07:45:00	1.176	0	0
DW020912-0064	Pennypack	grab	PO4	mg/L	PP690	12SEP02:08:35:00	1.034	0	0
DW020912-0064	Pennypack	grab	TP	mg/L	PP690	12SEP02:08:35:00	0.977	0	0
DW020912-0065	Pennypack	grab	PO4	mg/L	PP340	12SEP02:09:00:00	0.905	0	0
DW020912-0065	Pennypack	grab	TP	mg/L	PP340	12SEP02:09:00:00	0.889	0	0
DW020912-0067	Pennypack	grab	PO4	mg/L	PP180	12SEP02:09:50:00	0.857	0	0
DW020912-0067	Pennypack	grab	TP	mg/L	PP180	12SEP02:09:50:00	0.846	0	0
DW020919-0090	Pennypack	grab	Turbidity	NTU	PP1380	19SEP02:08:20:00	634	0	0
DW020919-0095	Pennypack	grab	PO4	mg/L	PP1680	19SEP02:09:15:00	3.709	0	0
DW020919-0095	Pennypack	grab	TP	mg/L	PP1680	19SEP02:09:15:00	3.985	0	0
DW040811-0067	Pennypack	grab	BOD30	mg/L	PP970_PP985	11AUG04:12:20:00	4026	0	0
DW041104-0054	Pennypack	grab	F	mg/L	PPFC025	04NOV04:10:45:00	0.587	0	0

DW041104-0057	Pennypack	grab	Cd	mg/L	PP990	04NOV04:11:10:00	0.005	0	0
DW070117-0061	Pennypack	grab	DissZn	mg/L	PP1850	17JAN07:09:25:00	0.02	0	0
DW070117-0061	Pennypack	grab	Zn	mg/L	PP1850	17JAN07:09:25:00	0.006	0	0
DW070131-0066	Pennypack	grab	TKN	mg/L	PP180	31JAN07:11:40:00	112	0	0
DW070207-0065	Pennypack	grab	PO4	mg/L	PP1380	07FEB07:11:05:00	0.793	0	0
DW070207-0065	Pennypack	grab	TP	mg/L	PP1380	07FEB07:11:05:00	0.775	0	0
DW070207-0072	Pennypack	grab	DissMn	mg/L	PPW010	07FEB07:11:30:00	0.101	0	0
DW070425-0062	Pennypack	grab	PO4	mg/L	PP1380	25APR07:09:50:00	0.457	0	0
DW070425-0062	Pennypack	grab	TP	mg/L	PP1380	25APR07:09:50:00	0.433	0	0
DW070425-0072	Pennypack	grab	DissFe	mg/L	PP970 PP985	25APR07:10:00:00	0.112	0	0
DW070425-0072	Pennypack	grab	Fe	mg/L	PP970 PP985	25APR07:10:00:00	0.006	0	0
DW070425-0071	Pennypack	grab	DissMn	mg/L	PP1150	25APR07:10:28:00	0.03	0	0
DW070425-0071	Pennypack	grab	Mn	mg/L	PP1150	25APR07:10:28:00	0.026	0	0
DW070502-0063	Pennypack	grab	DissZn	mg/L	PPHU070	02MAY07:09:45:00	0.007	1	1
DW070502-0063	Pennypack	grab	Zn	mg/L	PPHU070	02MAY07:09:45:00	0.004	1	1
DW070509-0072	Pennypack	grab	DissFe	mg/L	PP340	09MAY07:12:00:00	0.15	0	0
DW070509-0072	Pennypack	grab	Fe	mg/L	PP340	09MAY07:12:00:00	0.117	0	0
DW070801-0064	Pennypack	grab	PO4	mg/L	PP970 PP985	01AUG07:09:20:00	0.94	0	1
DW070801-0064	Pennypack	grab	TP	mg/L	PP970 PP985	01AUG07:09:20:00	0.906	0	1
DW070801-0059	Pennypack	grab	PO4	mg/L	PP1380	01AUG07:09:40:00	1.849	0	1
DW070801-0059	Pennypack	grab	TP	mg/L	PP1380	01AUG07:09:40:00	1.74	0	1
DW070801-0065	Pennypack	grab	PO4	mg/L	PP1150	01AUG07:09:45:00	1.083	0	1
DW070801-0065	Pennypack	grab	TP	mg/L	PP1150	01AUG07:09:45:00	1.05	0	1
DW070801-0061	Pennypack	grab	PO4	mg/L	PP1680	01AUG07:10:00:00	2.73	0	1
DW070801-0061	Pennypack	grab	TP	mg/L	PP1680	01AUG07:10:00:00	2.62	0	1
DW070801-0063	Pennypack	grab	PO4	mg/L	PP2020	01AUG07:11:00:00	0.055	0	1
DW070801-0063	Pennypack	grab	TP	mg/L	PP2020	01AUG07:11:00:00	0.049	0	1
DW070801-0069	Pennypack	grab	DissFe	mg/L	PPW010	01AUG07:11:15:00	0.15	0	1
DW070801-0069	Pennypack	grab	Fe	mg/L	PPW010	01AUG07:11:15:00	0.112	0	1
DW070801-0070	Pennypack	grab	DissZn	mg/L	PP180	01AUG07:11:30:00	0.017	0	1
DW070801-0070	Pennypack	grab	Zn	mg/L	PP180	01AUG07:11:30:00	0.012	0	1
DW070801-0074	Pennypack	grab	PO4	mg/L	PP970 PP985	01AUG07:12:45:00	1.011	0	1

DW070801-0074	Pennypack	grab	TP	mg/L	PP970 PP985	01AUG07:12:45:00	0.967	0	1
DW070801-0075	Pennypack	grab	PO4	mg/L	PP990	01AUG07:12:55:00	1.006	0	1
DW070801-0075	Pennypack	grab	TP	mg/L	PP990	01AUG07:12:55:00	0.971	0	1
DW070808-0066	Pennypack	grab	PO4	mg/L	PP970 PP985	08AUG07:09:25:00	1.024	1	1
DW070808-0066	Pennypack	grab	TP	mg/L	PP970 PP985	08AUG07:09:25:00	1.02	1	1
DW070808-0067	Pennypack	grab	PO4	mg/L	PP1150	08AUG07:09:45:00	1.184	1	1
DW070808-0067	Pennypack	grab	TP	mg/L	PP1150	08AUG07:09:45:00	1.18	1	1
DW070808-0069	Pennypack	grab	PO4	mg/L	PP690	08AUG07:10:35:00	1.066	1	1
DW070808-0069	Pennypack	grab	TP	mg/L	PP690	08AUG07:10:35:00	1.06	1	1
DW070810-0058	Pennypack	grab	PO4	mg/L	PP970 PP985	10AUG07:08:52:00	0.993	1	1
DW070810-0058	Pennypack	grab	TP	mg/L	PP970 PP985	10AUG07:08:52:00	0.983	1	1
DW070815-0070	Pennypack	grab	PO4	mg/L	PP1380	15AUG07:09:30:00	2.258	0	0
DW070815-0070	Pennypack	grab	TP	mg/L	PP1380	15AUG07:09:30:00	1.99	0	0
DW070815-0062	Pennypack	grab	Cu	mg/L	PP970 PP985	15AUG07:09:55:00	0.004	0	0
DW070815-0062	Pennypack	grab	DissCu	mg/L	PP970 PP985	15AUG07:09:55:00	0.007	0	0
DW070815-0071	Pennypack	grab	PO4	mg/L	PP1680	15AUG07:10:00:00	3.399	0	0
DW070815-0071	Pennypack	grab	TP	mg/L	PP1680	15AUG07:10:00:00	2.97	0	0
DW070815-0063	Pennypack	grab	Cu	mg/L	PP1150	15AUG07:10:26:00	0.005	0	0
DW070815-0063	Pennypack	grab	DissCu	mg/L	PP1150	15AUG07:10:26:00	0.008	0	0
DW070815-0065	Pennypack	grab	Cu	mg/L	PP690	15AUG07:11:06:00	0.004	0	0
DW070815-0065	Pennypack	grab	DissCu	mg/L	PP690	15AUG07:11:06:00	0.008	0	0
DW070815-0074	Pennypack	grab	DissZn	mg/L	PP2020	15AUG07:11:15:00	0.01	0	0
DW070815-0074	Pennypack	grab	Zn	mg/L	PP2020	15AUG07:11:15:00	0.004	0	0
DW070815-0066	Pennypack	grab	Cu	mg/L	PP340	15AUG07:11:30:00	0.004	0	0
DW070815-0066	Pennypack	grab	DissCu	mg/L	PP340	15AUG07:11:30:00	0.007	0	0
DW070815-0068	Pennypack	grab	Cu	mg/L	PP180	15AUG07:12:05:00	0.003	0	0
DW070815-0068	Pennypack	grab	DissCu	mg/L	PP180	15AUG07:12:05:00	0.006	0	0
DW070822-0062	Pennypack	grab	DissZn	mg/L	PP2020	22AUG07:11:20:00	0.014	1	1
DW070822-0062	Pennypack	grab	Zn	mg/L	PP2020	22AUG07:11:20:00	0.009	1	1
DW070926-0059	Pennypack	grab	NO2	mg/L	PP1850	26SEP07:12:16:00	0.5	0	0
DW071010-0111	Pennypack	comp	Cr	mg/L	PP1680	09OCT07:15:40:00	0.075	1	1
DW071010-0111	Pennypack	comp	Cu	mg/L	PP1680	09OCT07:15:40:00	0.24	1	1

DW071010-0111	Pennypack	comp	Fe	mg/L	PP1680	09OCT07:15:40:00	68.7	1	1
DW071010-0111	Pennypack	comp	Mn	mg/L	PP1680	09OCT07:15:40:00	5.5	1	1
DW071010-0111	Pennypack	comp	Pb	mg/L	PP1680	09OCT07:15:40:00	0.305	1	1
DW071010-0111	Pennypack	comp	Zn	mg/L	PP1680	09OCT07:15:40:00	1.45	1	1
DW071010-0112	Pennypack	comp	Mn	mg/L	PP1680	09OCT07:16:00:00	3.85	1	1
DW071010-0084	Pennypack	comp	PO4	mg/L	PP970 PP985	09OCT07:19:30:00	1.206	1	1
DW071010-0084	Pennypack	comp	TP	mg/L	PP970 PP985	09OCT07:19:30:00	1.07	1	1
DW080516-0063	Pennypack	comp	Ecoli	/100mL	PP1850	16MAY08:08:10:00	1200	1	1
DW080516-0063	Pennypack	comp	Fecal	/100mL	PP1850	16MAY08:08:10:00	1100	1	1
DW080516-0048	Pennypack	grab	Ecoli	/100mL	PP340	16MAY08:09:05:00	1100	1	1
DW080516-0048	Pennypack	grab	Fecal	/100mL	PP340	16MAY08:09:05:00	1091	1	1
DW080517-0012	Pennypack	comp	TSS	mg/L	PP340	16MAY08:16:00:00	525.9	1	1

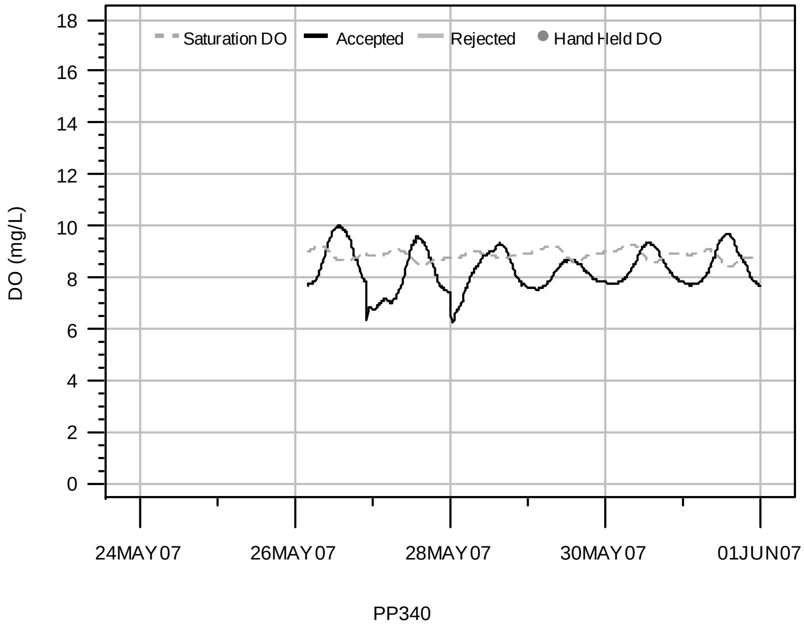

Figure D.1 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 05/24/07 to 06/01/07

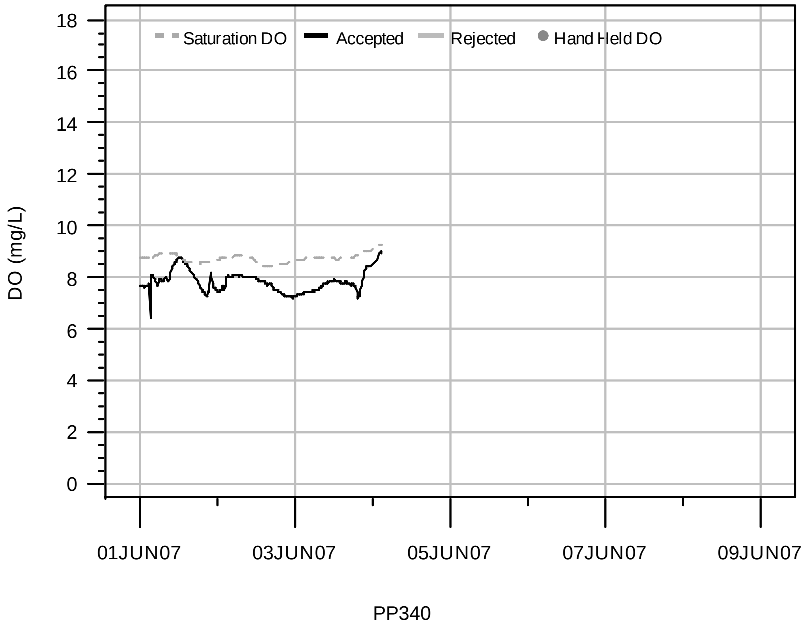

Figure D.2 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 06/01/07 to 06/09/07

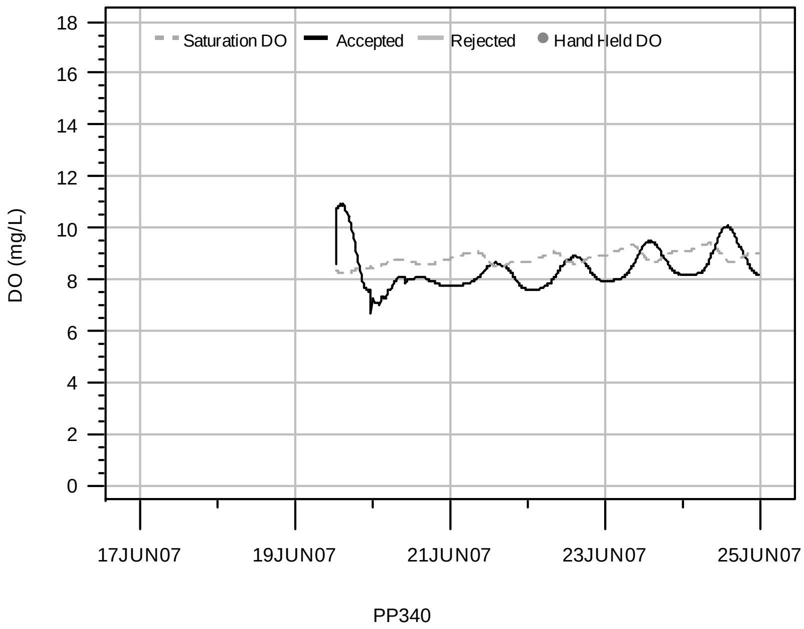

Figure D.3 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 06/17/07 to 06/25/07

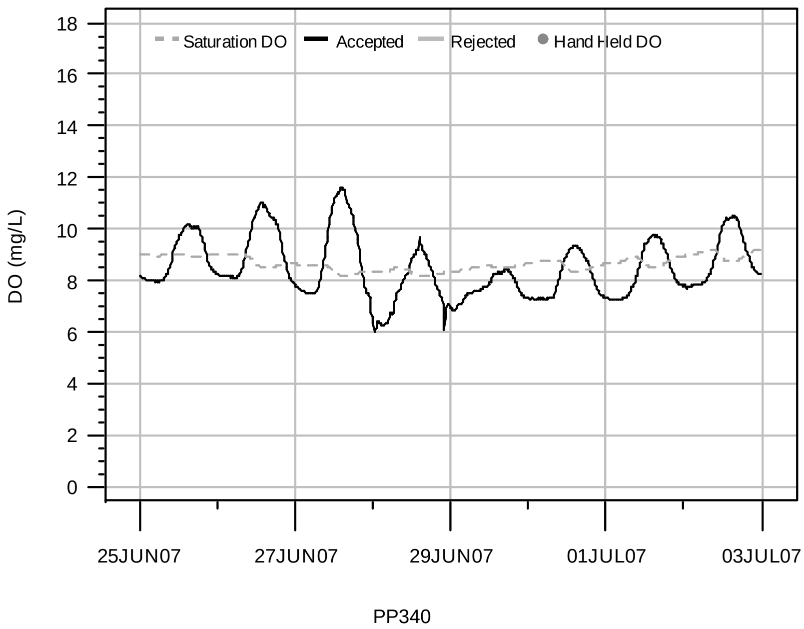

Figure D.4 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 06/25/07 to 07/03/07

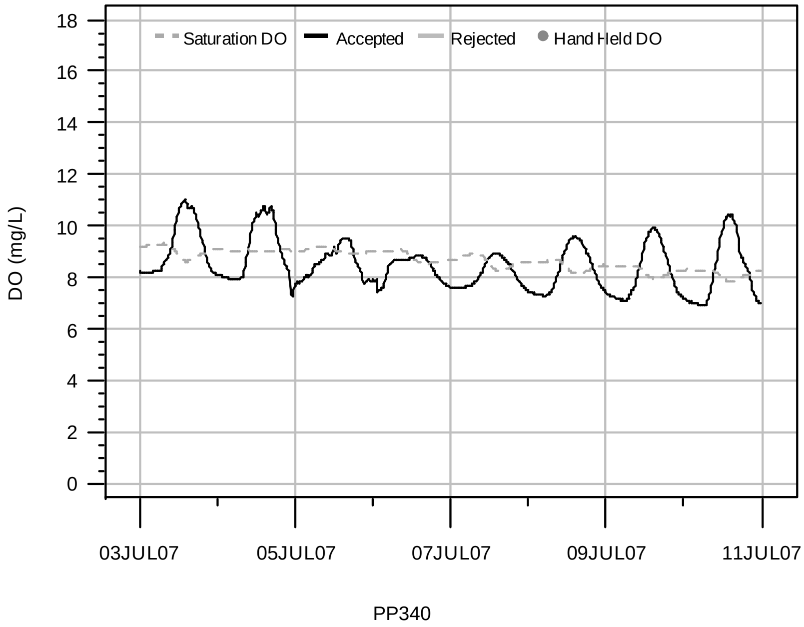

Figure D.5 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 07/03/07 to 07/11/07

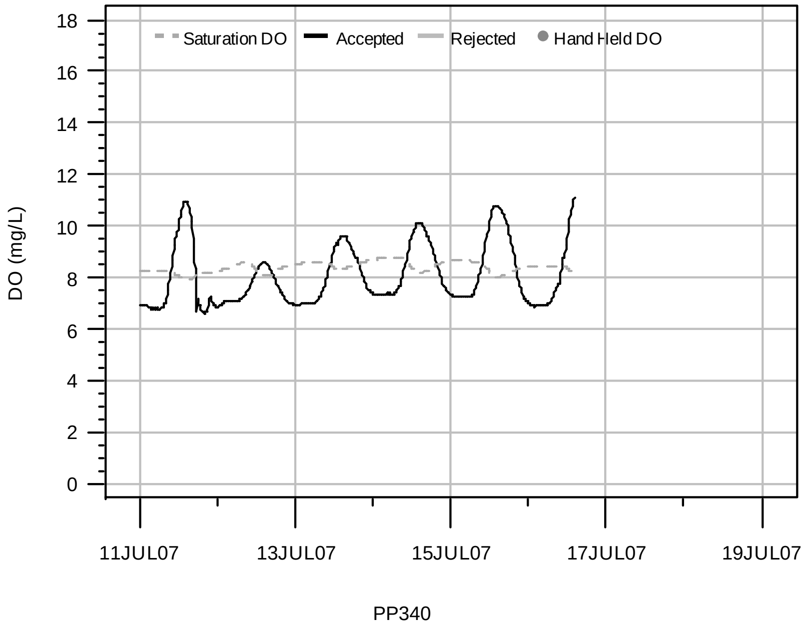

Figure D.6 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 07/11/07 to 07/19/07

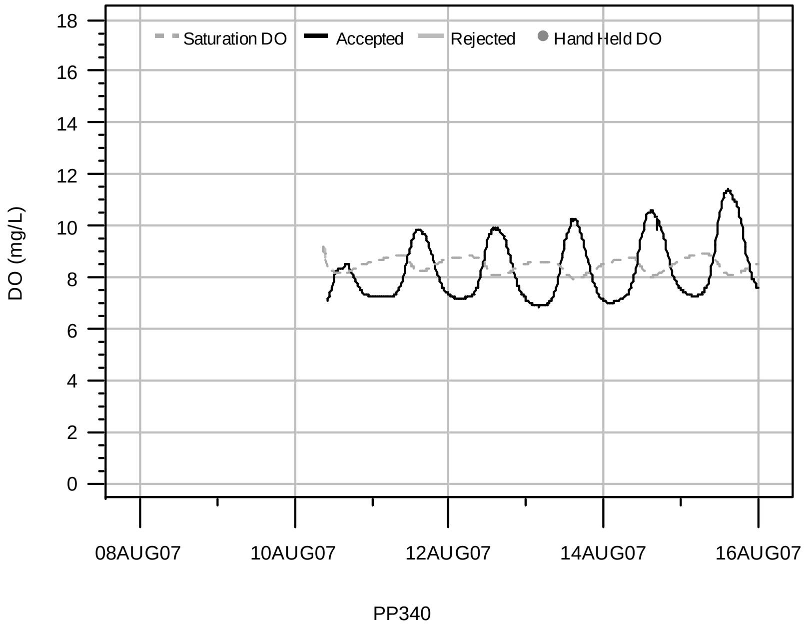

Figure D.7 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 08/08/07 to 08/16/07

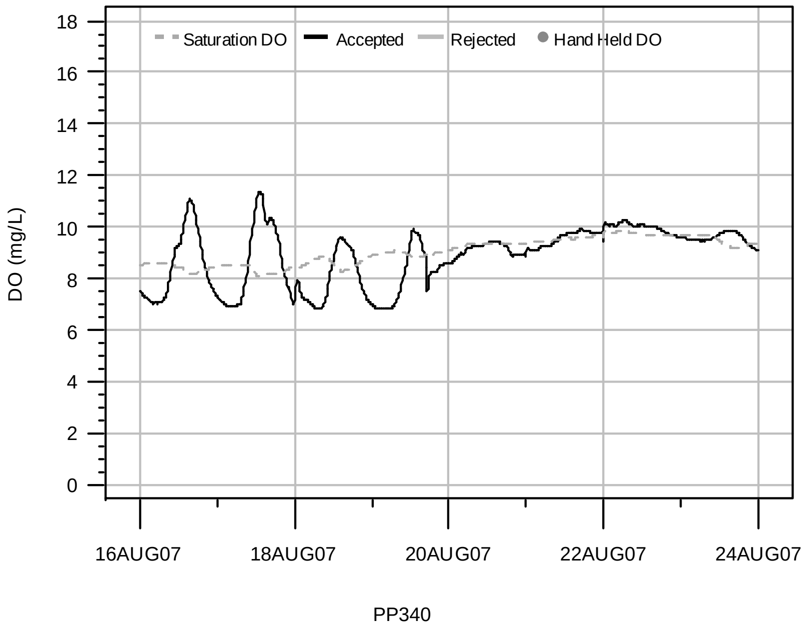

Figure D.8 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 08/16/07 to 08/24/07

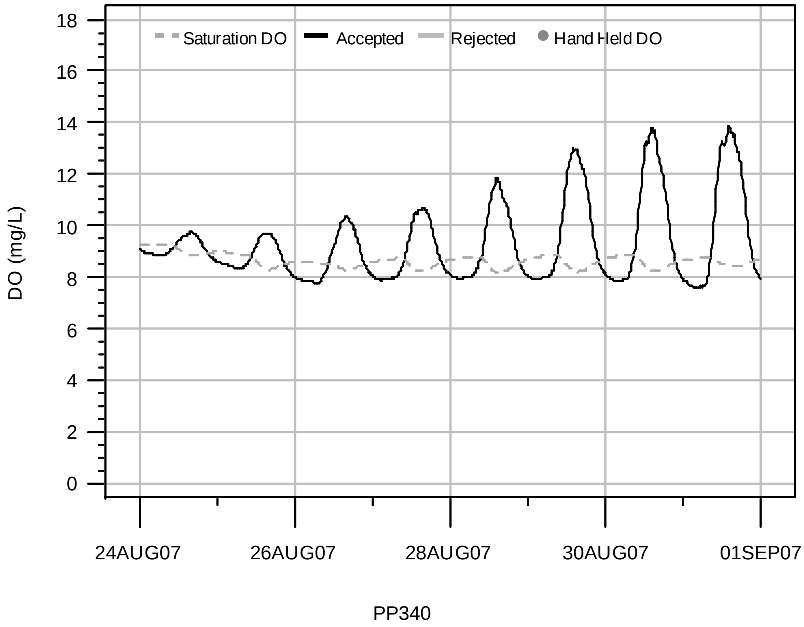

Figure D.9 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 08/24/07 to 09/01/07

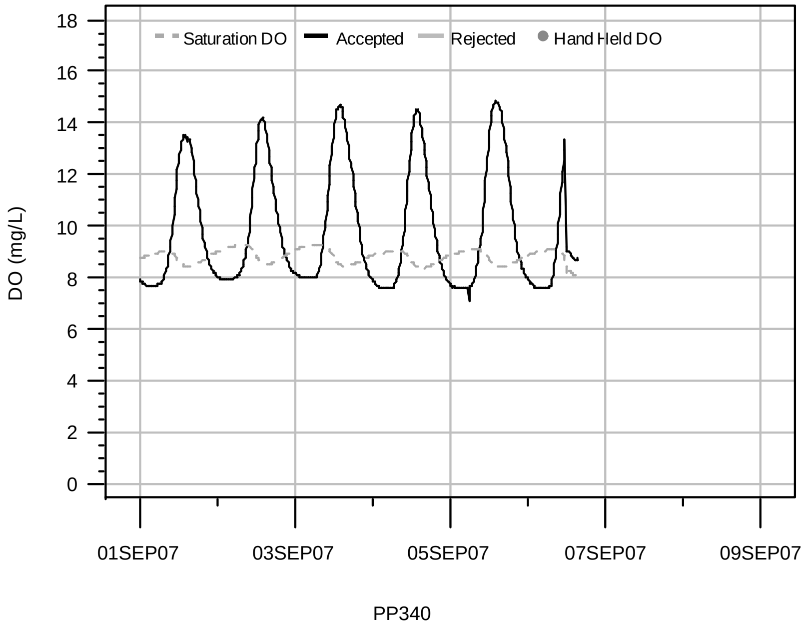

Figure D.10 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 09/01/07 to 09/09/07

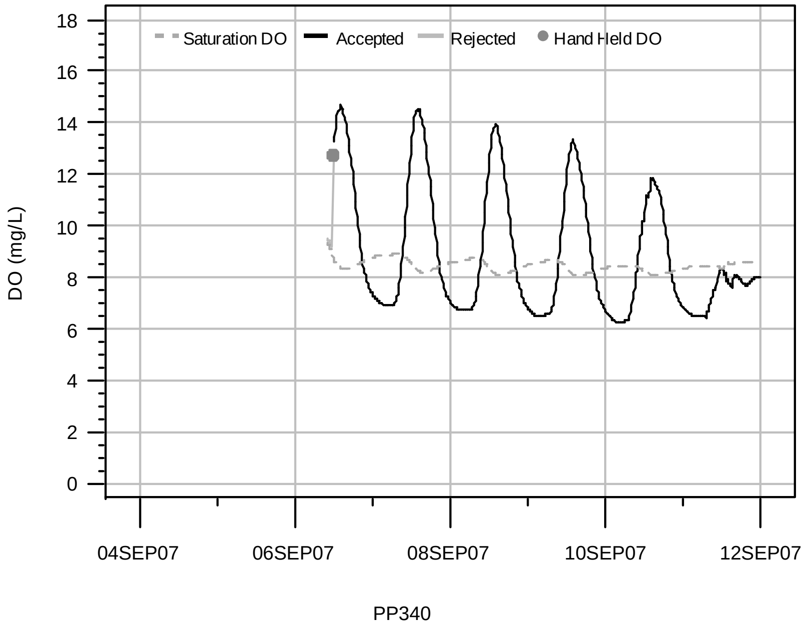

Figure D.11 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 09/04/07 to 09/12/07

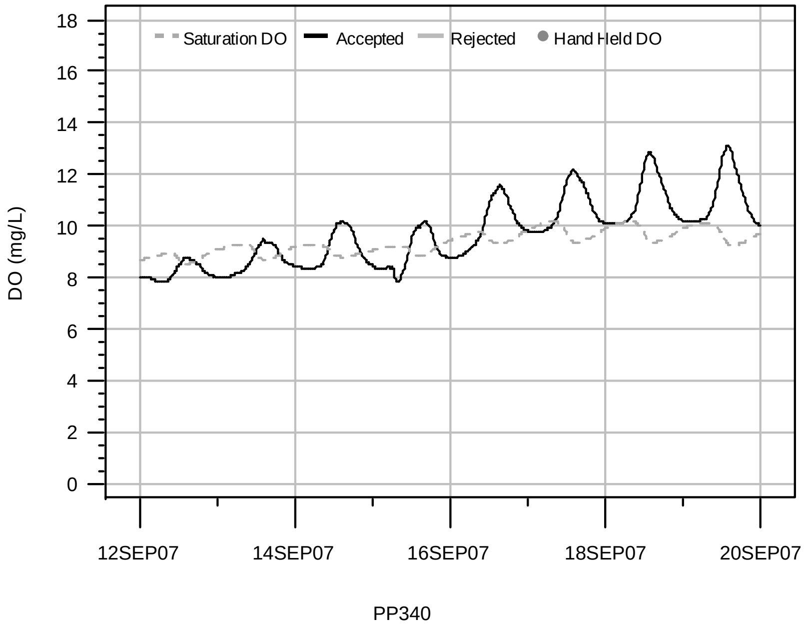

Figure D.12 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 09/12/07 to 09/20/07

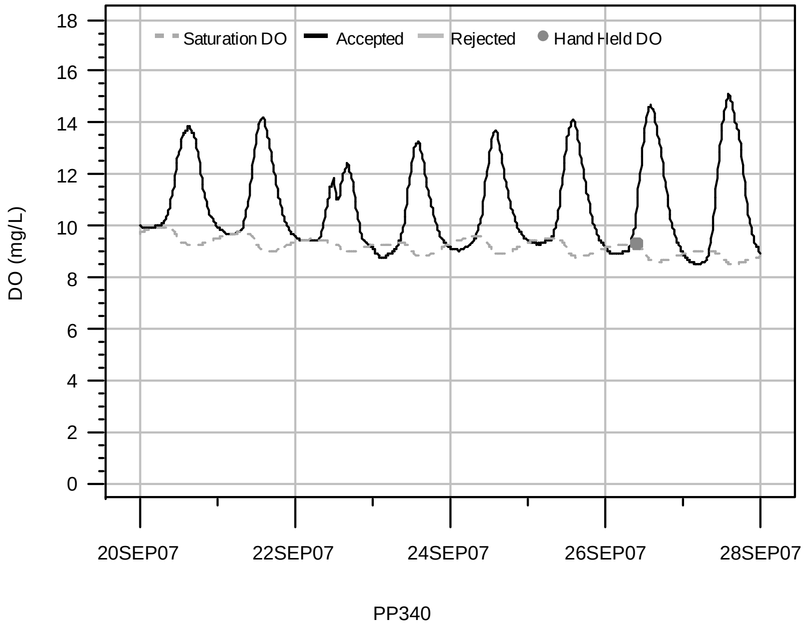

Figure D.13 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 09/20/07 to 09/28/07

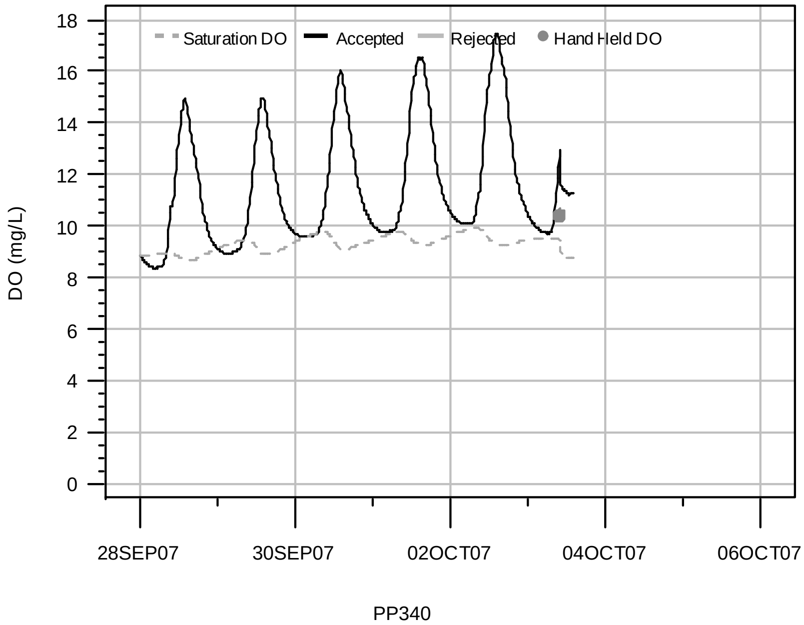

Figure D.14 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 09/28/07 to 10/06/07

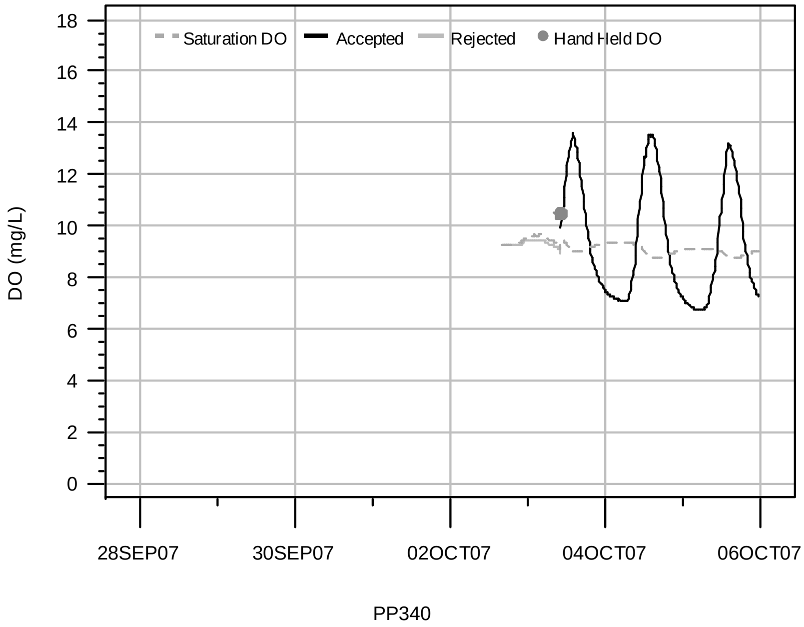

Figure D.15 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 09/28/07 to 10/06/07

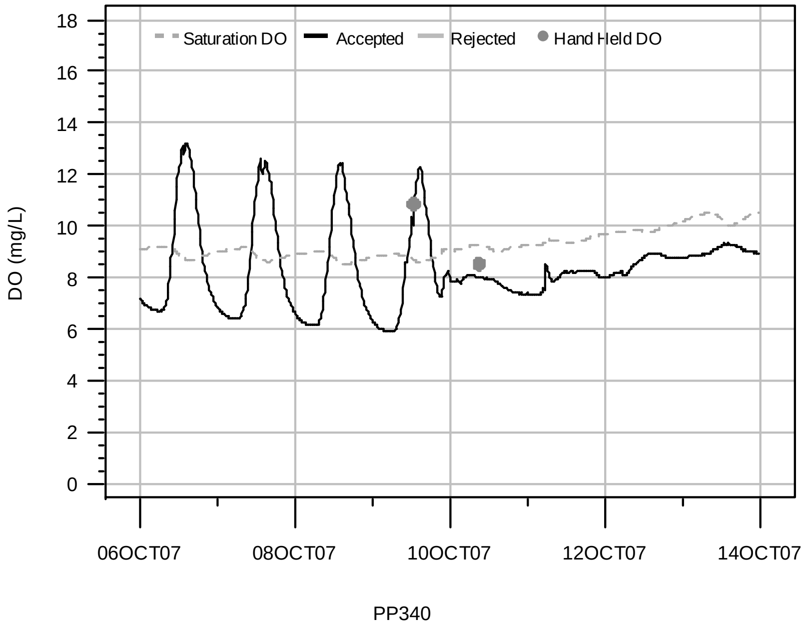

Figure D.16 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 10/06/07 to 10/14/07

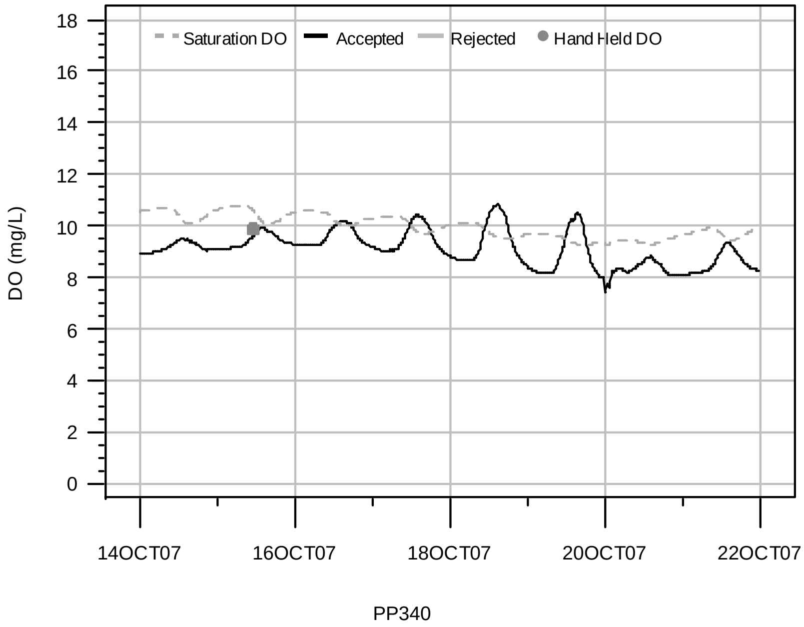

Figure D.17 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 10/14/07 to 10/22/07

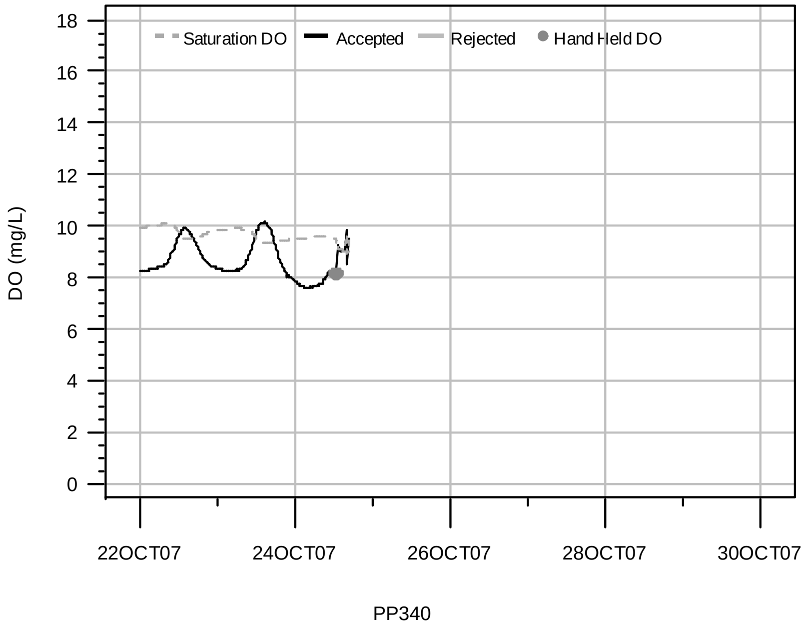

Figure D.18 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 10/22/07 to 10/30/07

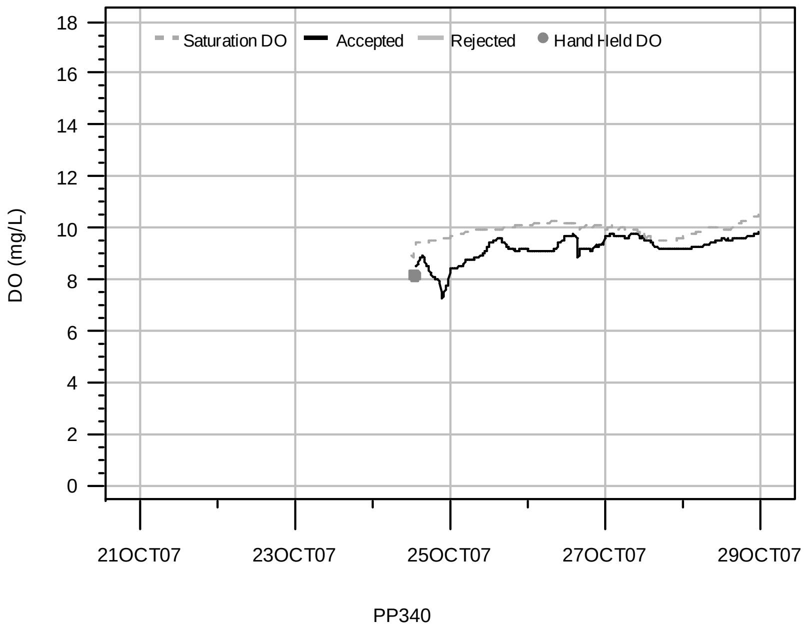

Figure D.19 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 10/21/07 to 10/29/07

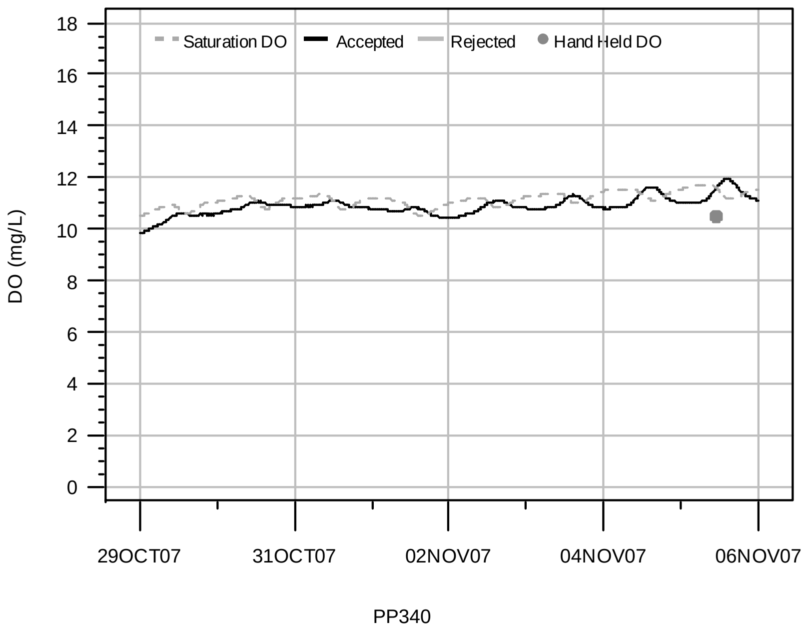

Figure D.20 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 10/29/07 to 11/06/07

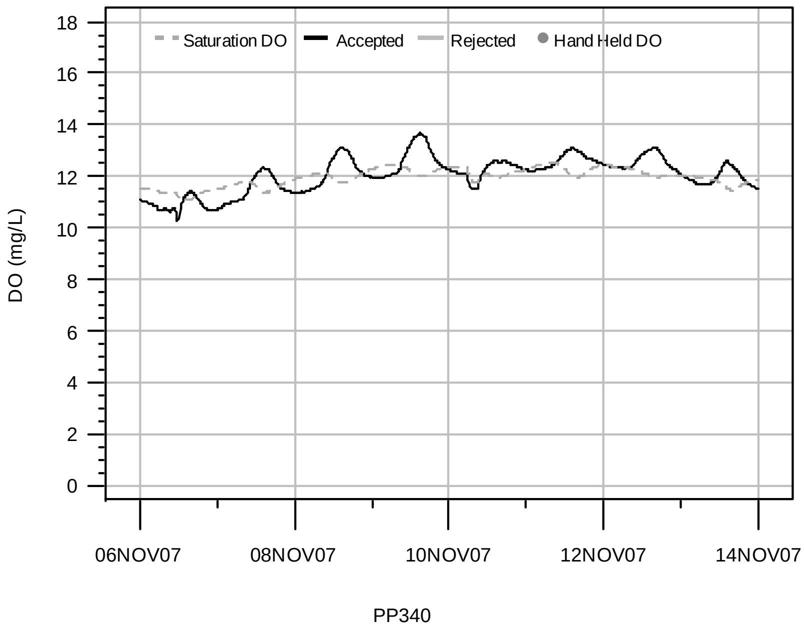

Figure D.21 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 11/06/07 to 11/14/07

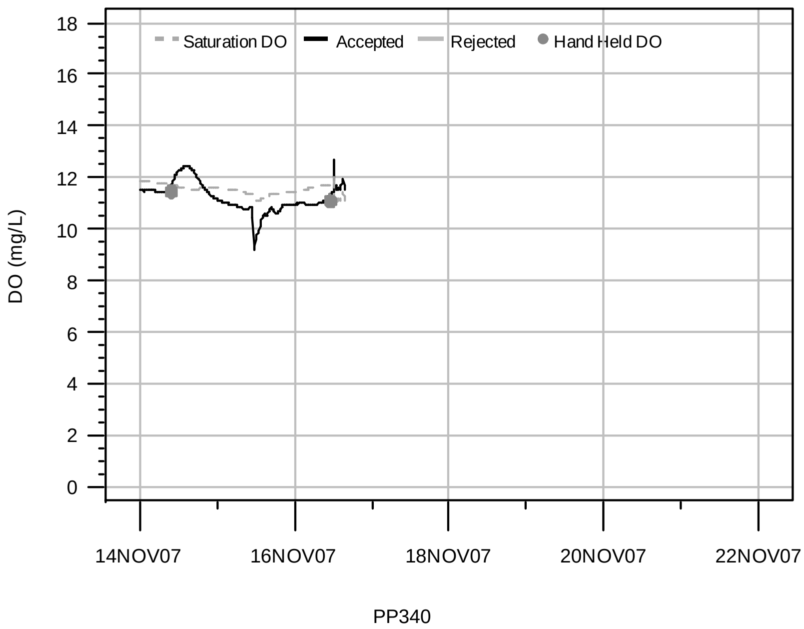

Figure D.22 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 11/14/07 to 11/22/07

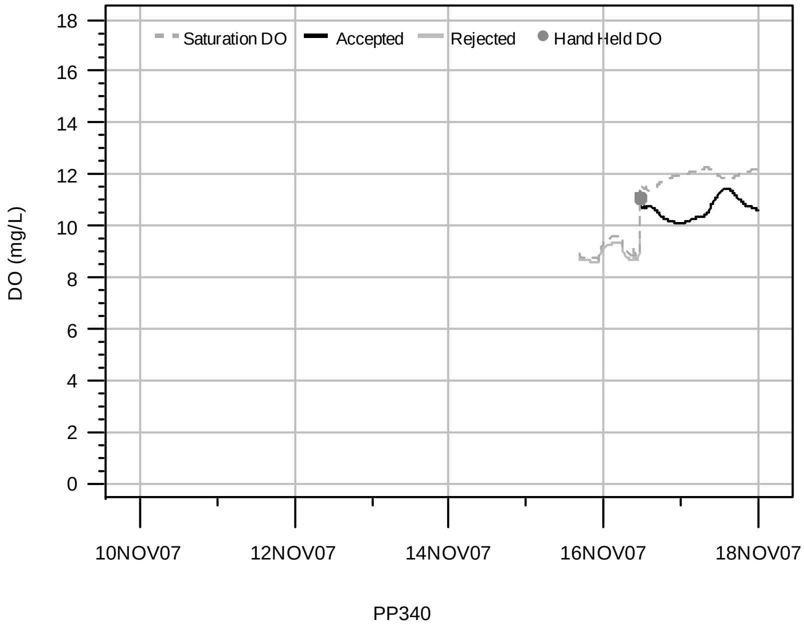

Figure D.23 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 11/10/07 to 11/18/07

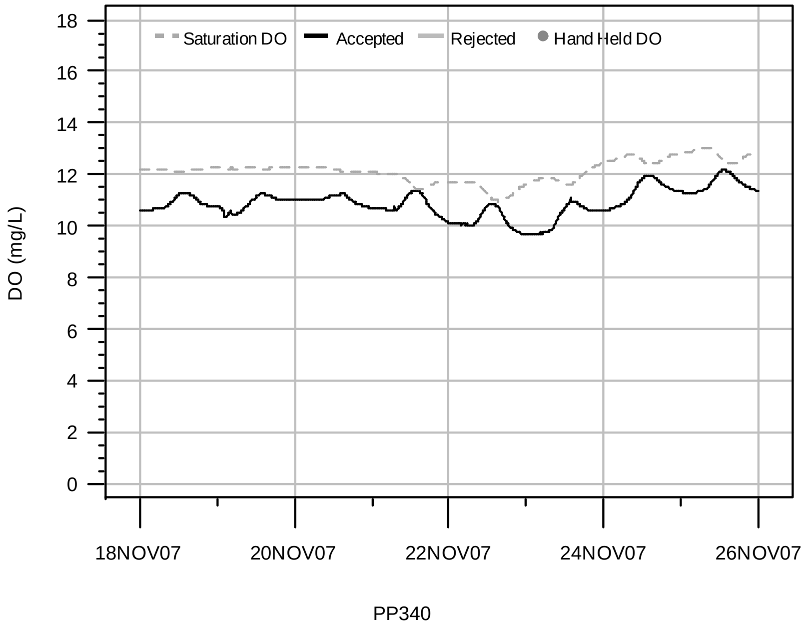

Figure D.24 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 11/18/07 to 11/26/07

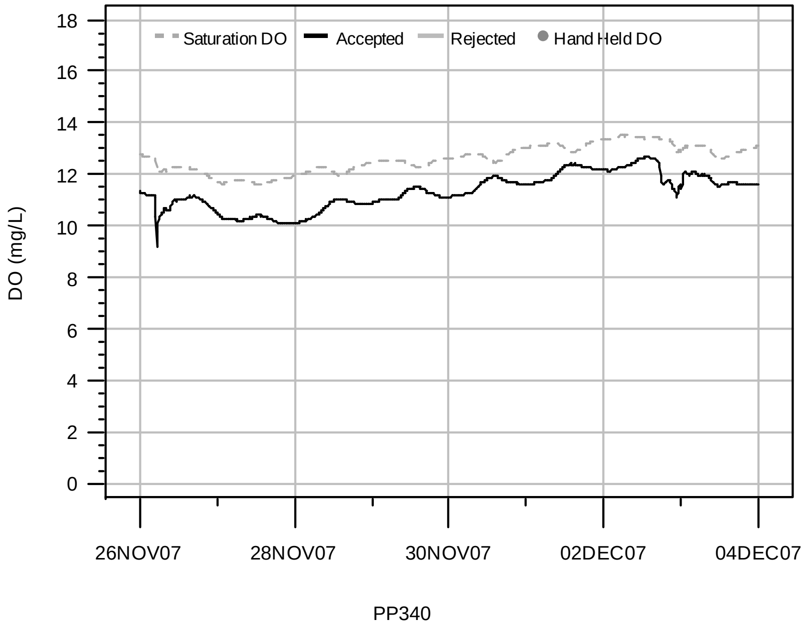

Figure D.25 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 11/26/07 to 12/04/07

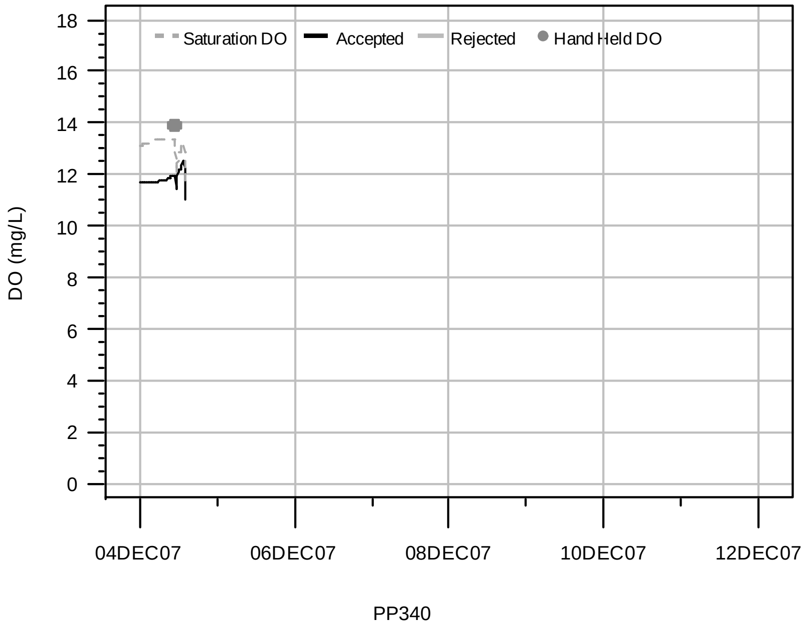

Figure D.26 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP340, 12/04/07 to 12/12/07

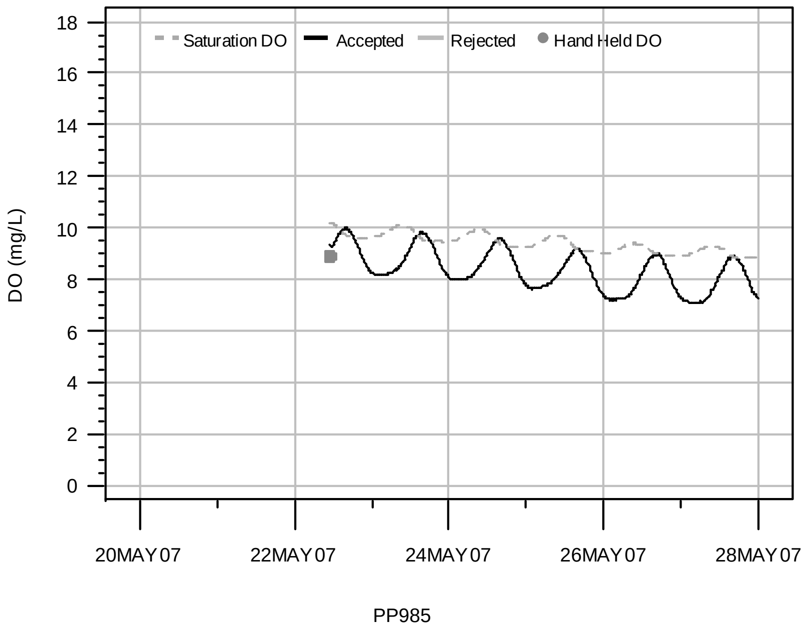

Figure D.27 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 05/20/07 to 05/28/07

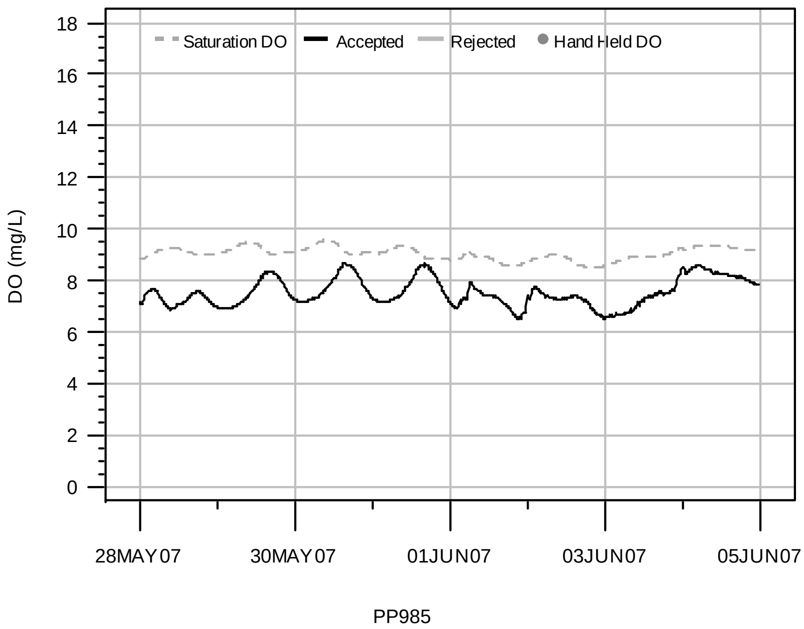

Figure D.28 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 05/28/07 to 06/05/07

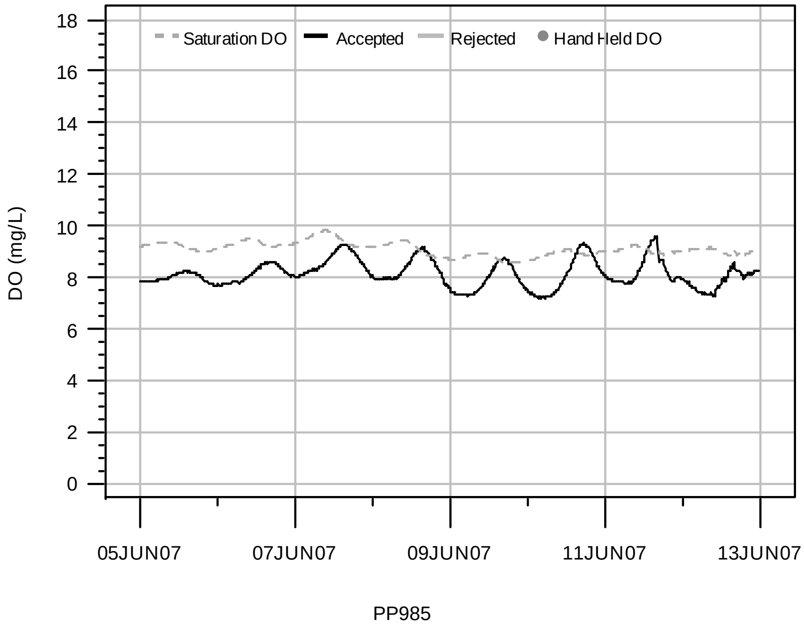

Figure D.29 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 06/05/07 to 06/13/07

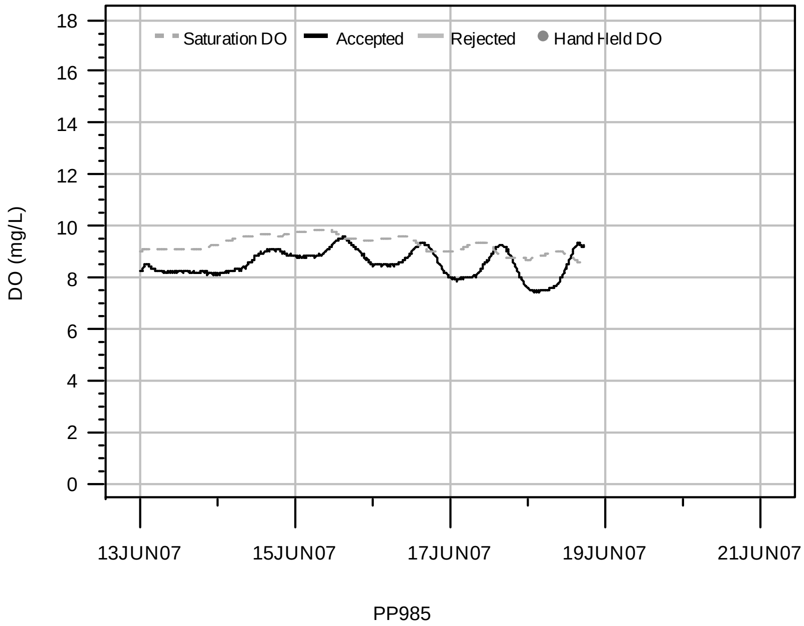

Figure D.30 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 06/13/07 to 06/21/07

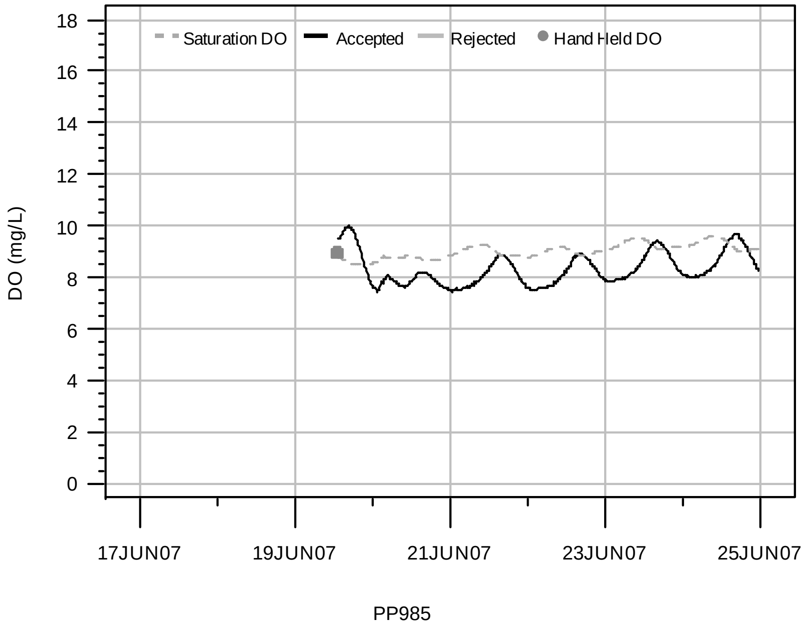

Figure D.31 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 06/17/07 to 06/25/07

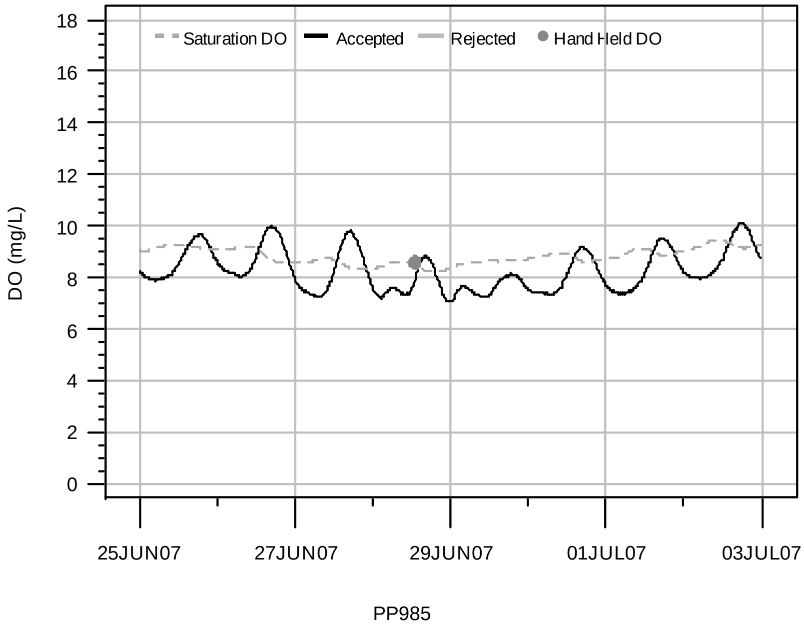

Figure D.32 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 06/25/07 to 07/03/07

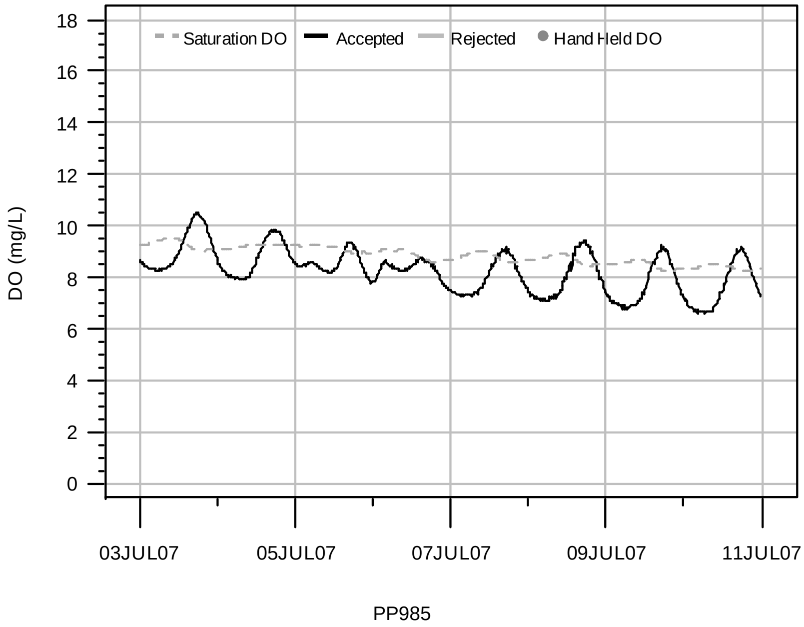

Figure D.33 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 07/03/07 to 07/11/07

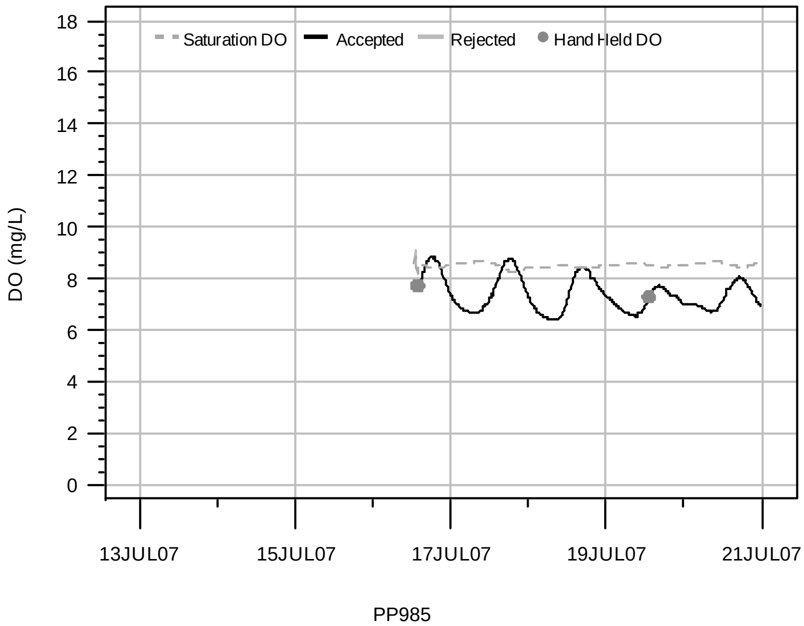

Figure D.34 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 07/13/07 to 07/21/07

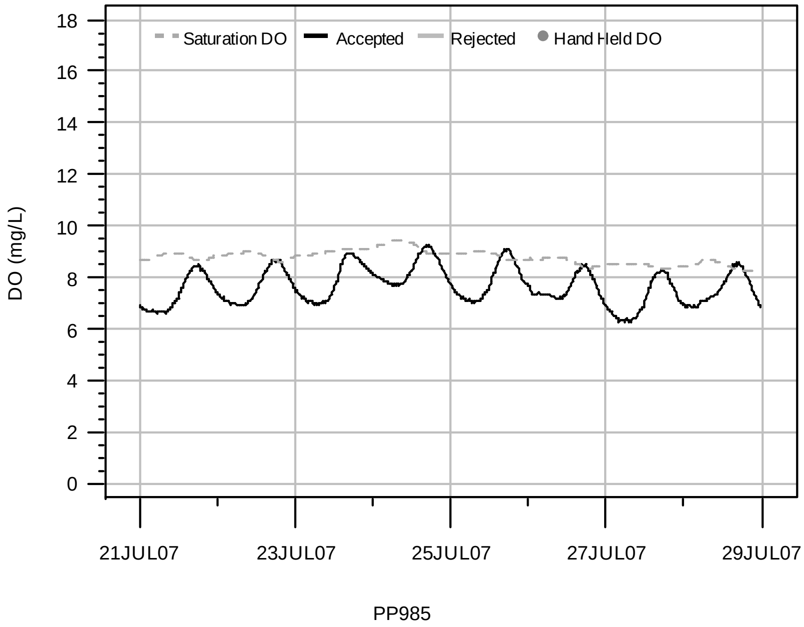

Figure D.35 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 07/21/07 to 07/29/07

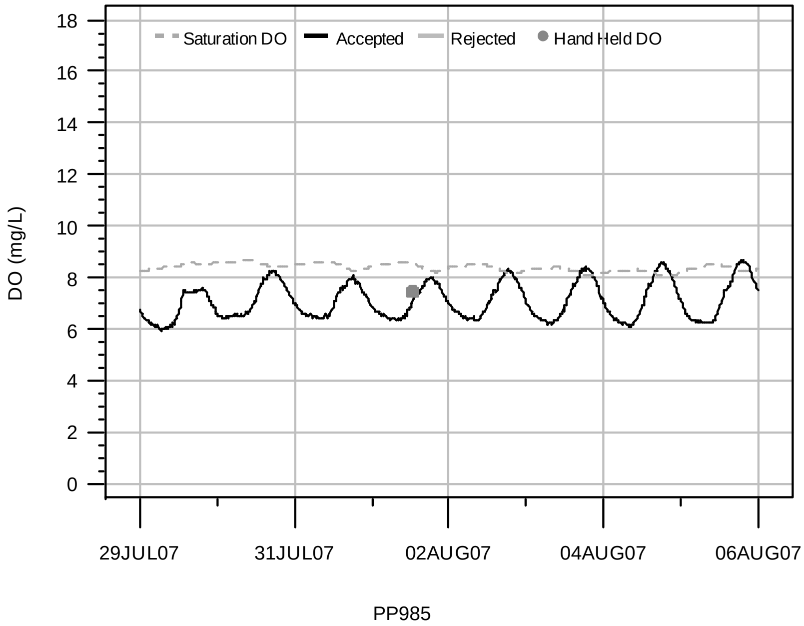

Figure D.36 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 07/29/07 to 08/06/07

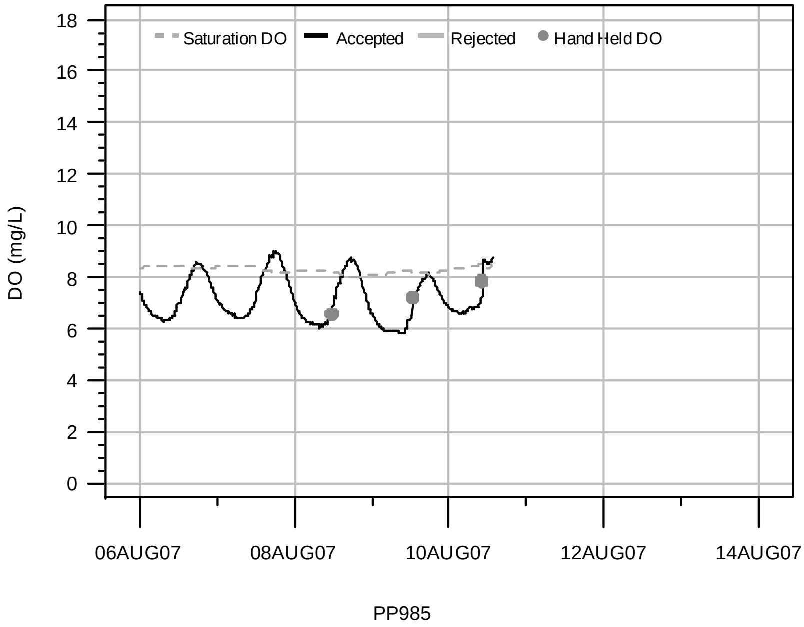

Figure D.37 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 08/06/07 to 08/14/07

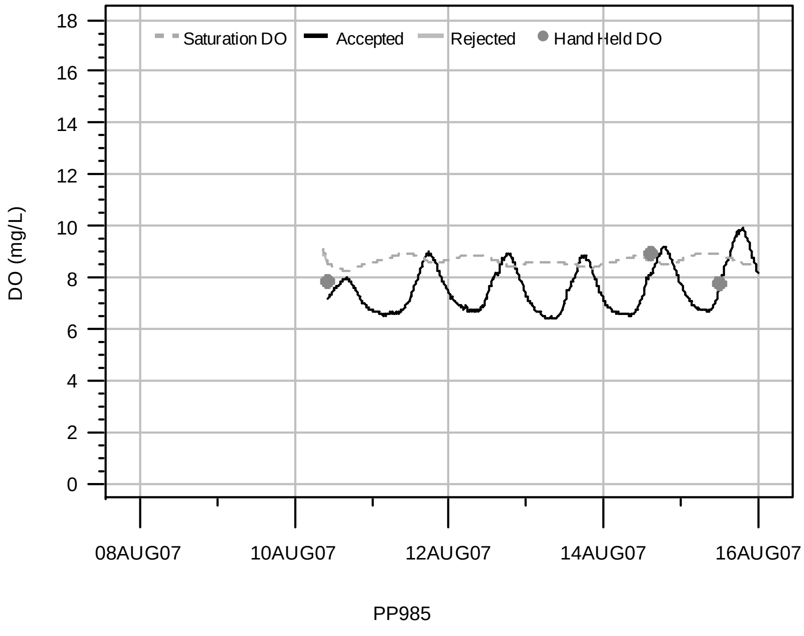

Figure D.38 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 08/08/07 to 08/16/07

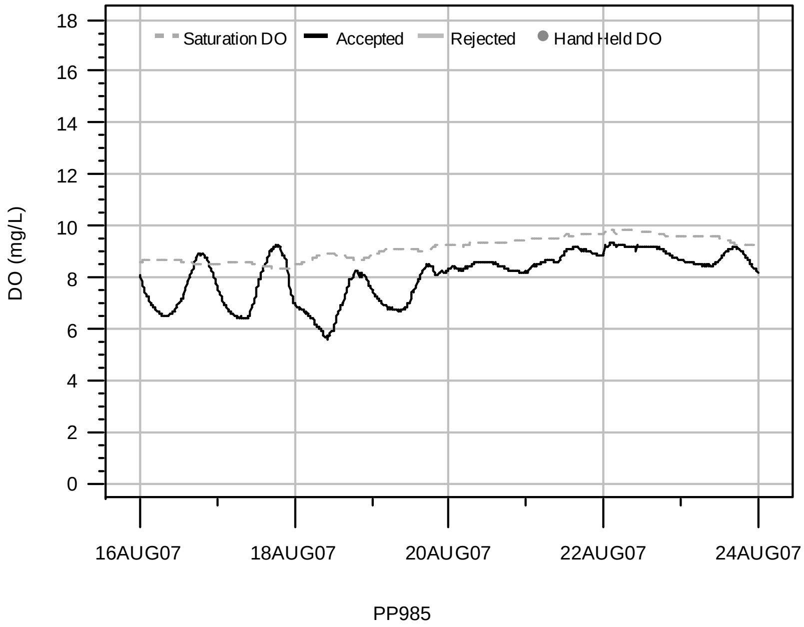

Figure D.39 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 08/16/07 to 08/24/07

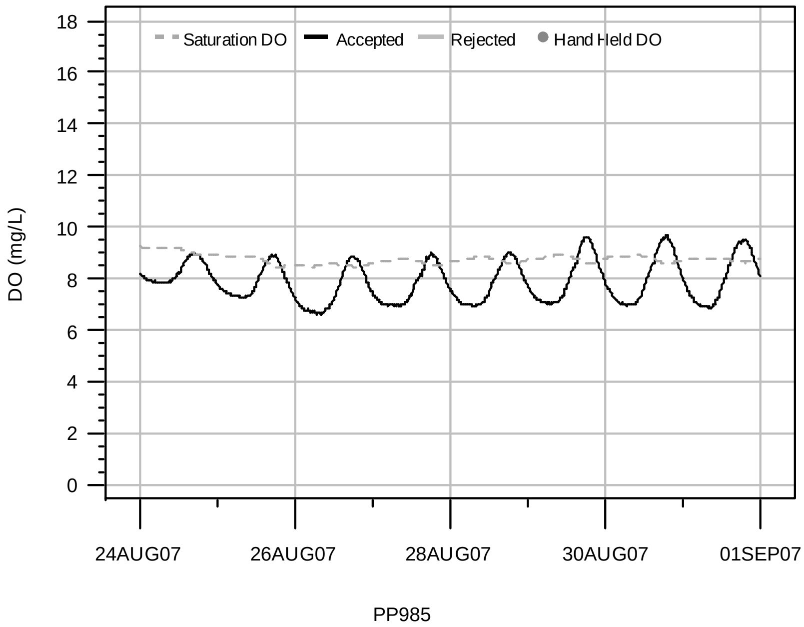

Figure D.40 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 08/24/07 to 09/1/07

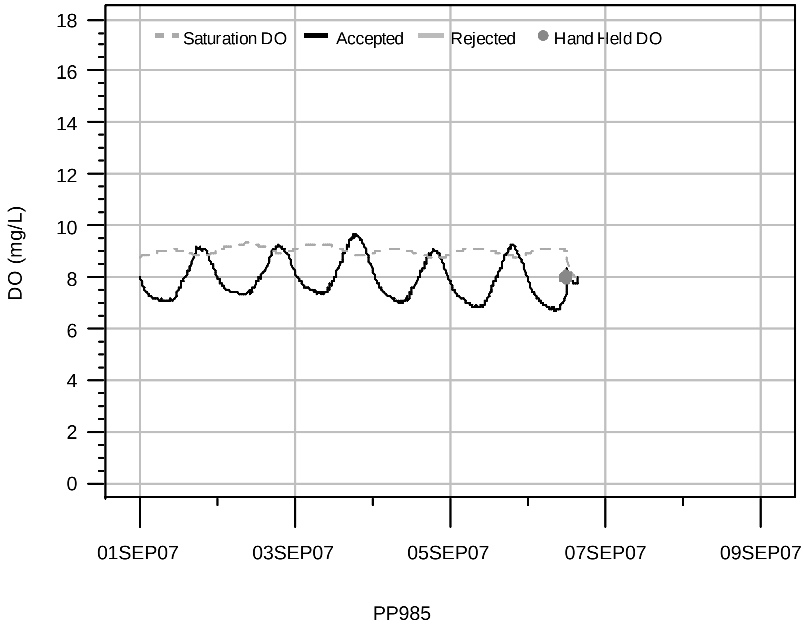

Figure D.41 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 09/01/07 to 09/09/07

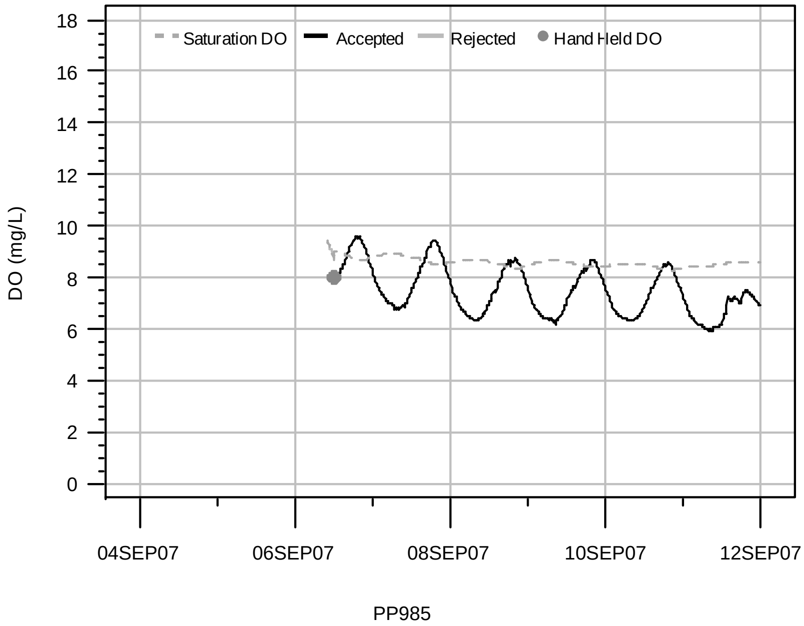

Figure D.42 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 09/04/07 to 09/12/07

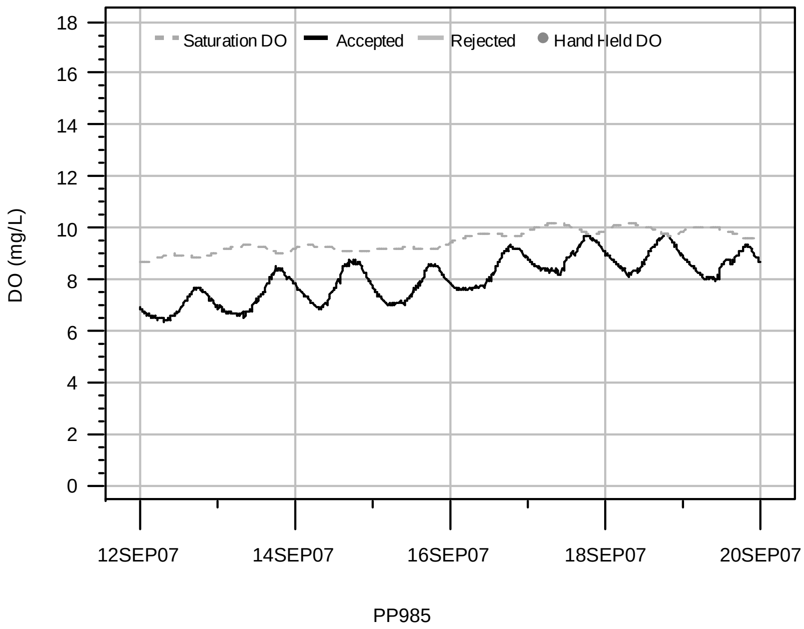

Figure D.43 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 09/12/07 to 09/20/07

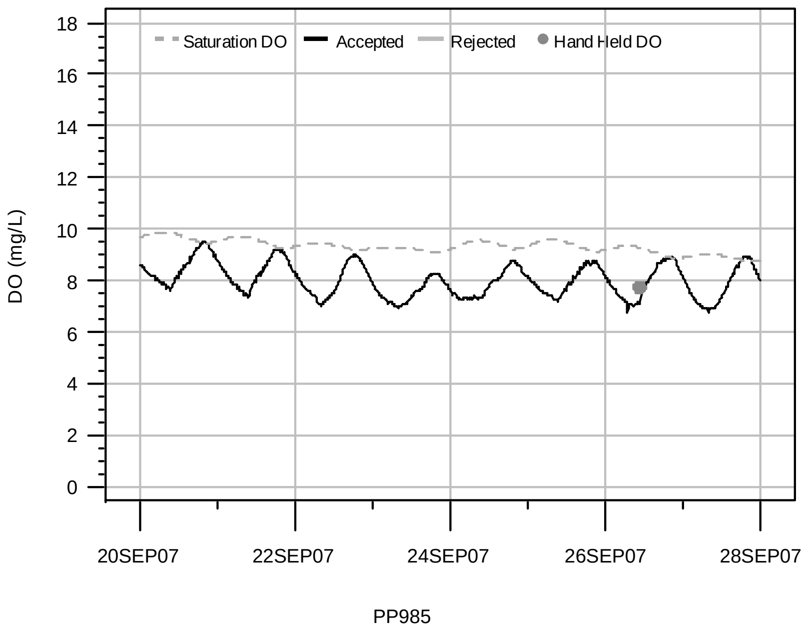

Figure D.44 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 09/20/07 to 09/28/07

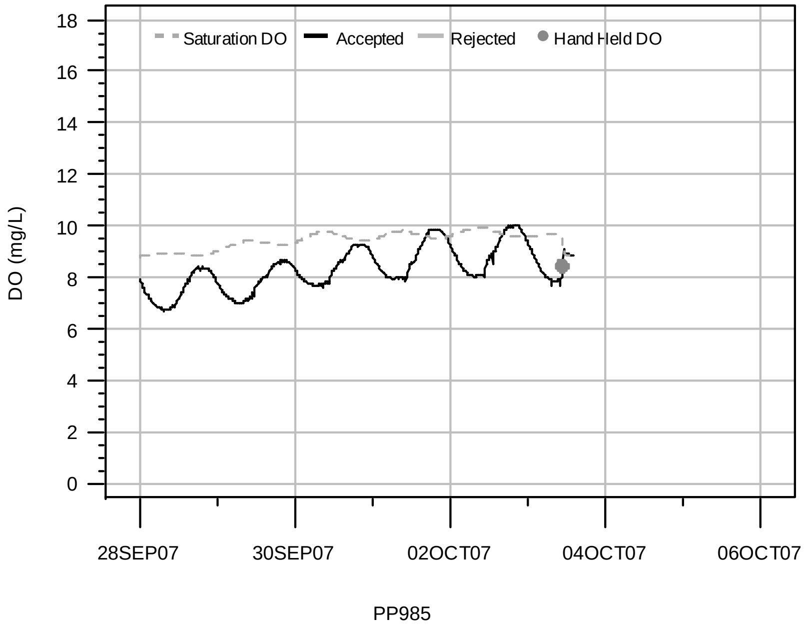

Figure D.45 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 09/28/07 to 10/06/07

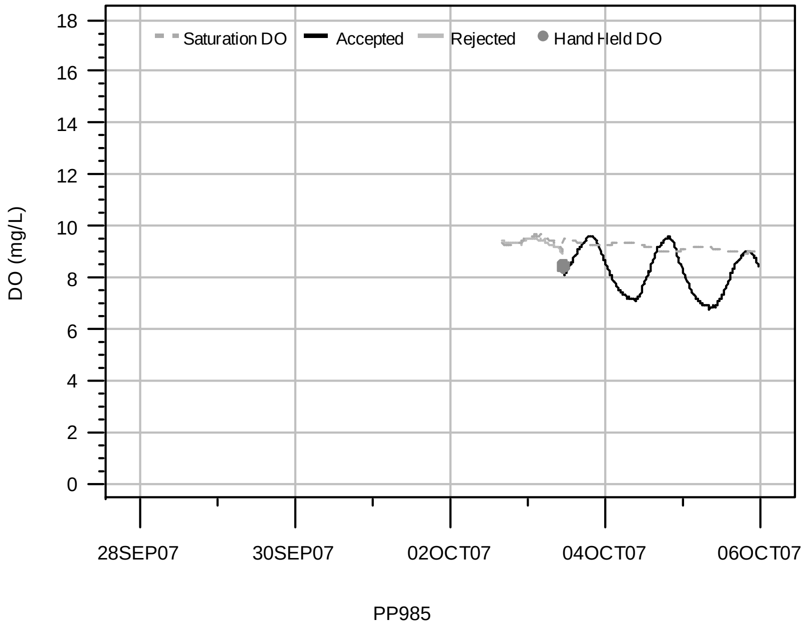

Figure D.46 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 09/28/07 to 10/06/07

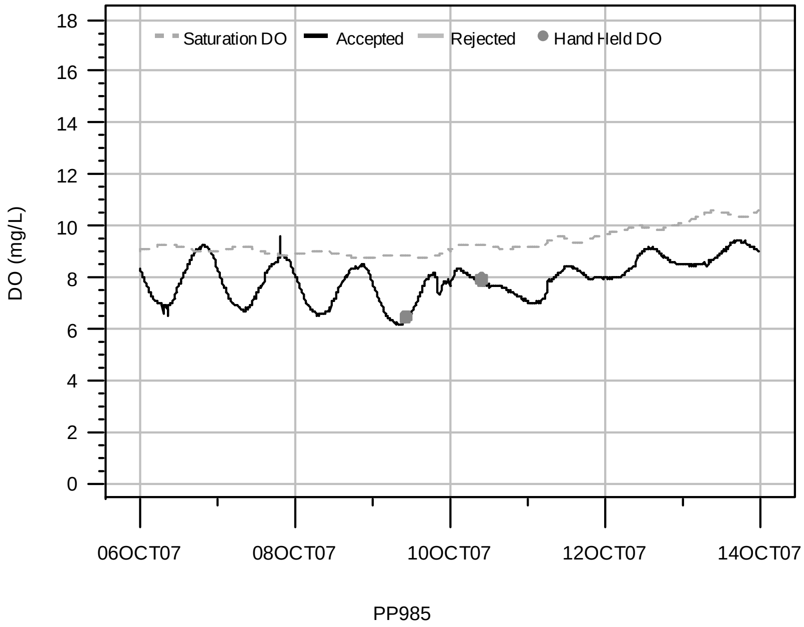

Figure D.47 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 10/06/07 to 10/14/07

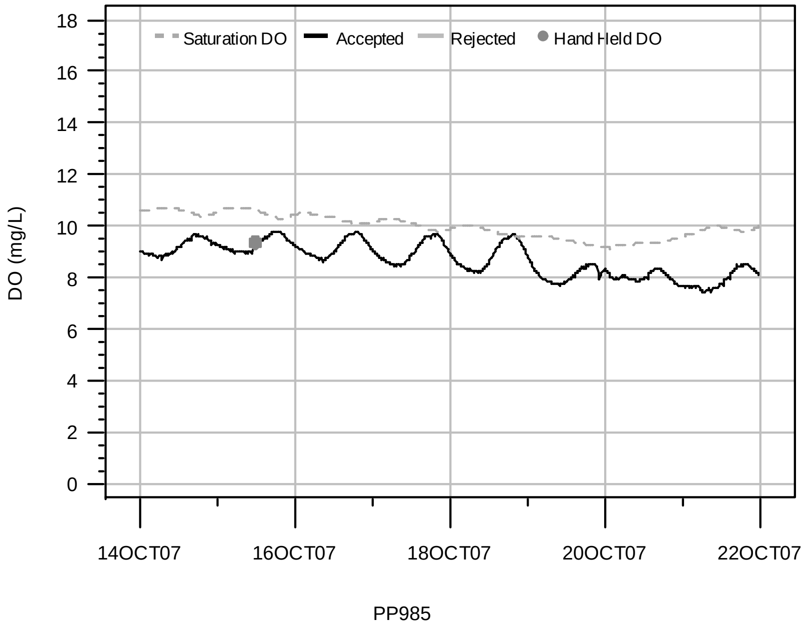

Figure D.48 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 10/14/07 to 10/22/07

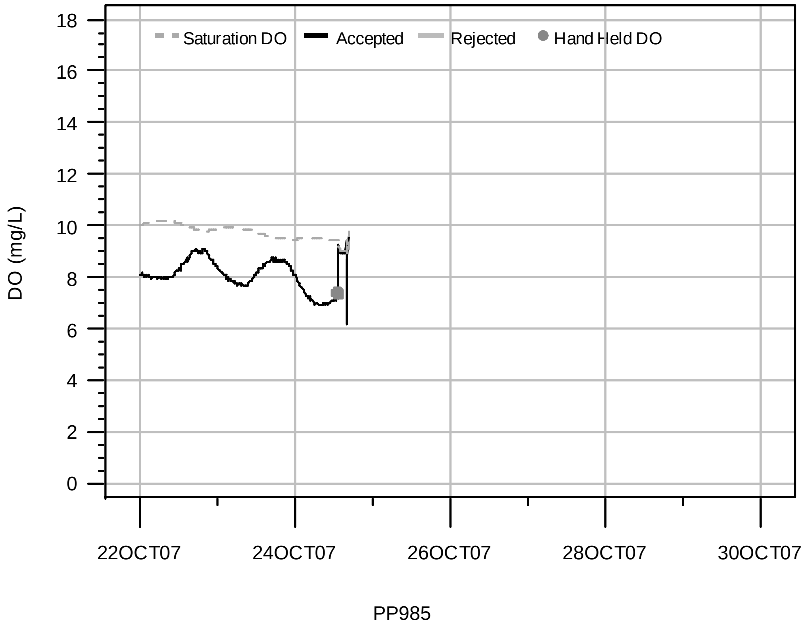

Figure D.49 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 10/22/07 to 10/30/07

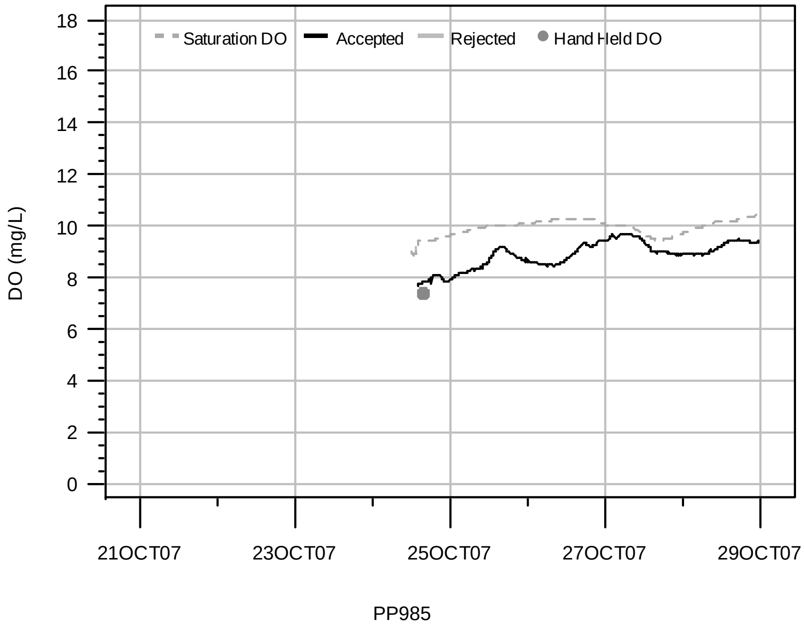

Figure D.50 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 10/21/07 to 10/29/07

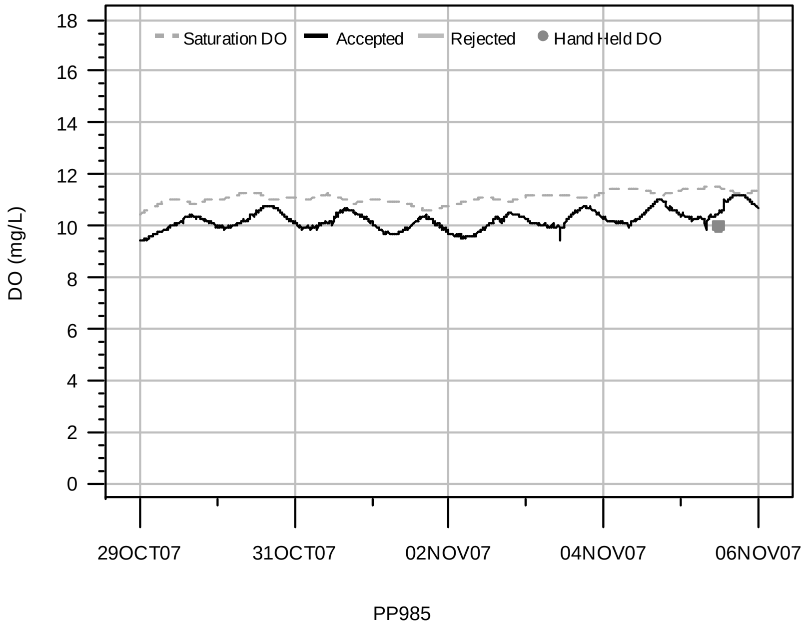

Figure D.51 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 10/29/07 to 11/06/07

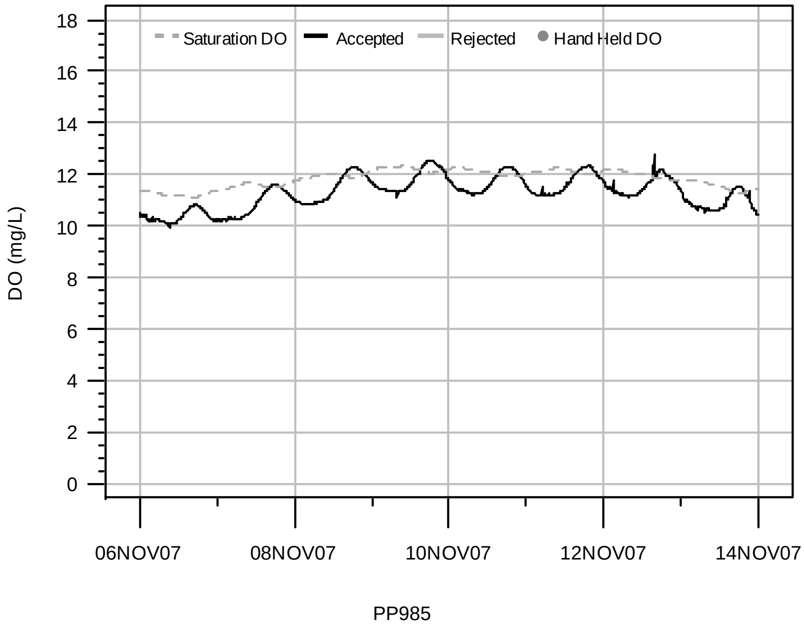

Figure D.52 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 11/06/07 to 11/14/07

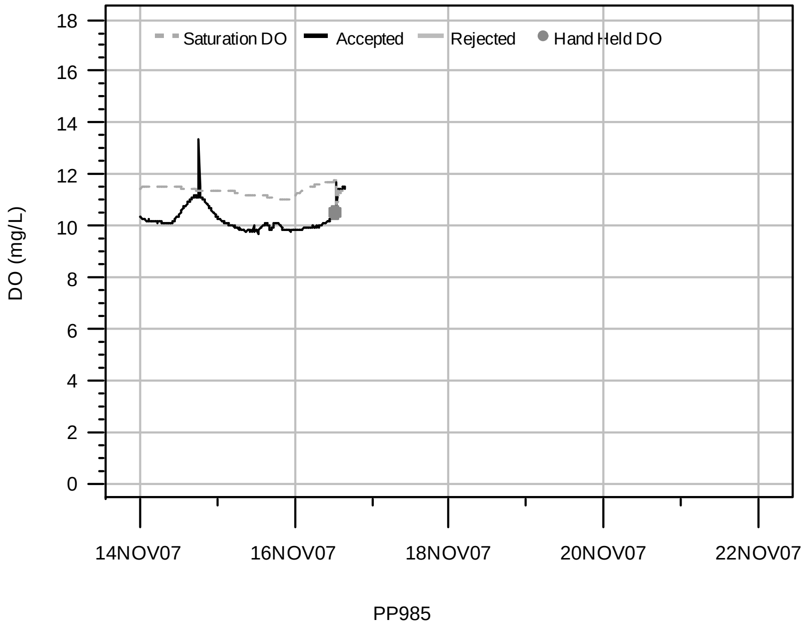

Figure D.53 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 11/14/07 to 11/22/07

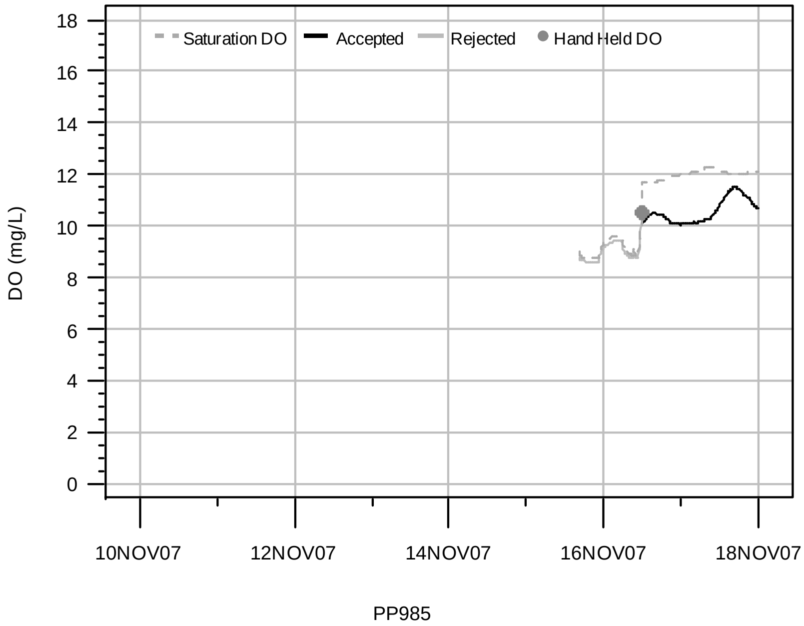

Figure D.54 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 11/10/07 to 11/18/07

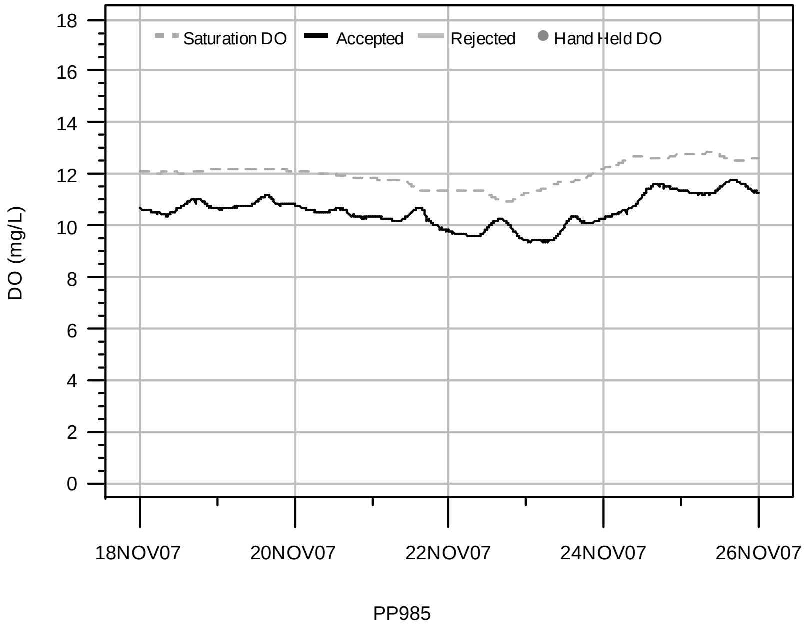

Figure D.55 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 11/18/07 to 11/26/07

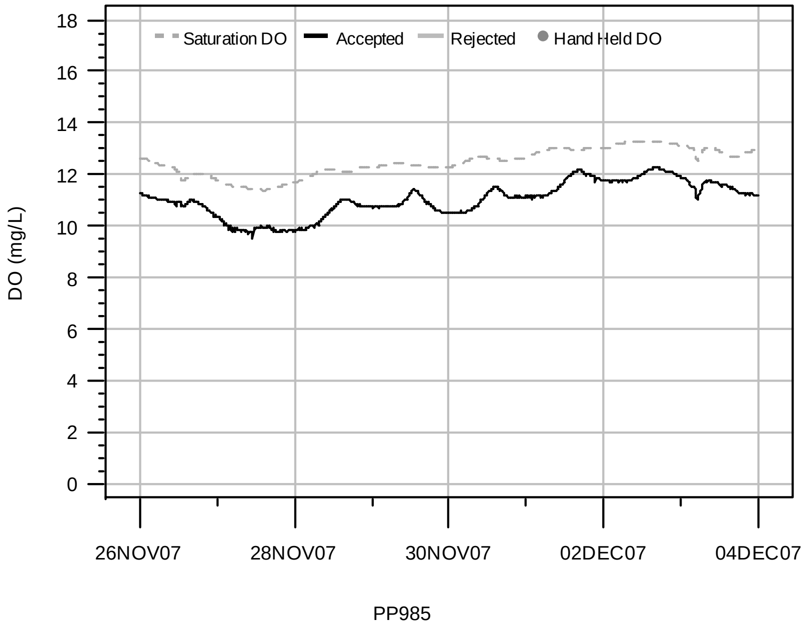

Figure D.56 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 11/26/07 to 12/04/07

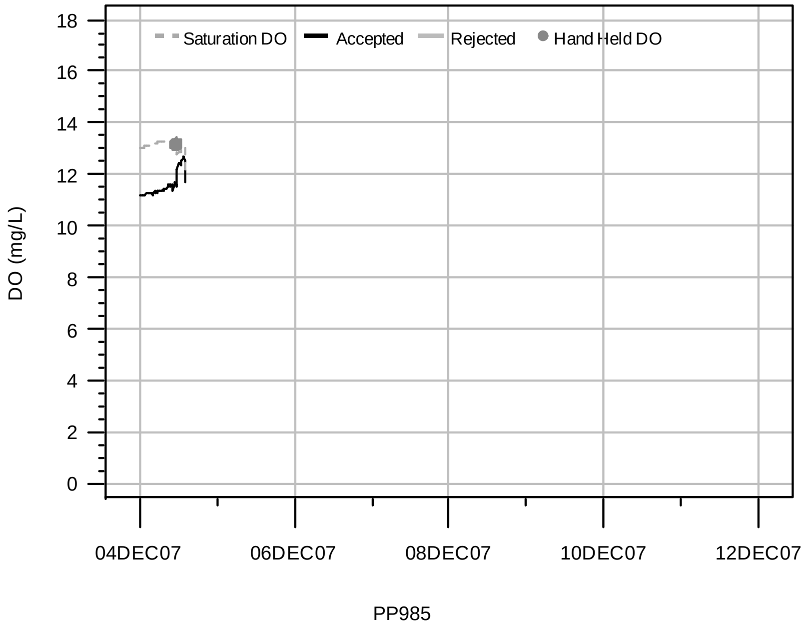

Figure D.57 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP985, 12/04/07 to 12/12/07

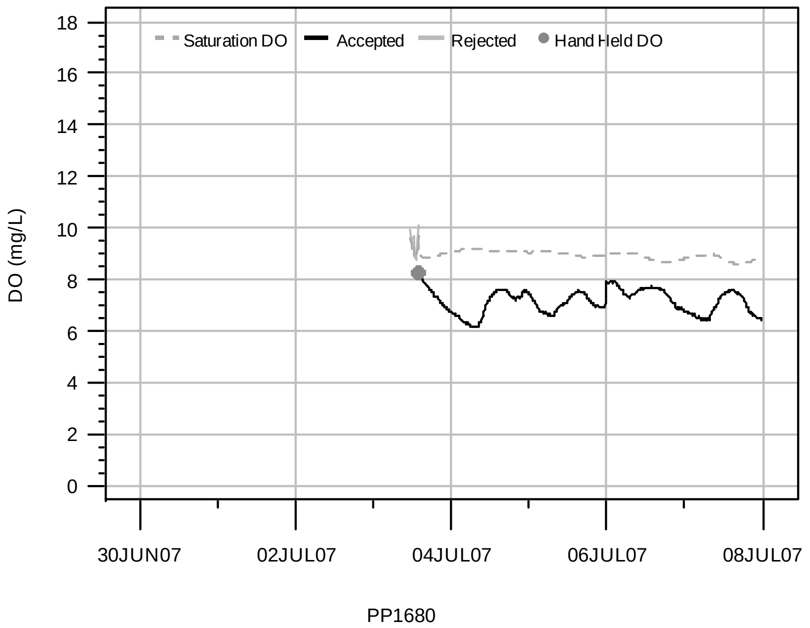

Figure D.58 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 06/30/07 to 07/08/07

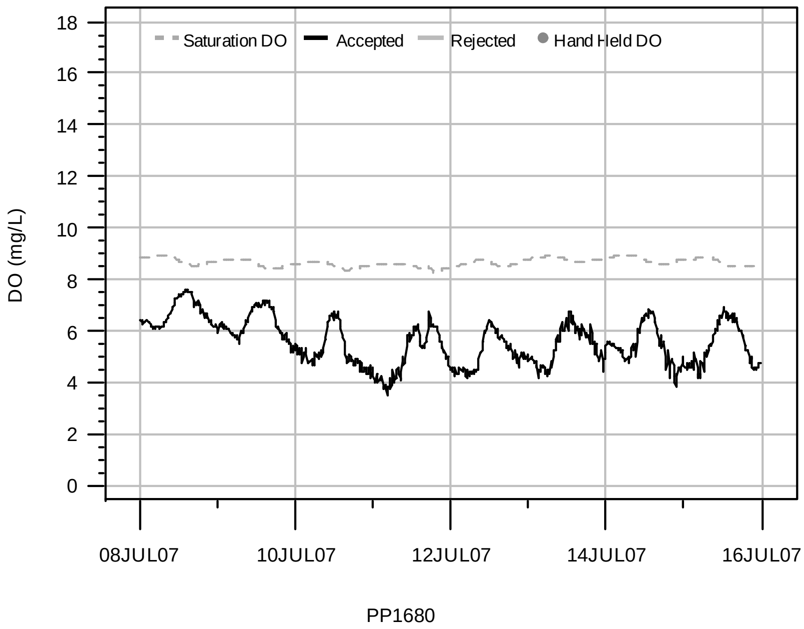

Figure D.59 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 07/08/07 to 07/16/07

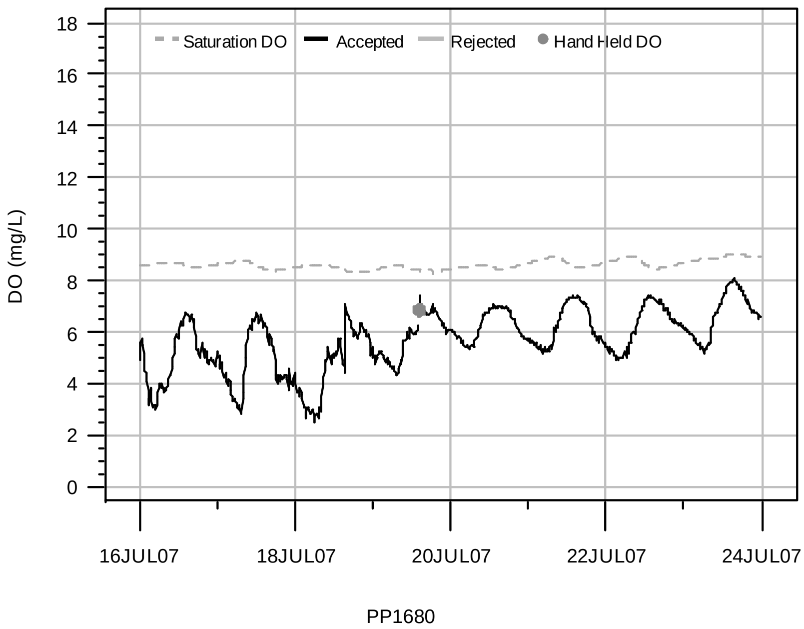

Figure D.60 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 07/16/07 to 07/24/07

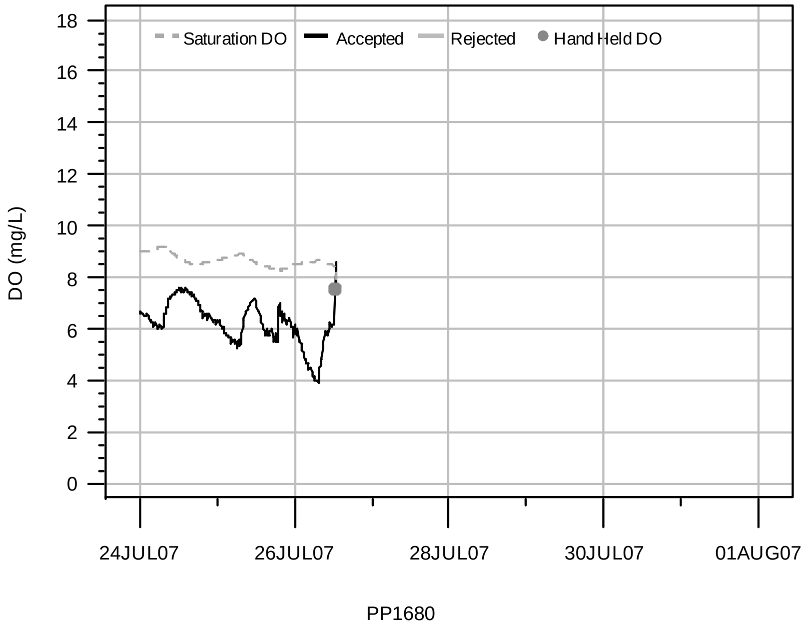

Figure D.61 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 07/24/07 to 08/01/07

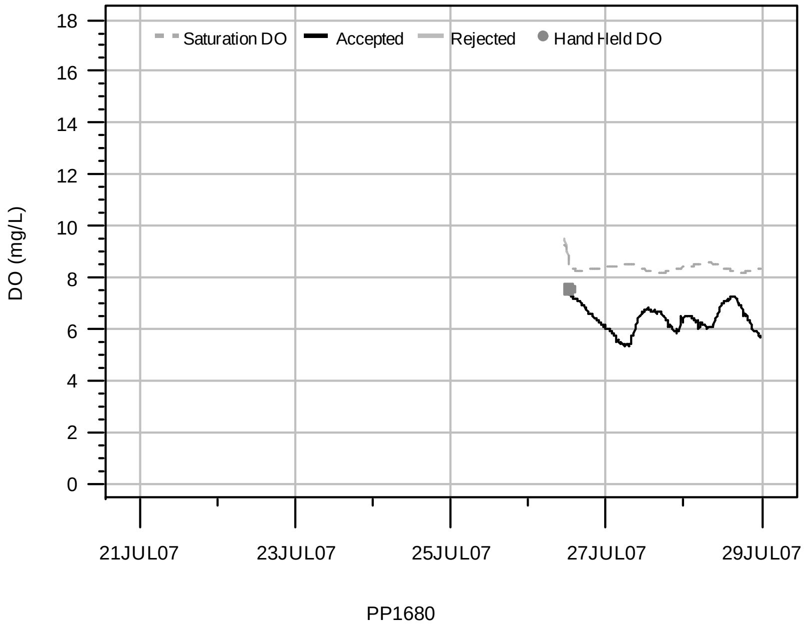

Figure D.62 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 07/21/07 to 07/29/07

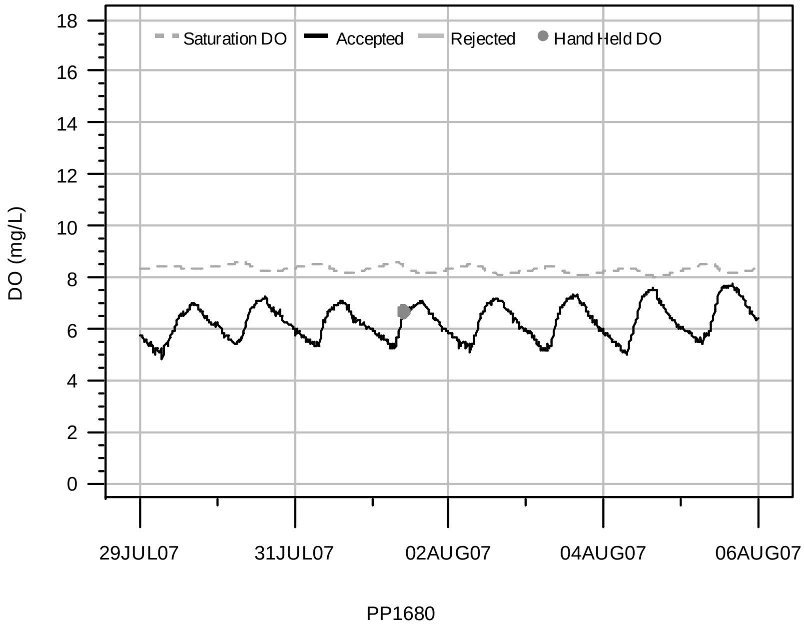

Figure D.63 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 07/29/07 to 08/06/07

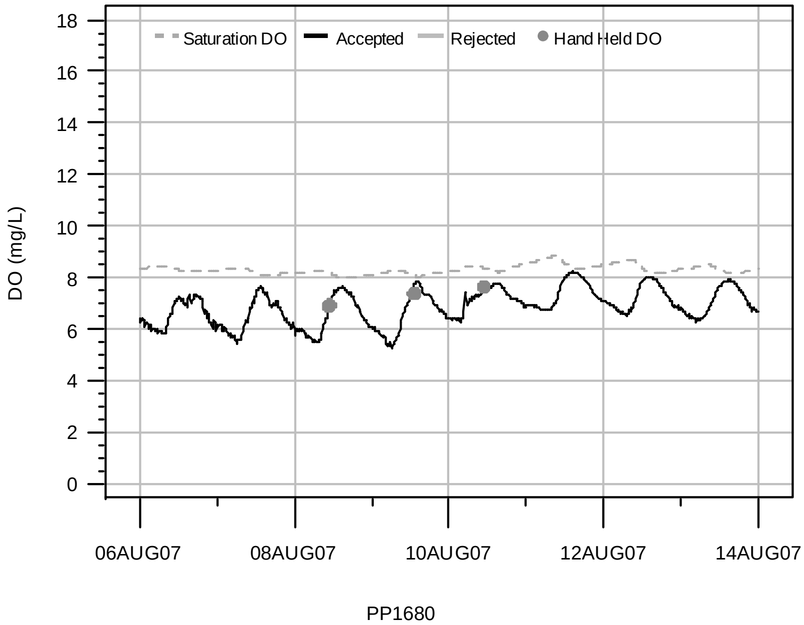

Figure D.64 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 08/06/07 to 08/14/07

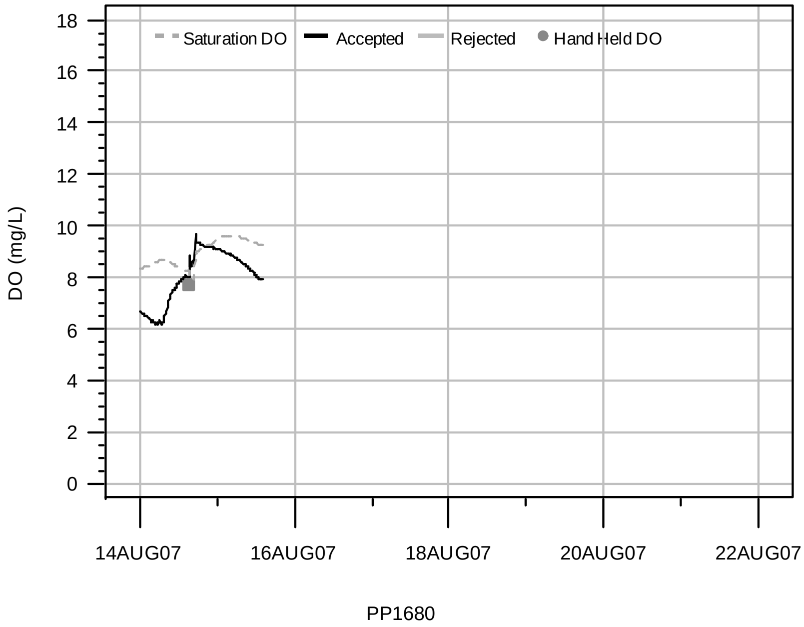

Figure D.65 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 08/14/07 to 08/22/07

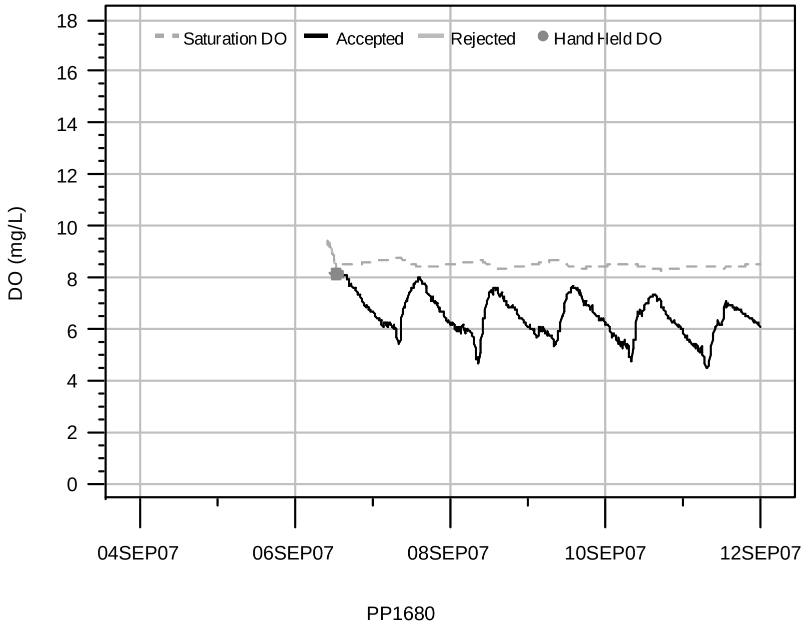

Figure D.66 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 09/04/07 to 09/12/07

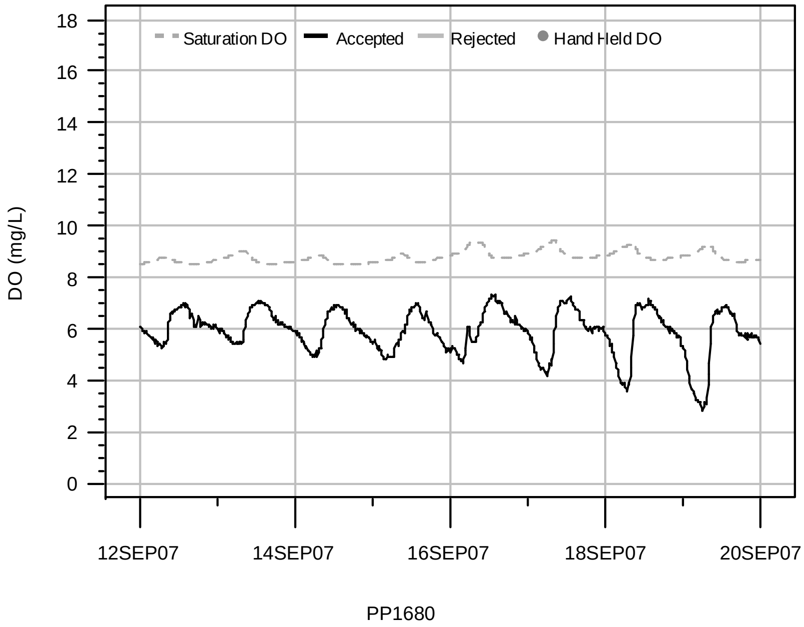

Figure D.67 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 09/12/07 to 09/20/07

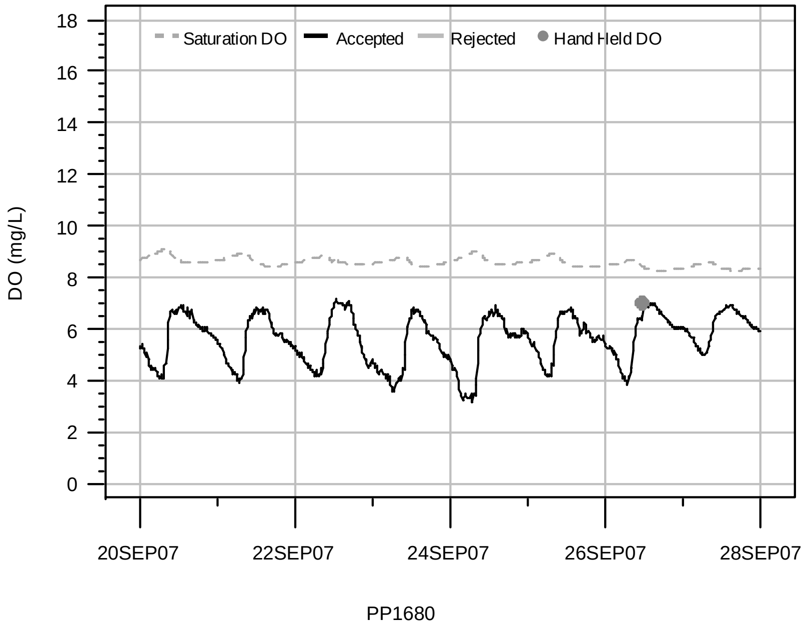

Figure D.68 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 09/20/07 to 09/28/07

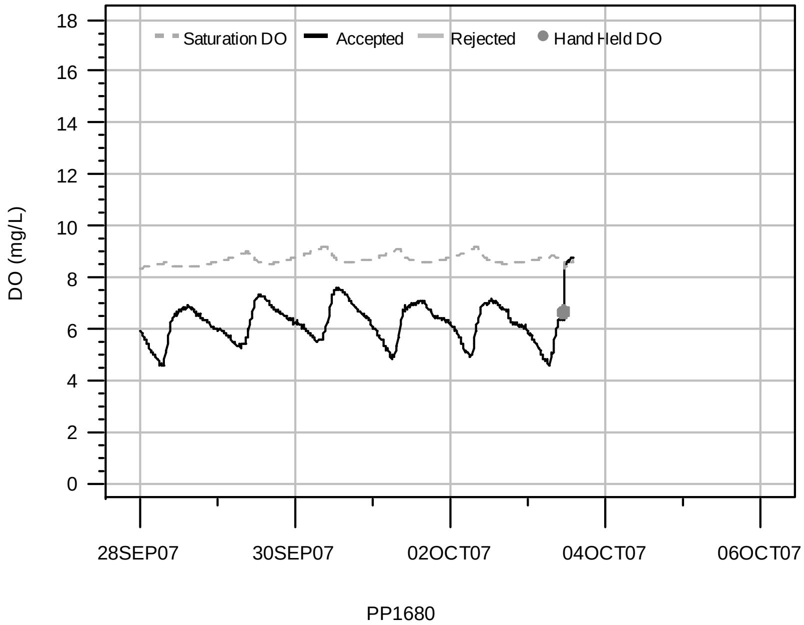

Figure D.69 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 09/28/07 to 10/06/07

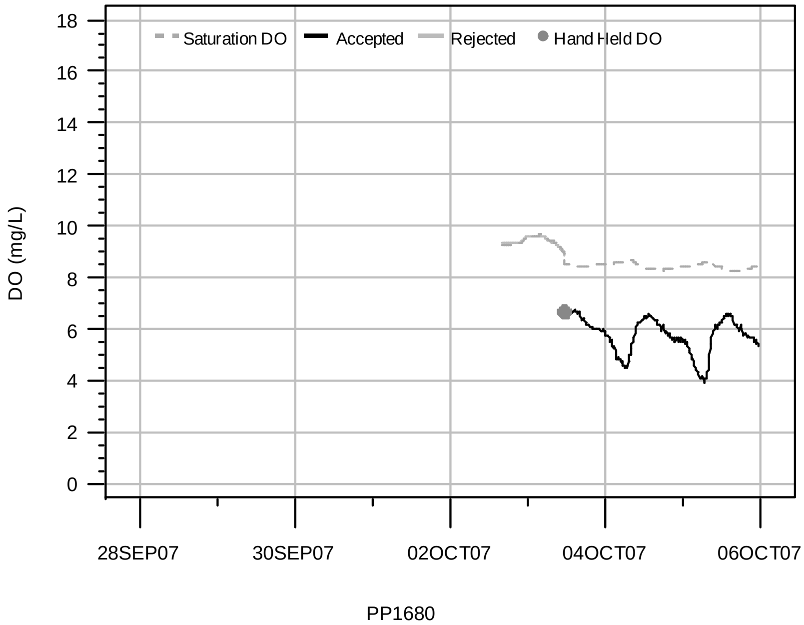

Figure D.70 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 09/28/07 to 10/06/07

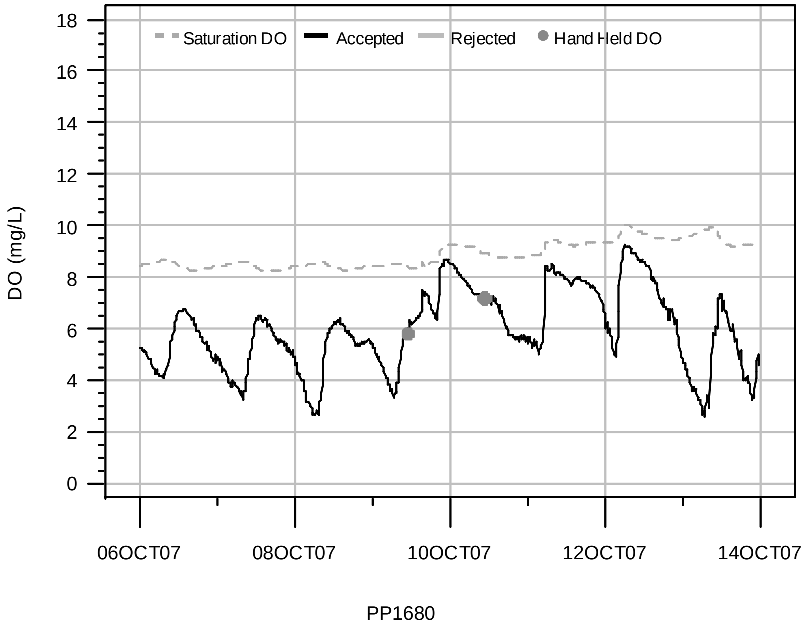

Figure D.71 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 10/06/07 to 10/14/07

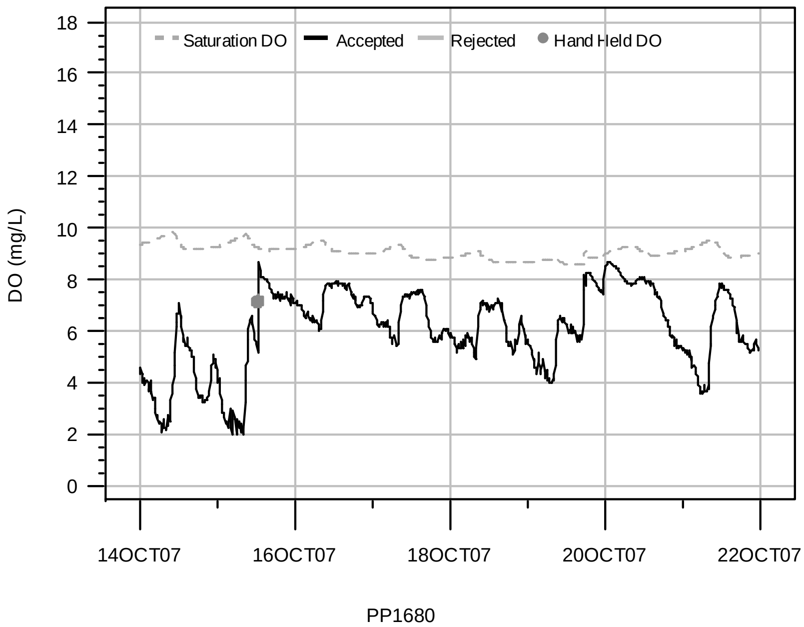

Figure D.72 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 10/14/07 to 10/22/07

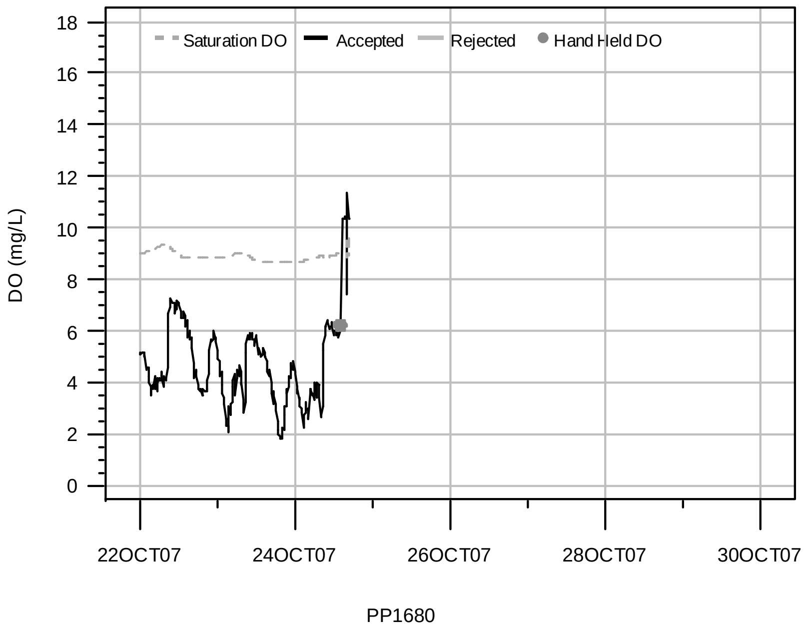

Figure D.73 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 10/22/07 to 10/30/07

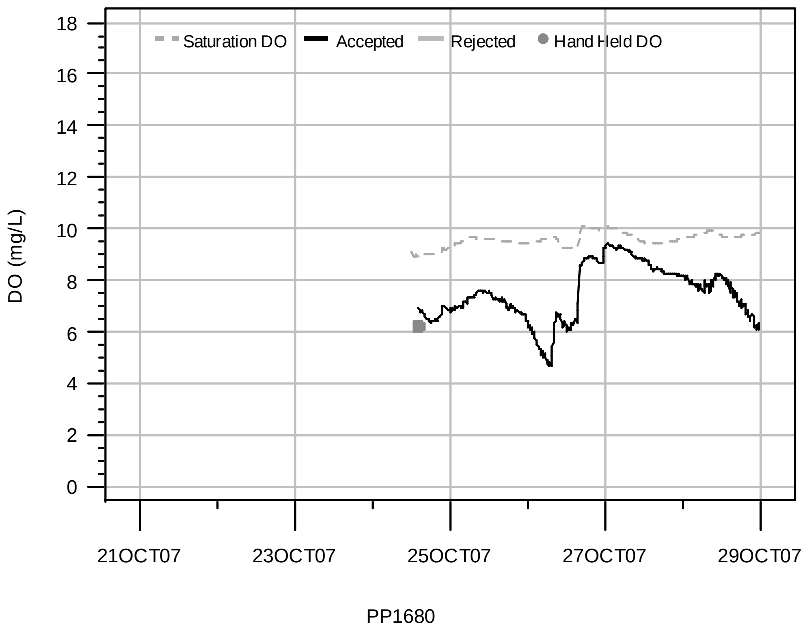

Figure D.74 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 10/21/07 to 10/29/07

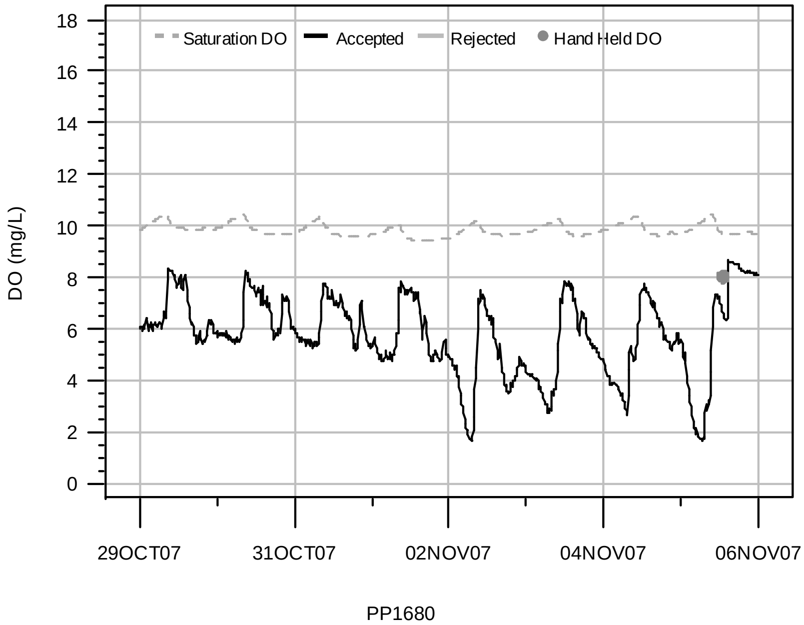

Figure D.75 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 10/29/07 to 11/06/07

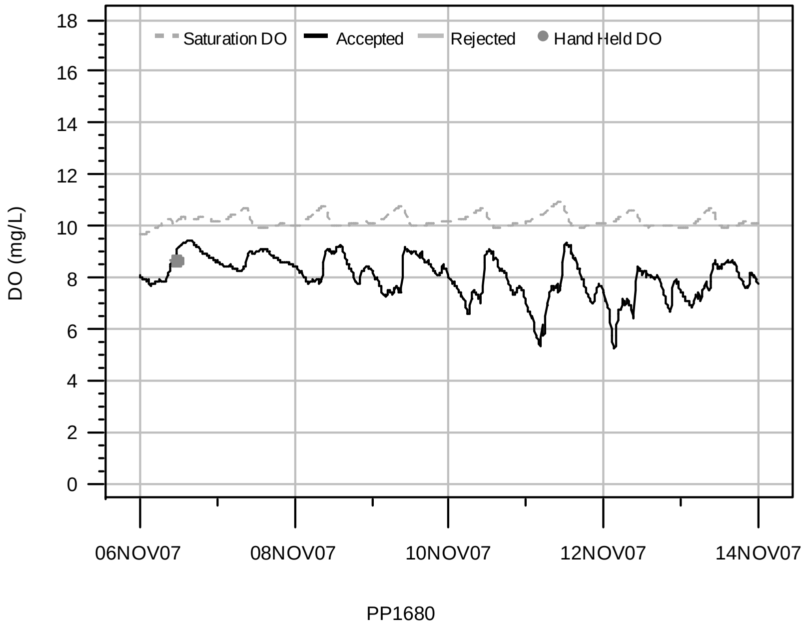

Figure D.76 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 11/06/07 to 11/14/07

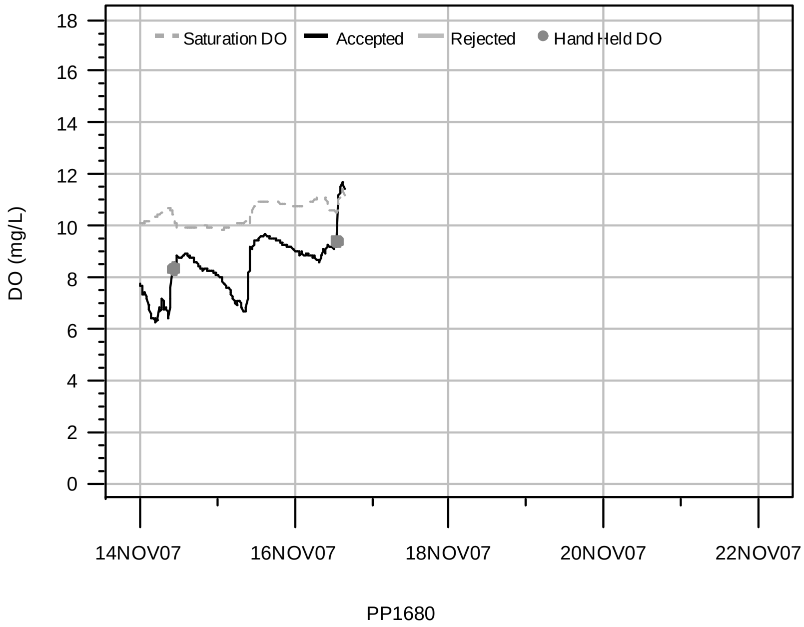

Figure D.77 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 11/14/07 to 11/22/07

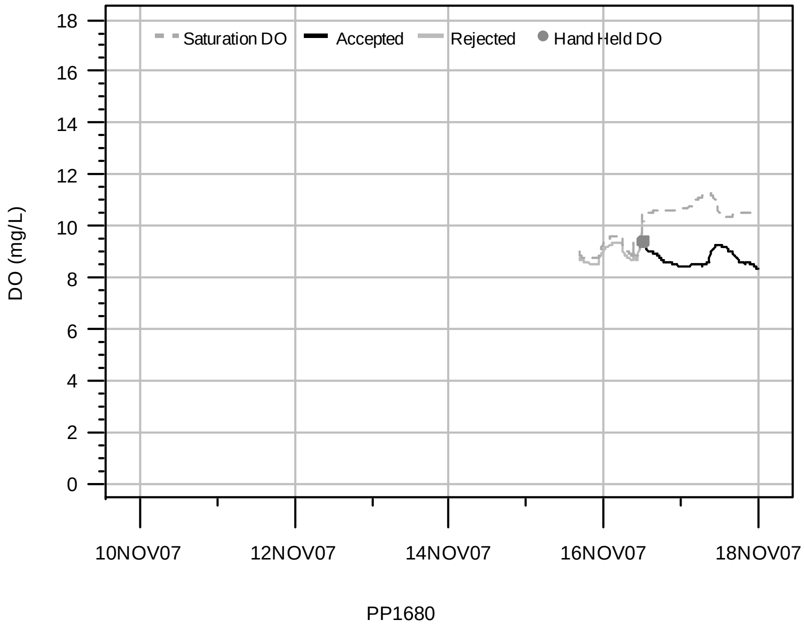

Figure D.78 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 11/10/07 to 11/18/07

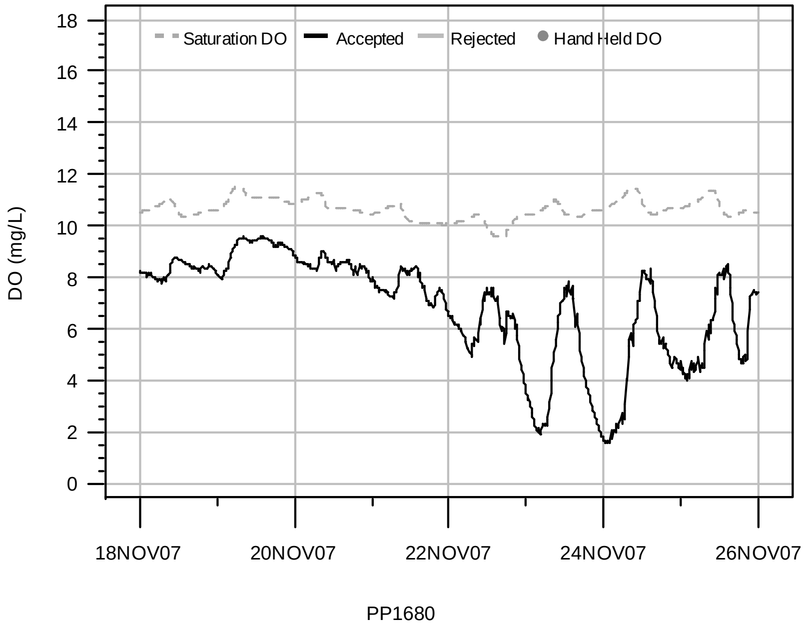

Figure D.79 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 11/18/07 to 11/26/07

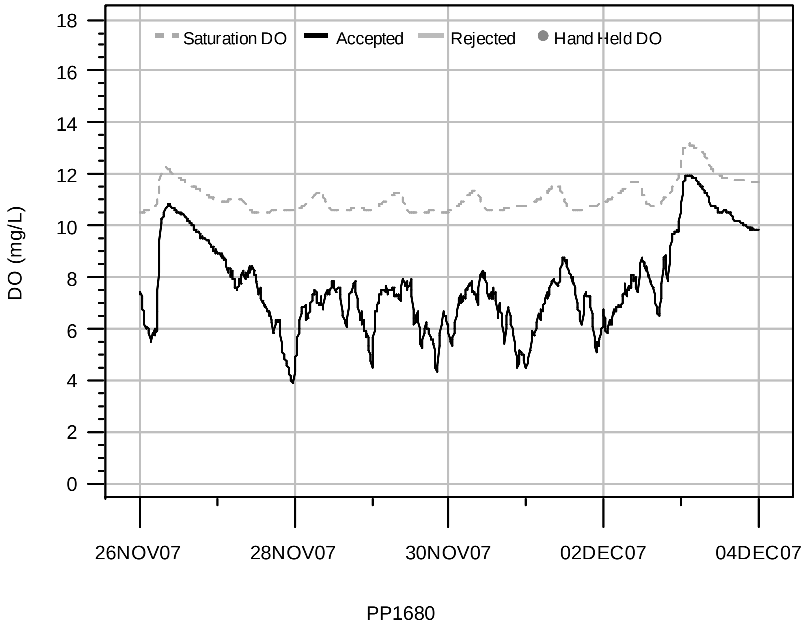

Figure D.80 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 11/26/07 to 12/04/07

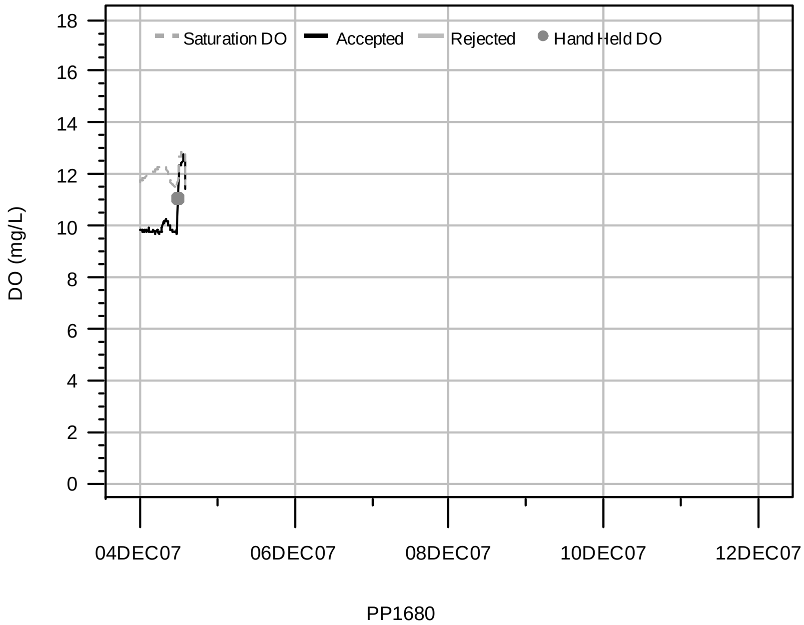

Figure D.81 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 12/04/07 to 12/12/07

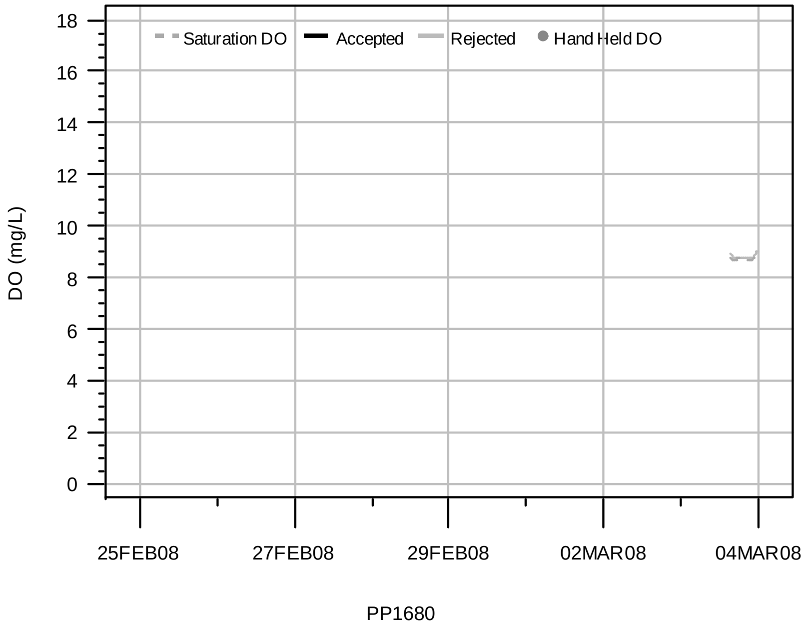

Figure D.82 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 02/25/08 to 03/04/08

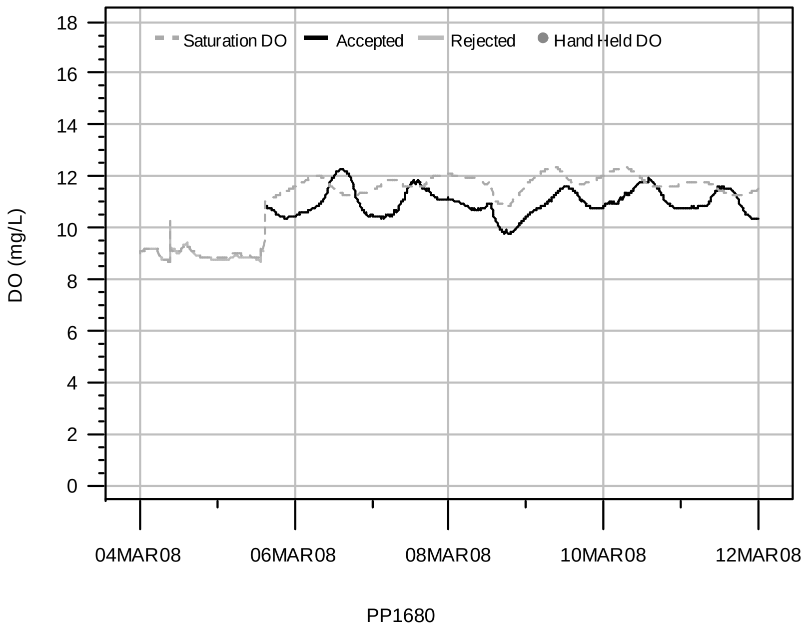

Figure D.83 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 03/04/08 to 03/12/08

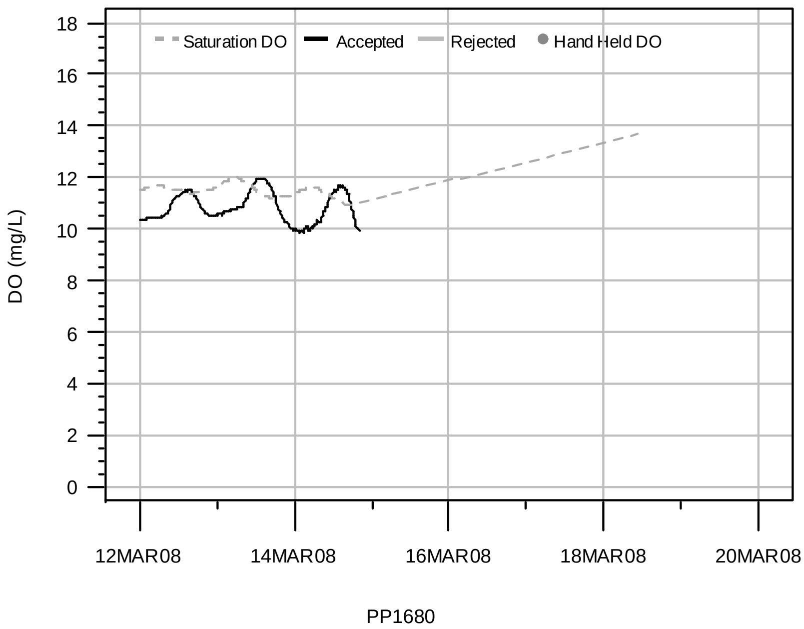

Figure D.84 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 03/12/08 to 03/20/08

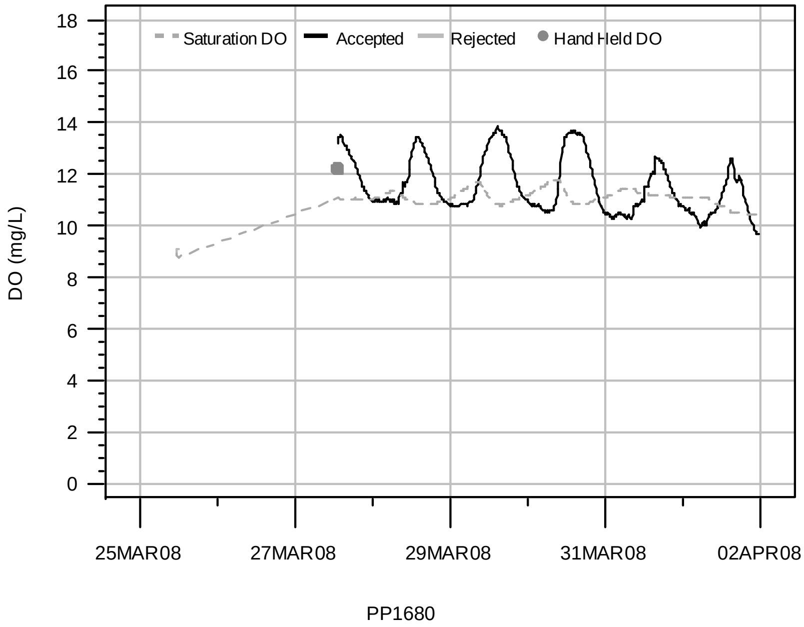

Figure D.85 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 03/25/08 to 04/02/08

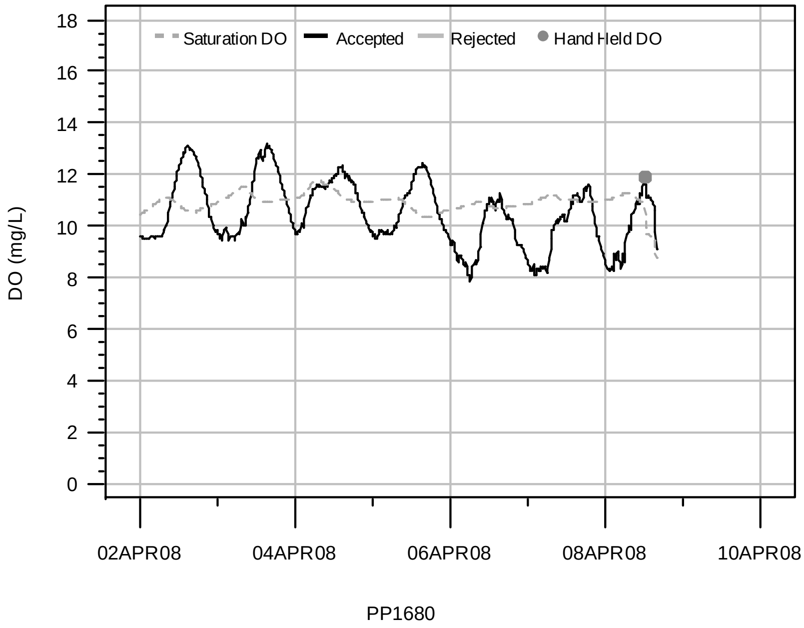

Figure D.86 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 04/02/08 to 04/10/08

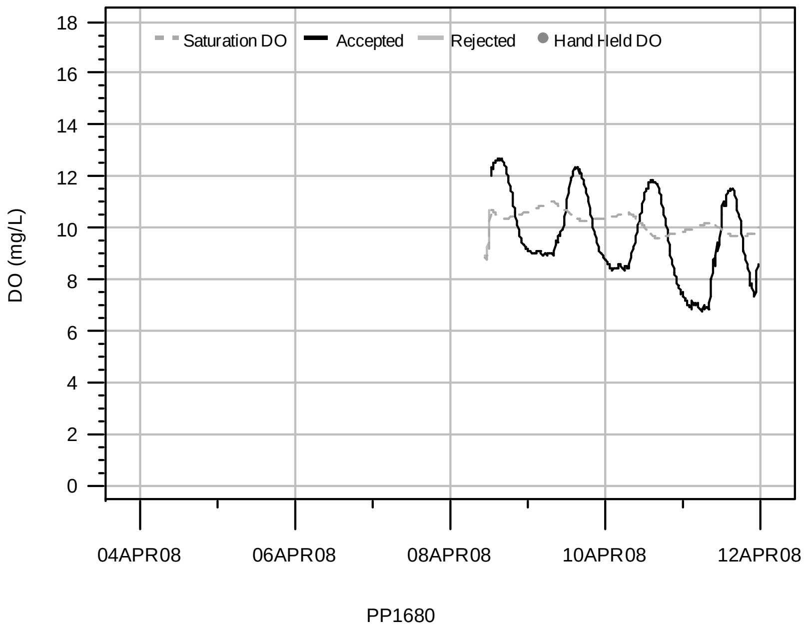

Figure D.87 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 04/04/08 to 04/12/08

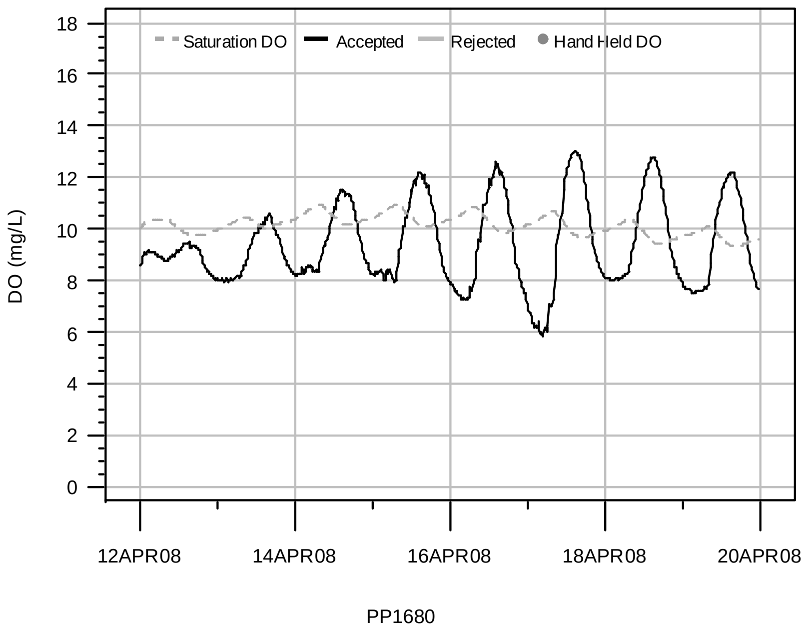

Figure D.88 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 04/12/08 to 04/20/08

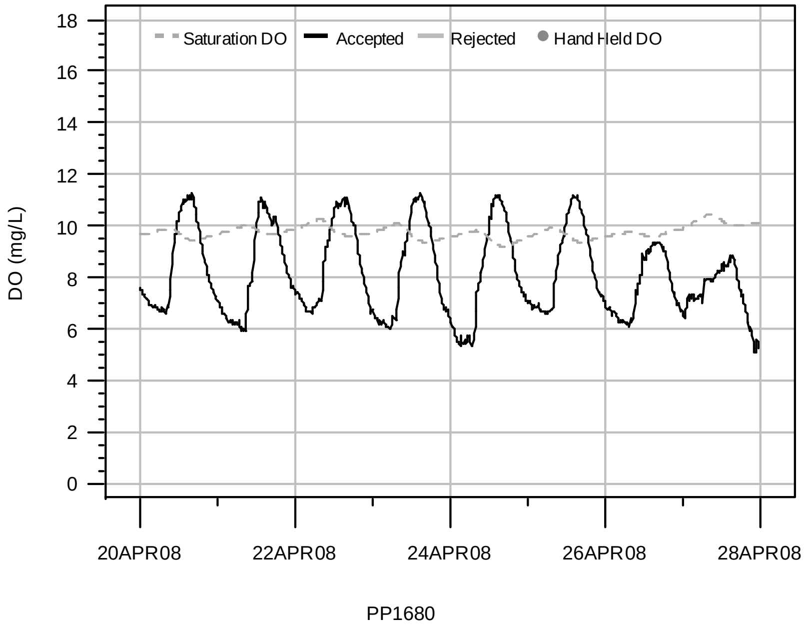

Figure D.89 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 04/20/08 to 04/28/08

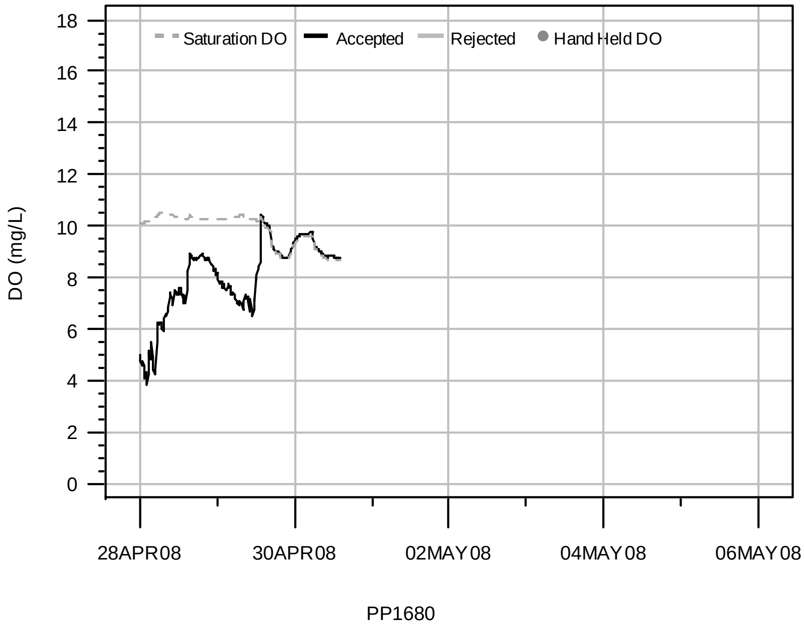

Figure D.90 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 04/28/08 to 05/06/08

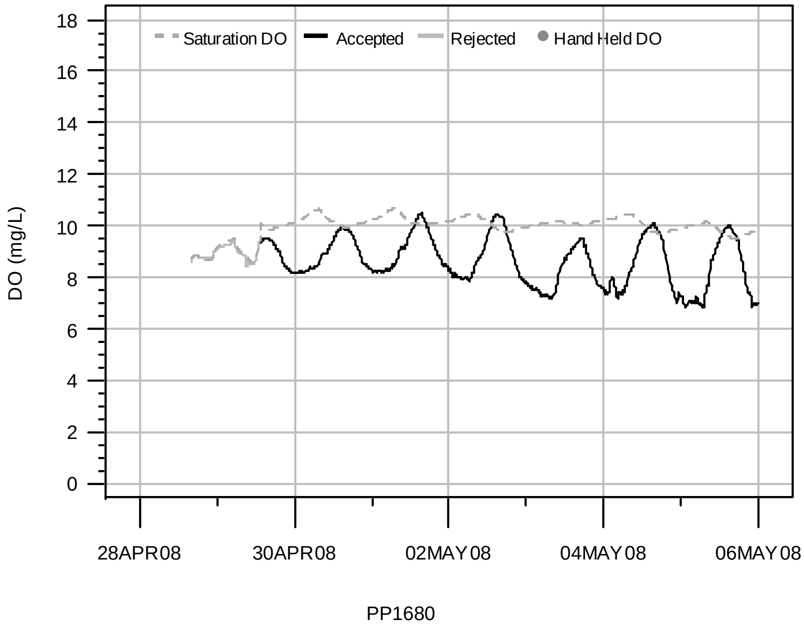

Figure D.91 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 04/28/08 to 05/06/08

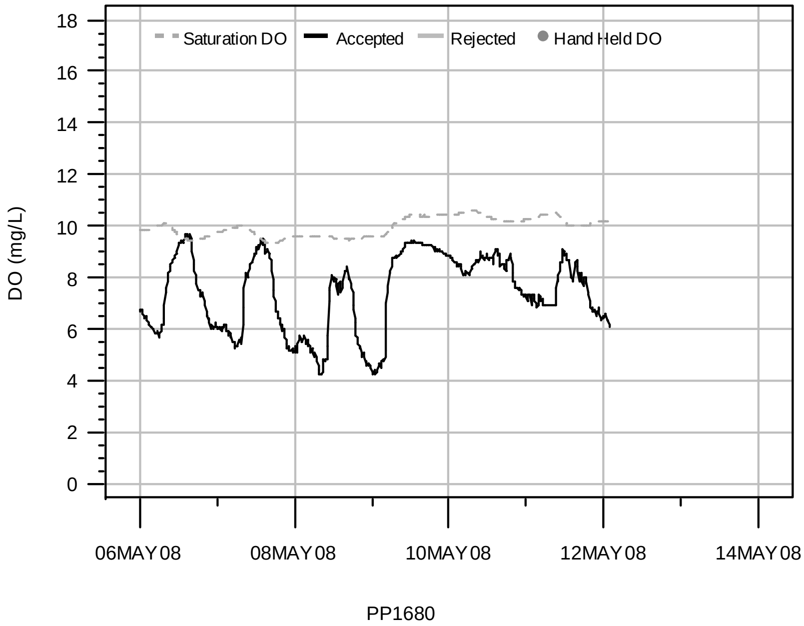

Figure D.92 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 05/06/08 to 05/14/08

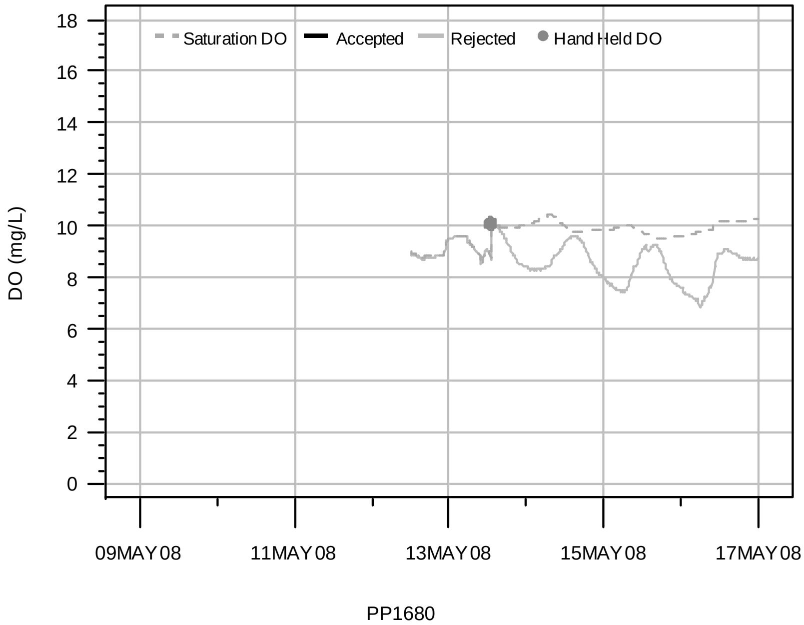

Figure D.93 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 05/09/08 to 05/17/08

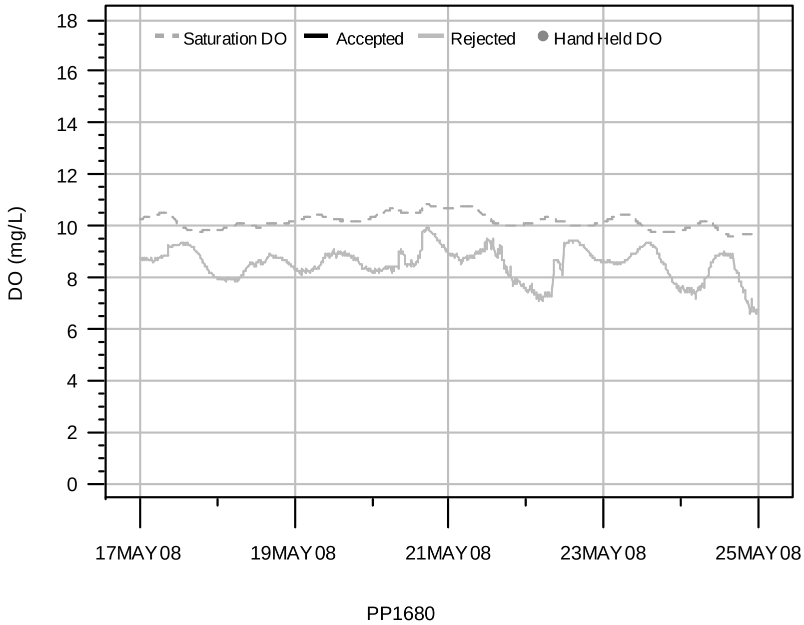

Figure D.94 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 05/17/08 to 05/25/08

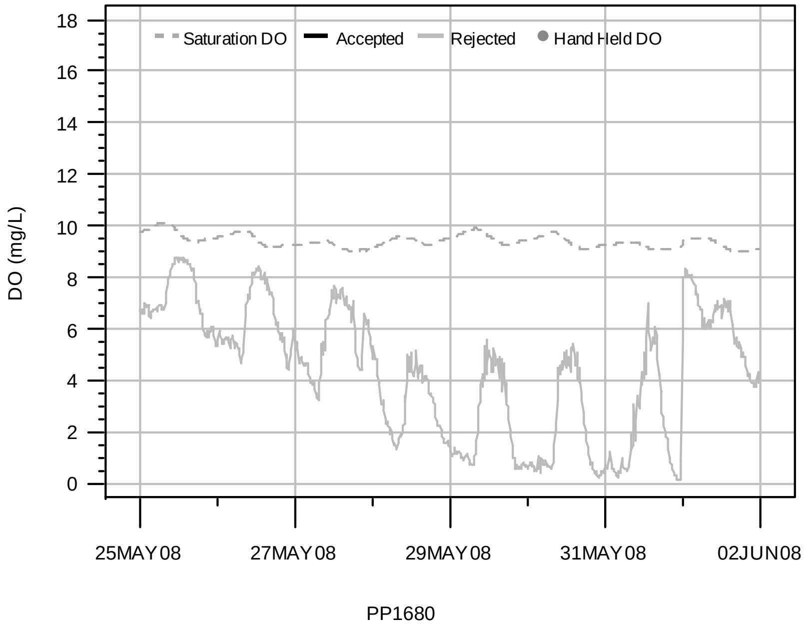

Figure D.95 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 05/25/08 to 06/02/08

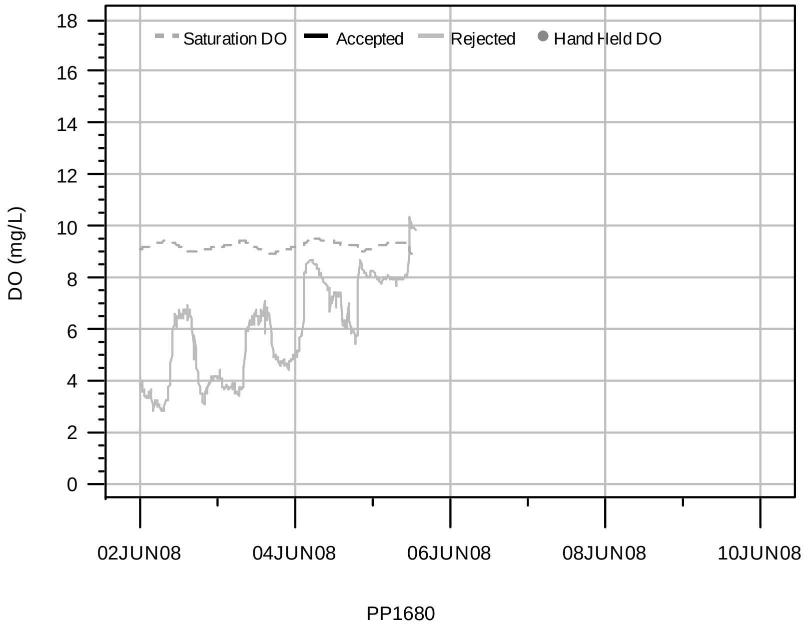

Figure D.96 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1680, 06/02/08 to 06/10/08

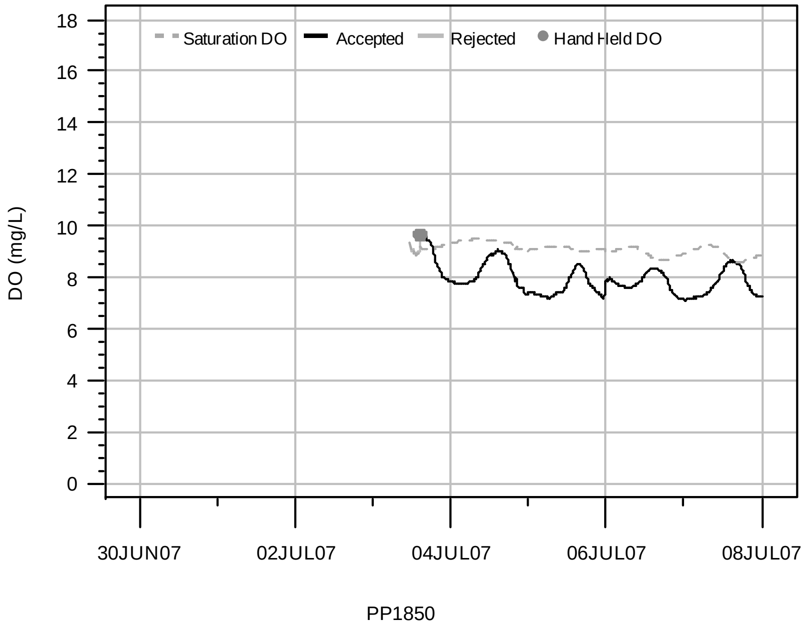

Figure D.97 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 06/30/07 to 07/08/07

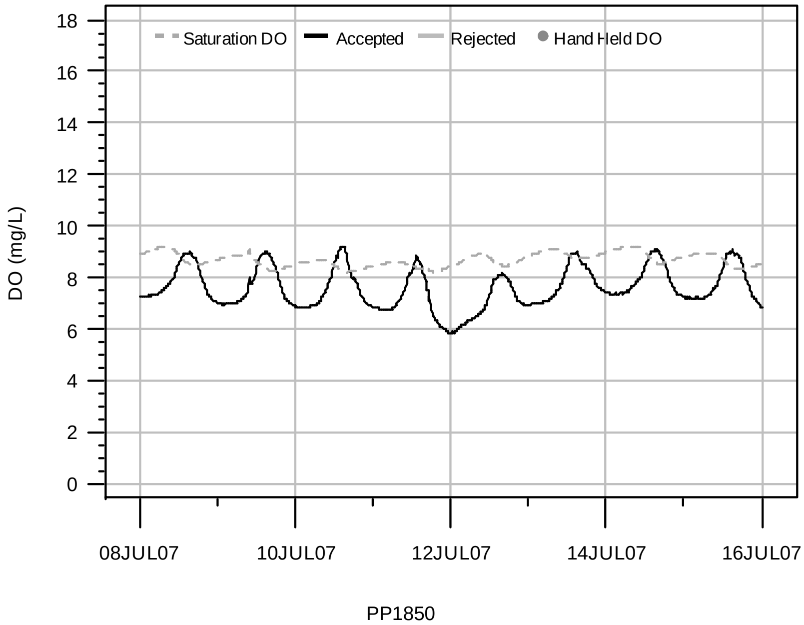

Figure D.98 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 07/08/07 to 07/16/07

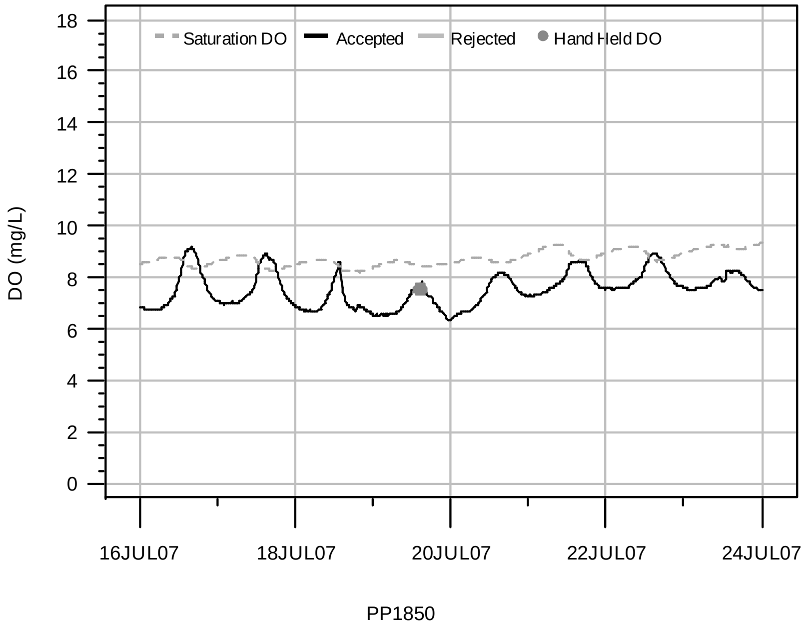

Figure D.99 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 07/16/07 to 07/24/07

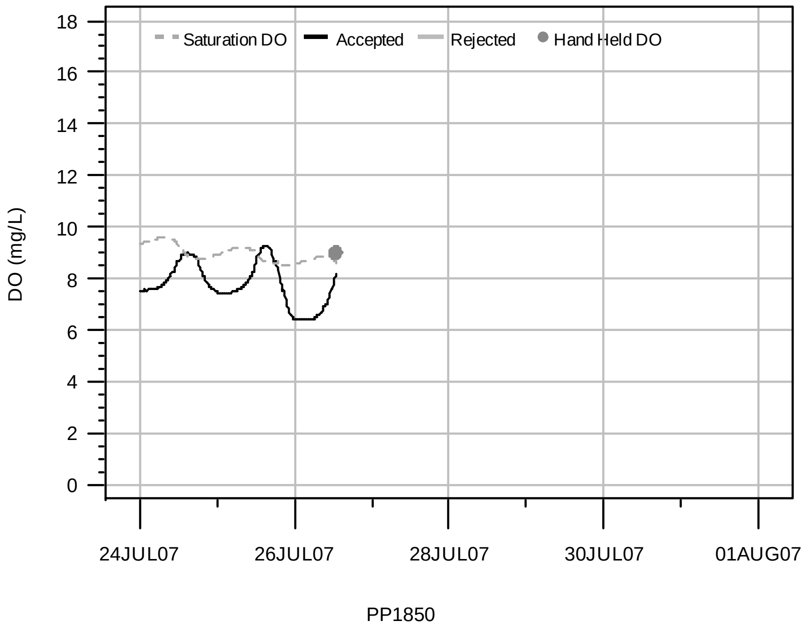

Figure D.100 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 07/24/07 to 08/01/07

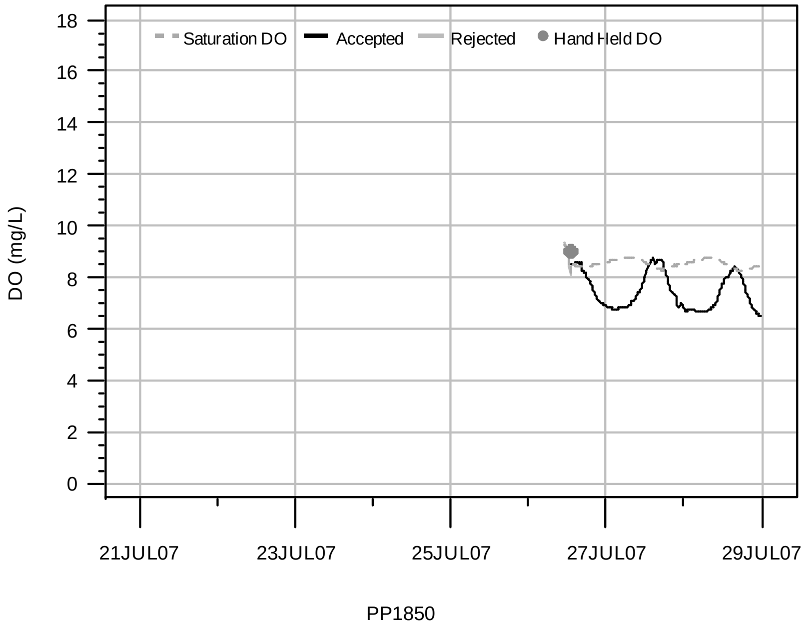

Figure D.101 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 07/21/07 to 07/29/07

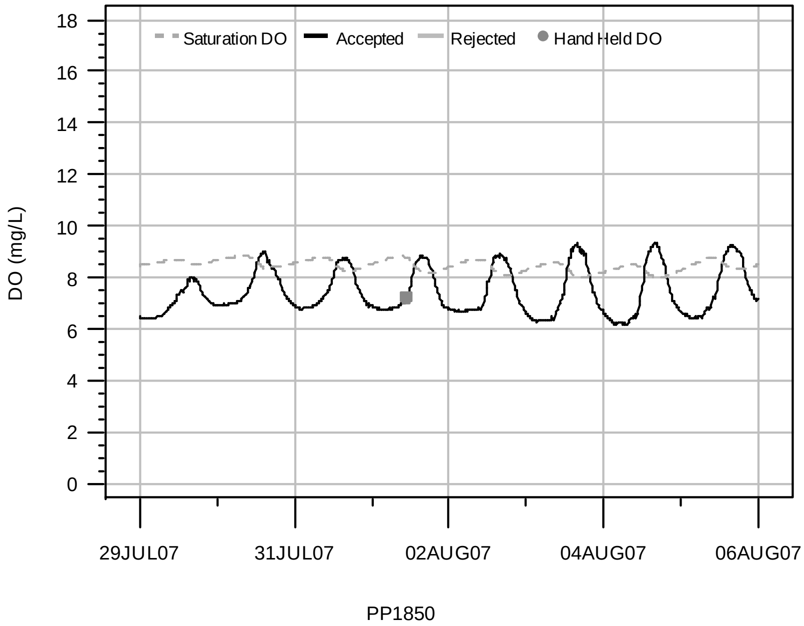

Figure D.102 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 07/29/07 to 08/06/07

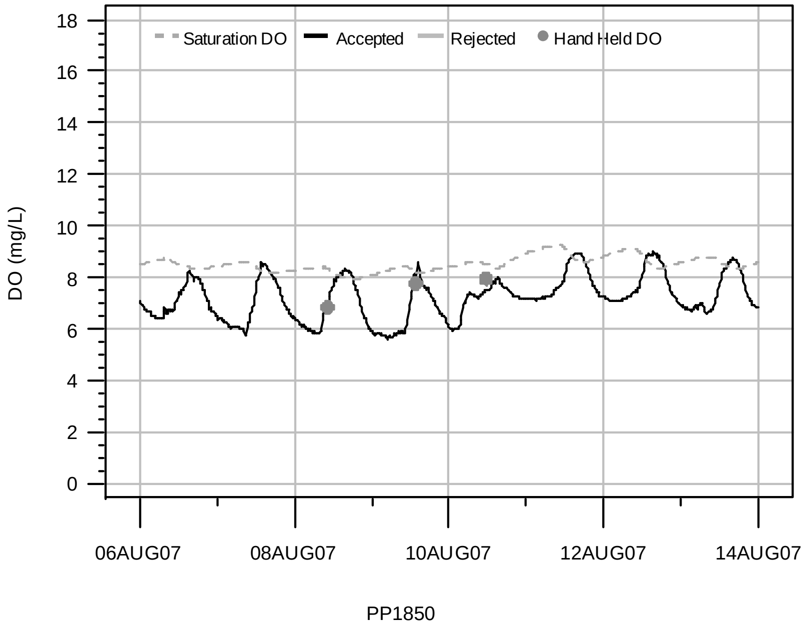

Figure D.103 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 08/06/07 to 08/14/07

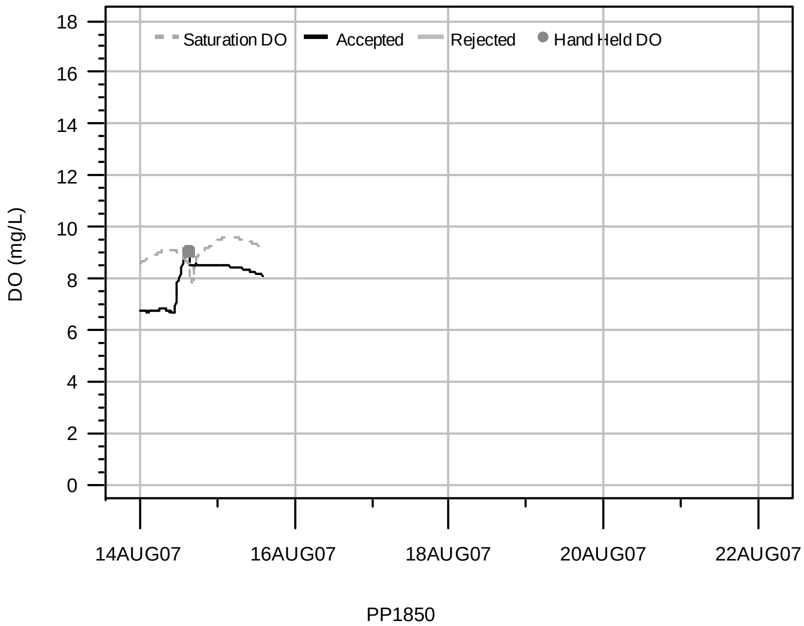

Figure D.104 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 08/14/07 to 08/22/07

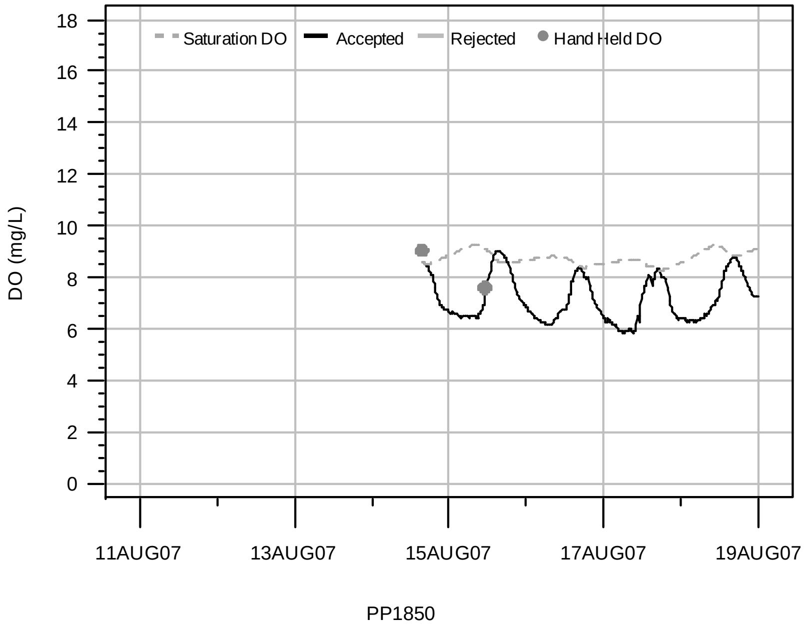

Figure D.105 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 08/11/07 to 08/19/07

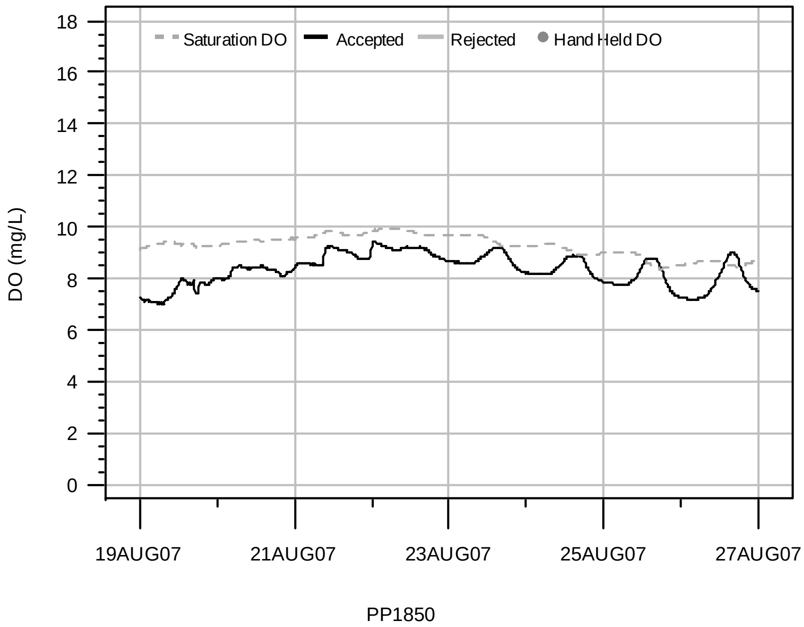

Figure D.106 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 08/19/07 to 08/27/07

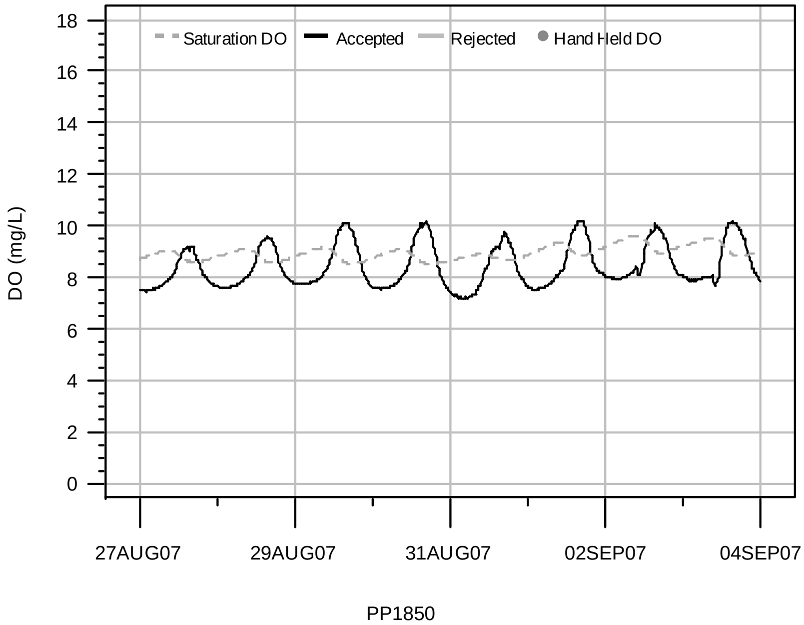

Figure D.107 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 08/27/08 to 09/04/07

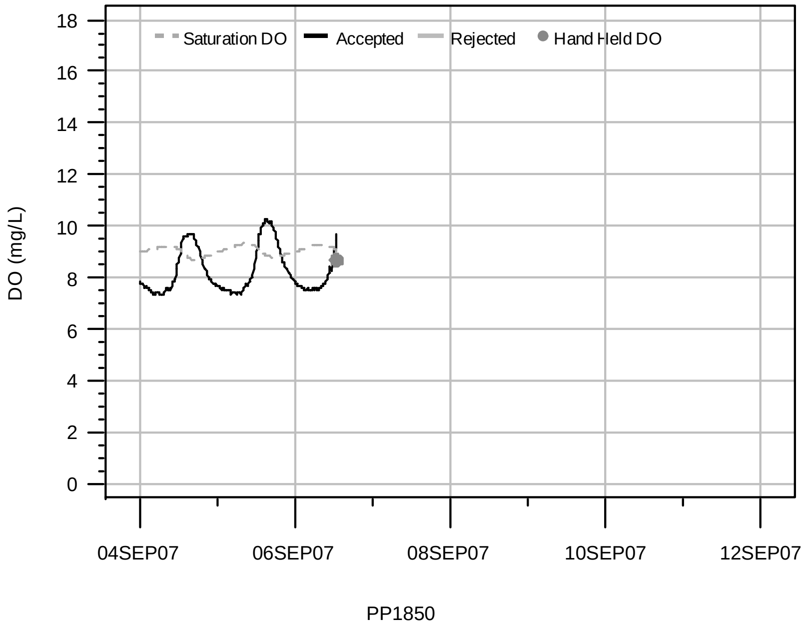

Figure D.108 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 09/04/07 to 09/12/07

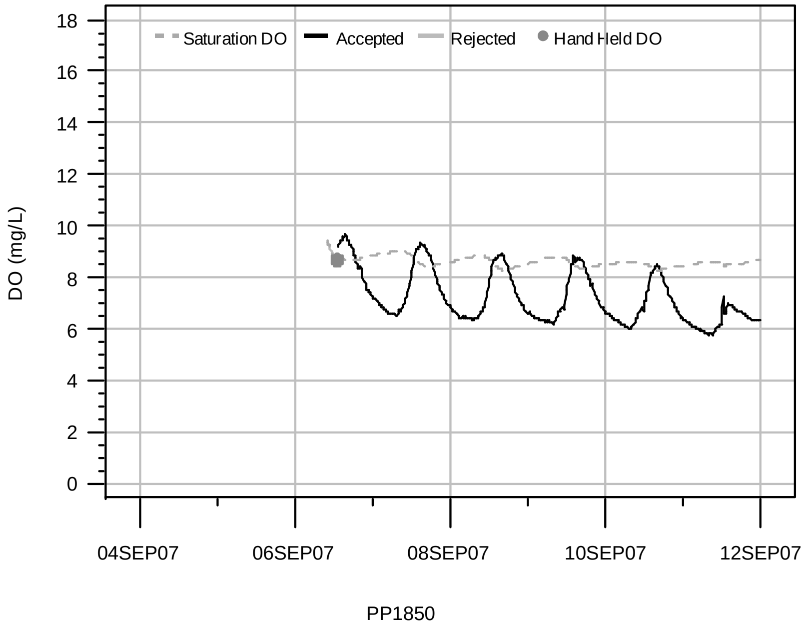

Figure D.109 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 09/04/07 to 09/12/07

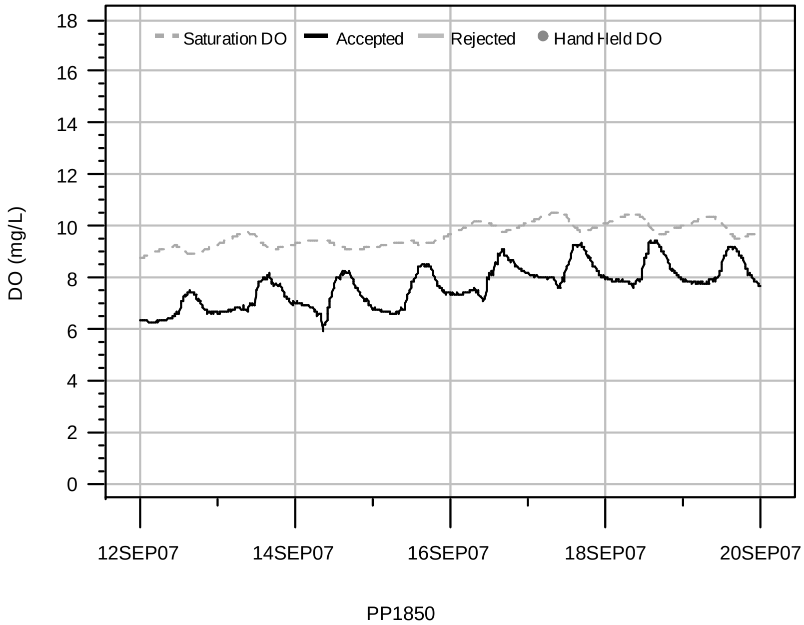

Figure D.110 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 09/12/07 to 09/20/07

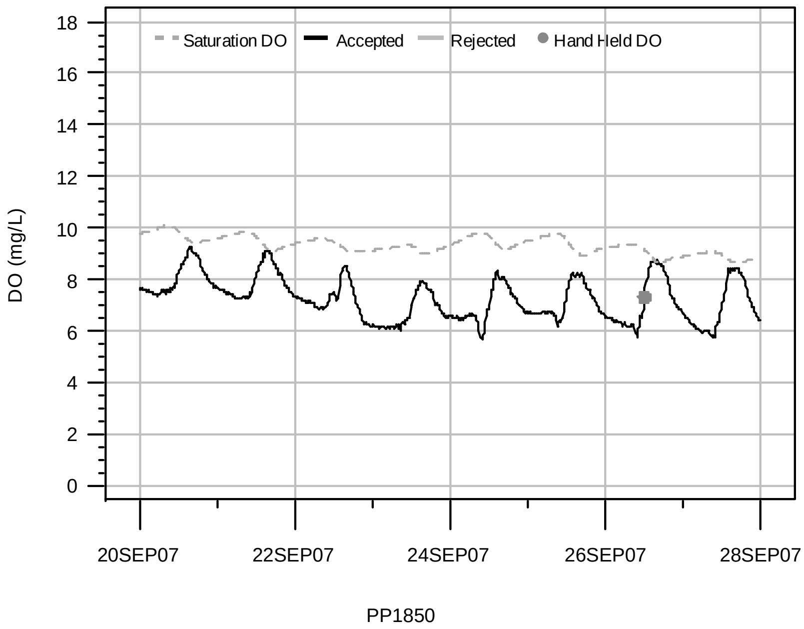

Figure D.111 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 09/20/07 to 09/28/07

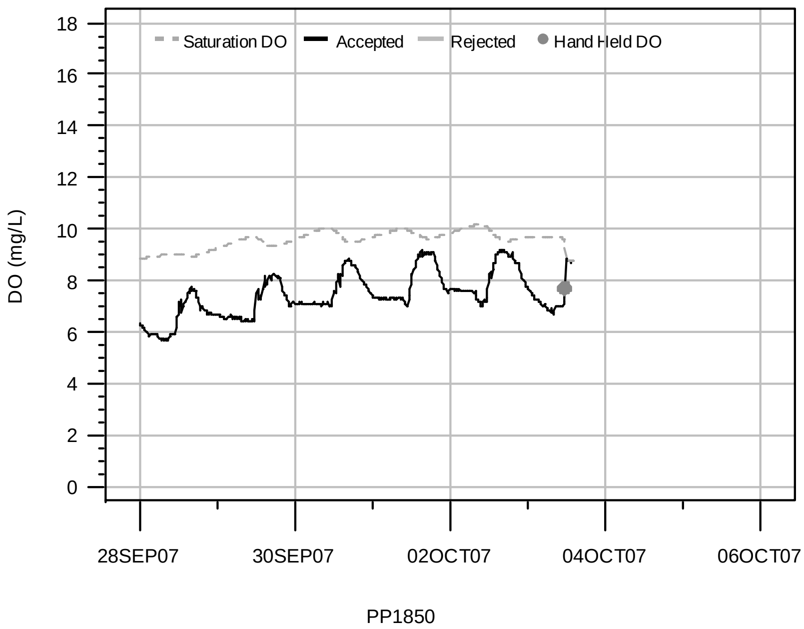

Figure D.112 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 09/28/07 to 10/06/07

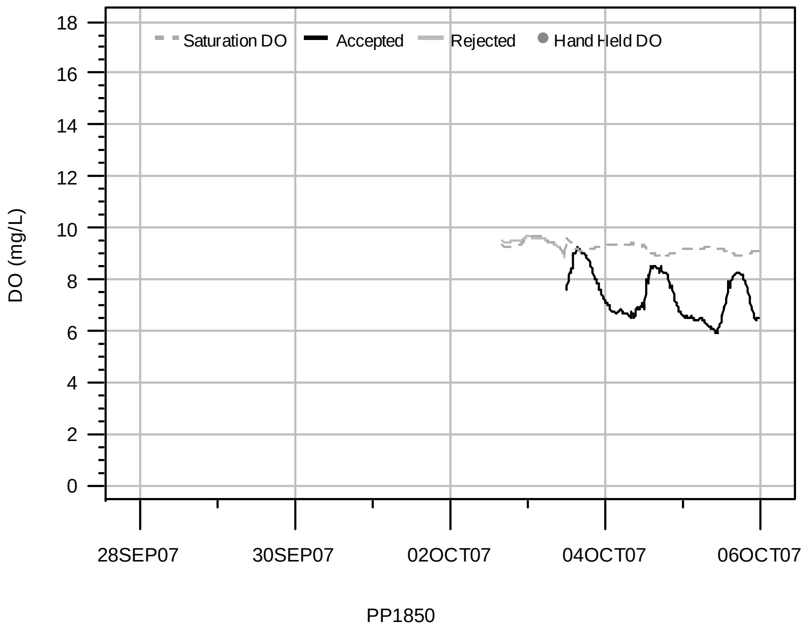

Figure D.113 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 09/28/07 to 10/06/07

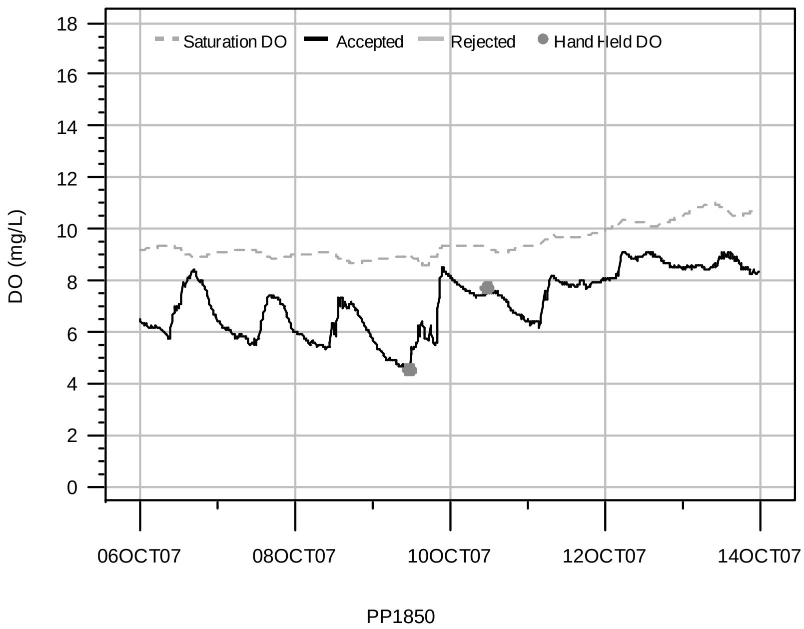

Figure D.114 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 10/06/07 to 10/14/07

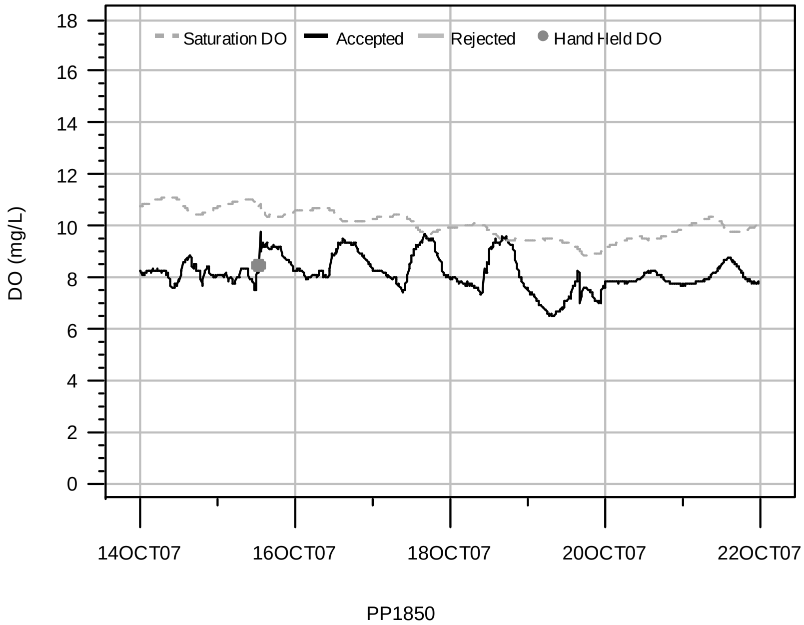

Figure D.115 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 10/14/07 to 10/22/07

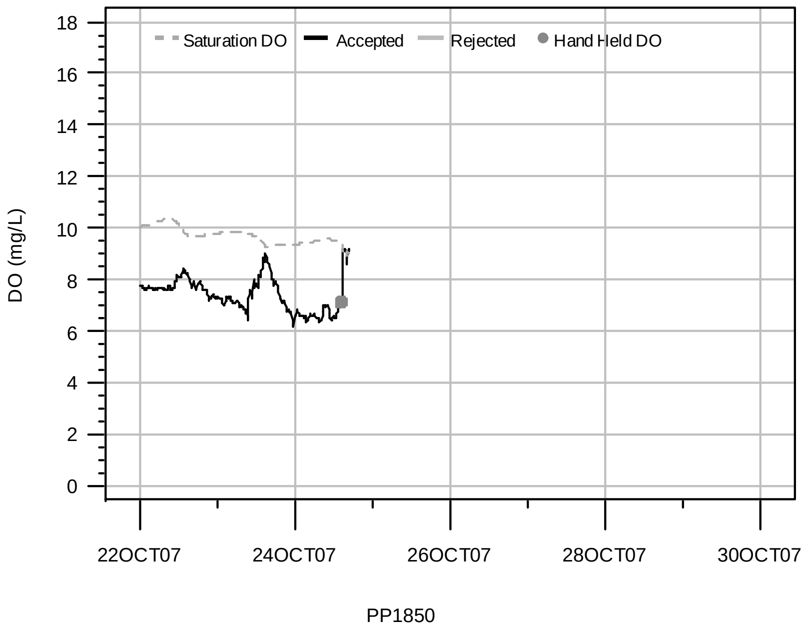

Figure D.116 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 10/22/07 to 10/30/07

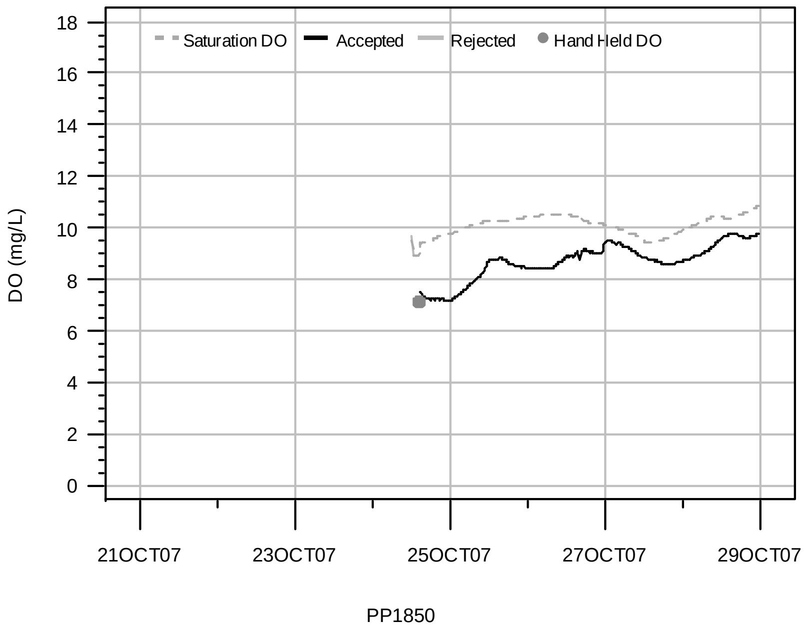

Figure D.117 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 10/21/07 to 10/29/07

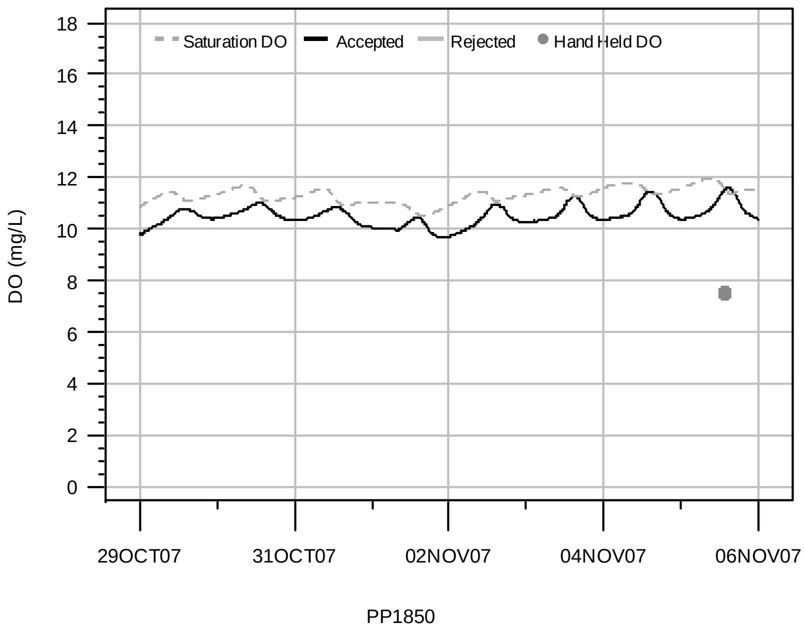

Figure D.118 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 10/29/07 to 11/06/07

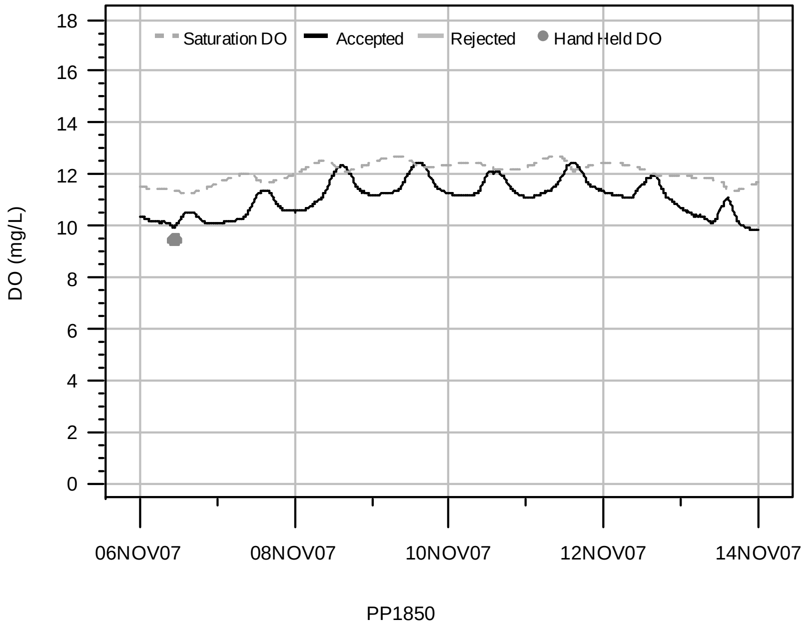

Figure D.119 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 11/06/07 to 11/14/07

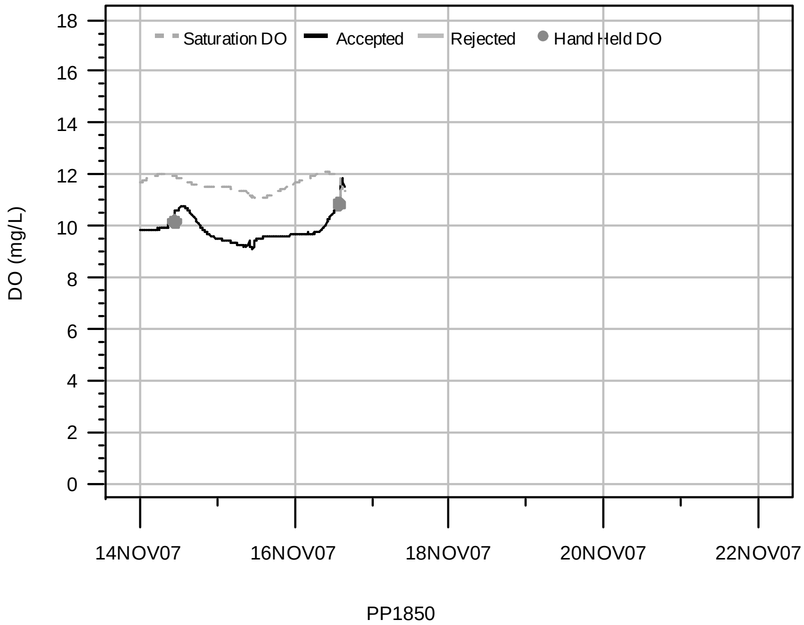

Figure D.120 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 11/14/07 to 11/22/07

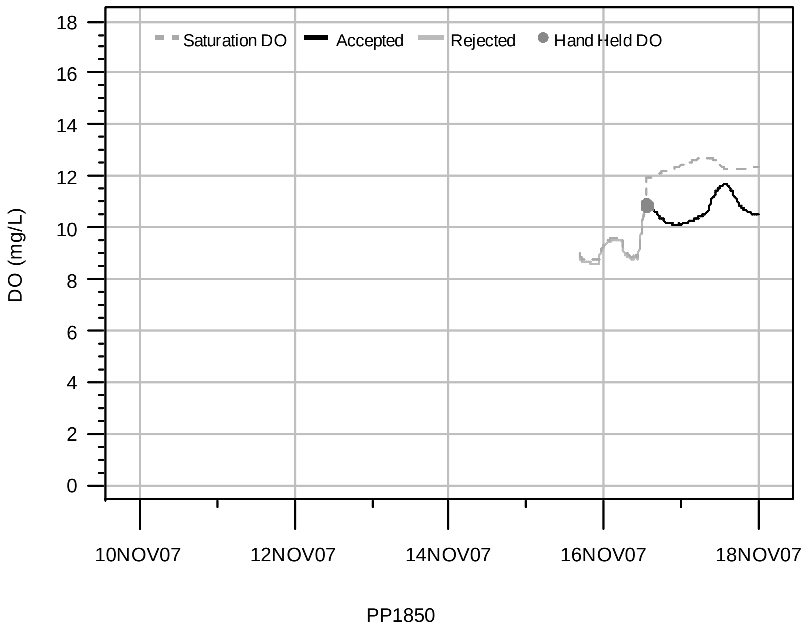

Figure D.121 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 11/10/07 to 11/18/07

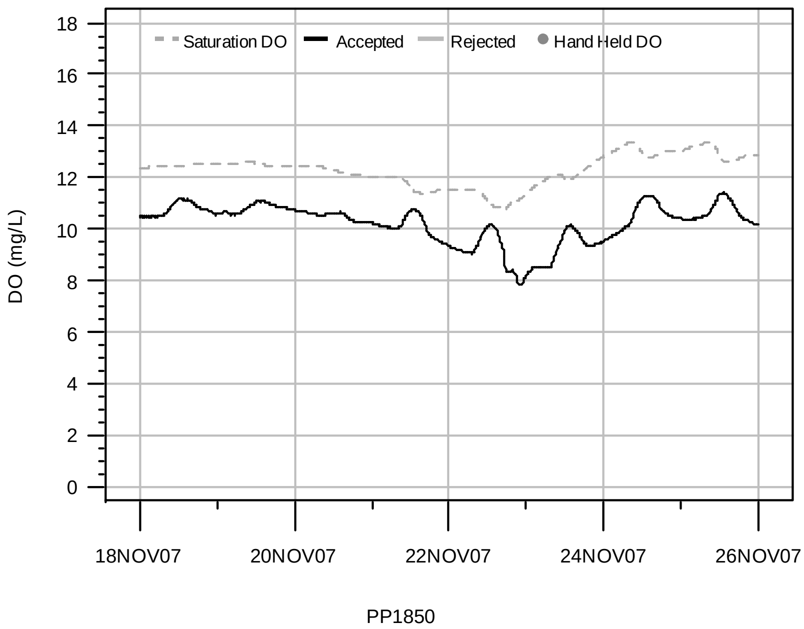

Figure D.122 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 11/18/07 to 11/26/07

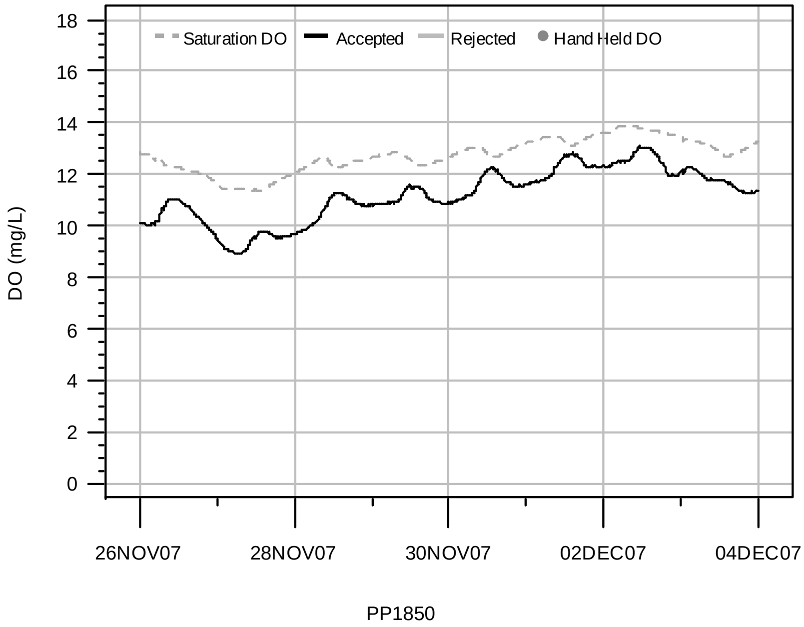

Figure D.123 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 11/26/07 to 12/04/07

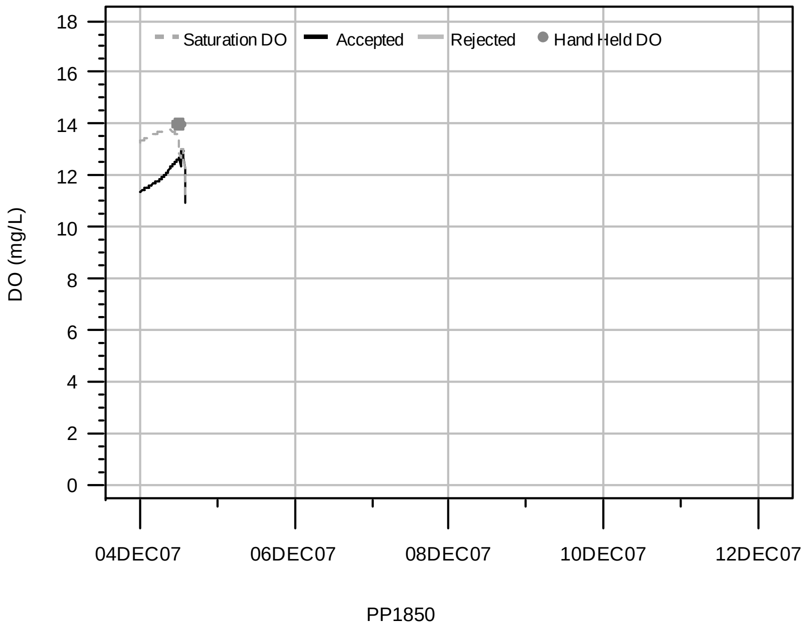

Figure D.124 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 12/04/07 to 12/12/07

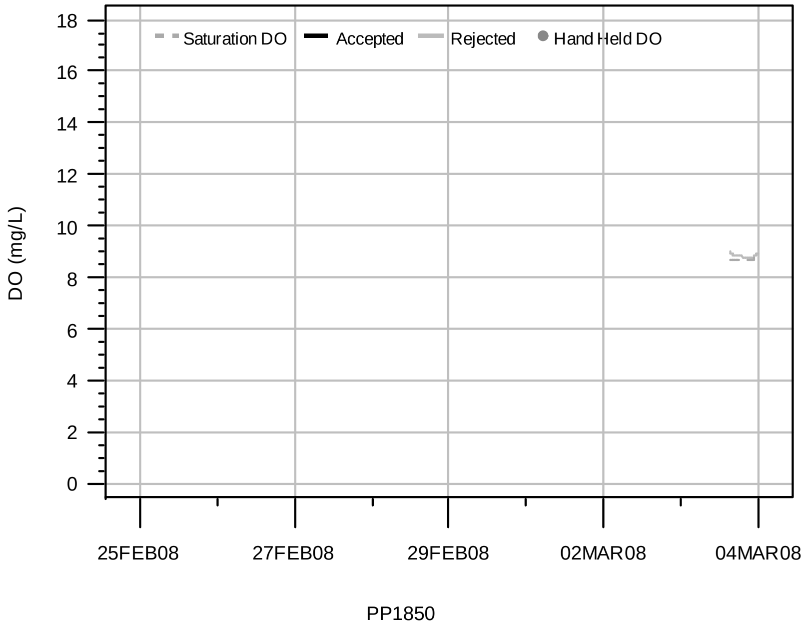

Figure D.125 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 02/25/08 to 03/04/08

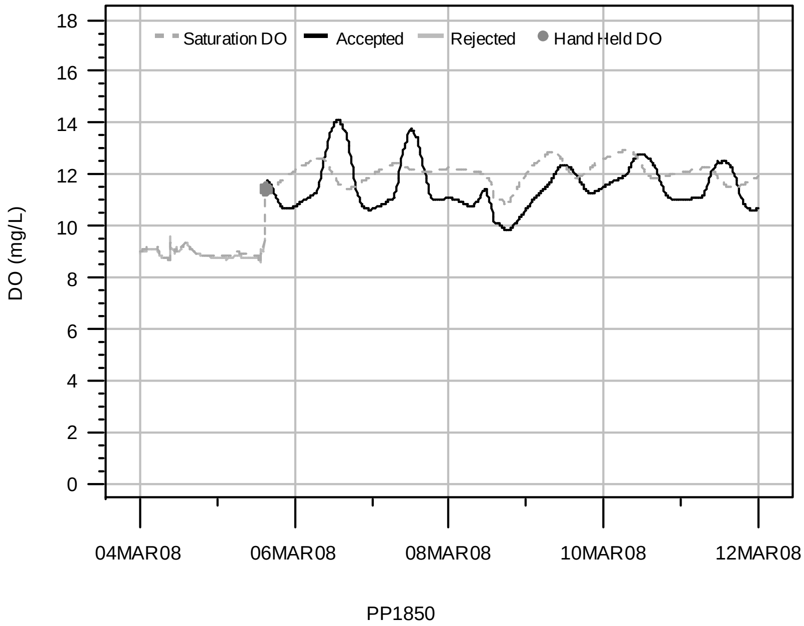

Figure D.126 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 03/04/08 to 03/12/08

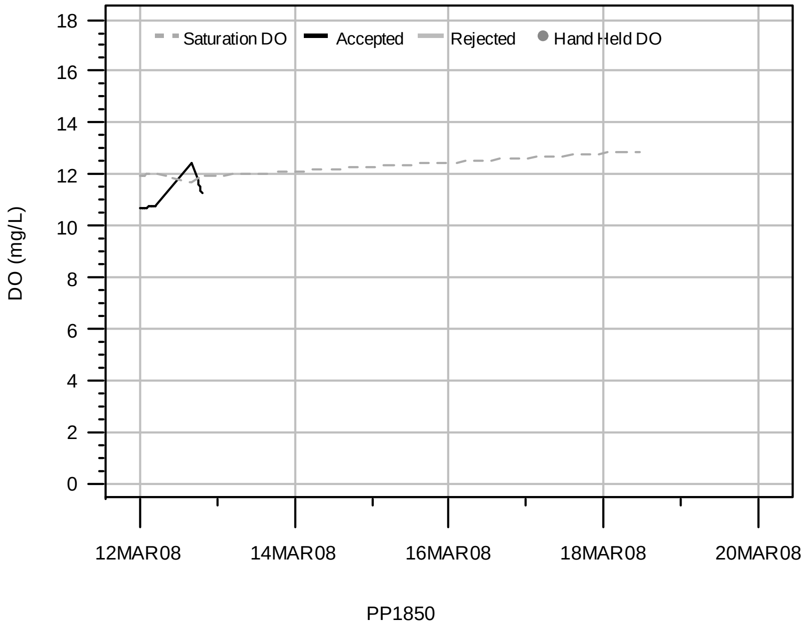

Figure D.127 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 03/12/08 to 03/20/08

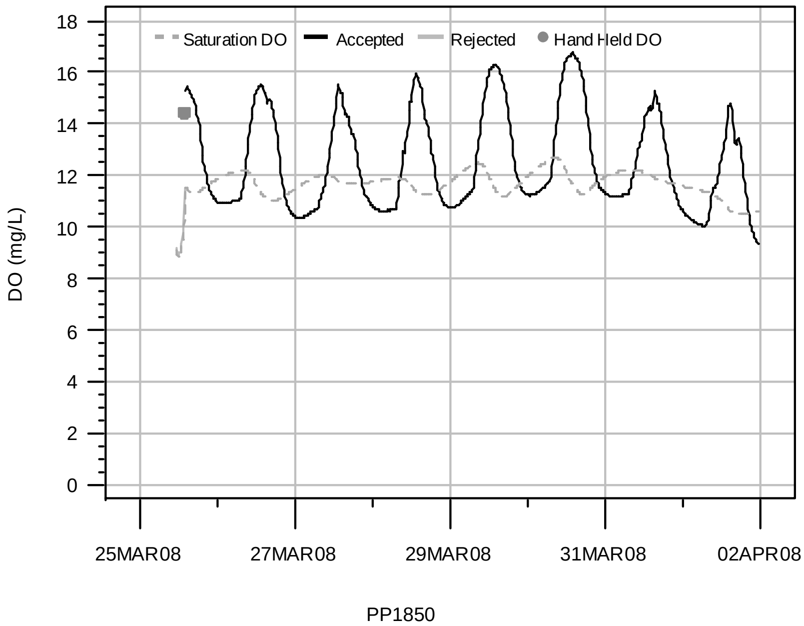

Figure D.128 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 03/25/08 to 04/02/08

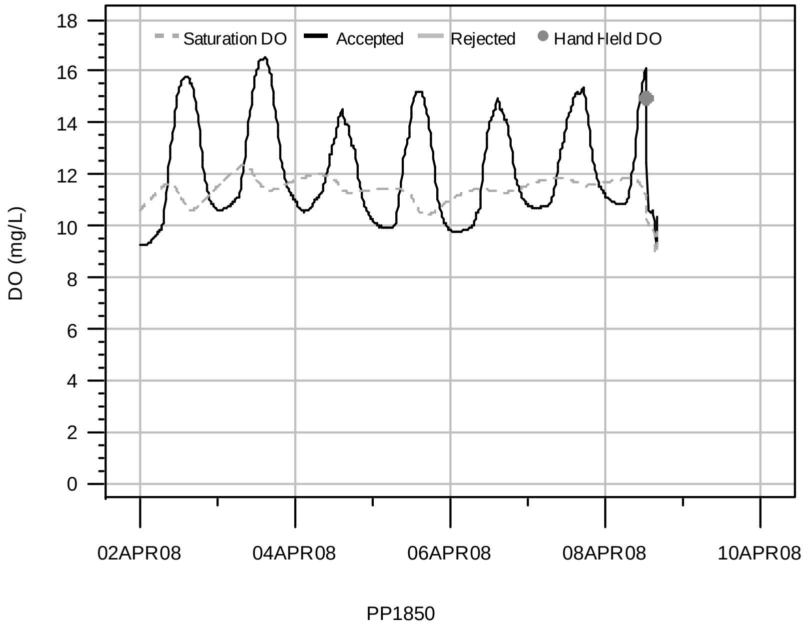

Figure D.129 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 04/02/08 to 04/10/08

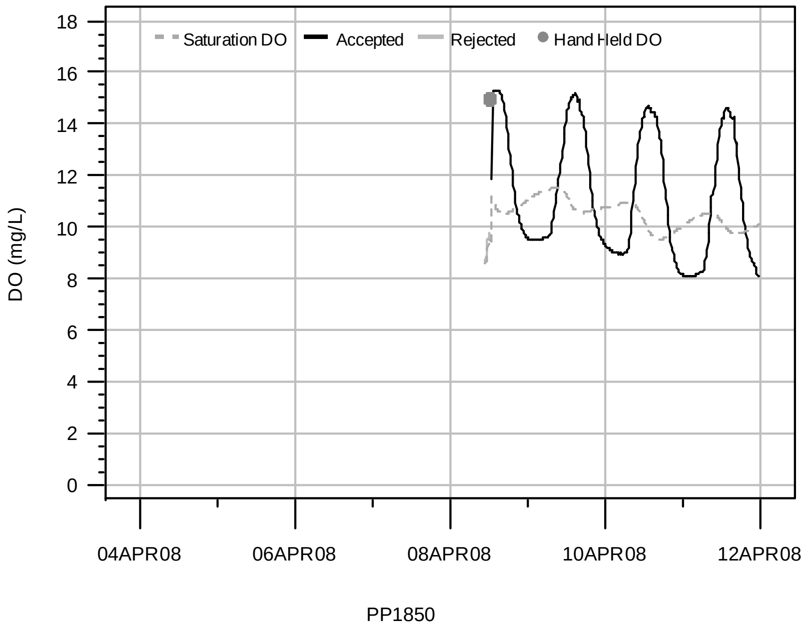

Figure D.130 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 04/04/08 to 04/12/08

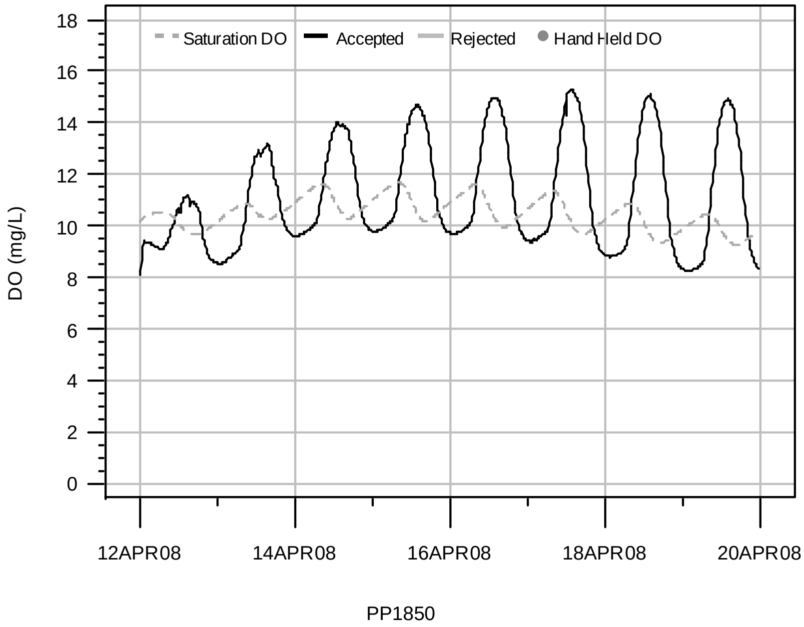

Figure D.131 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 04/12/08 to 04/20/08

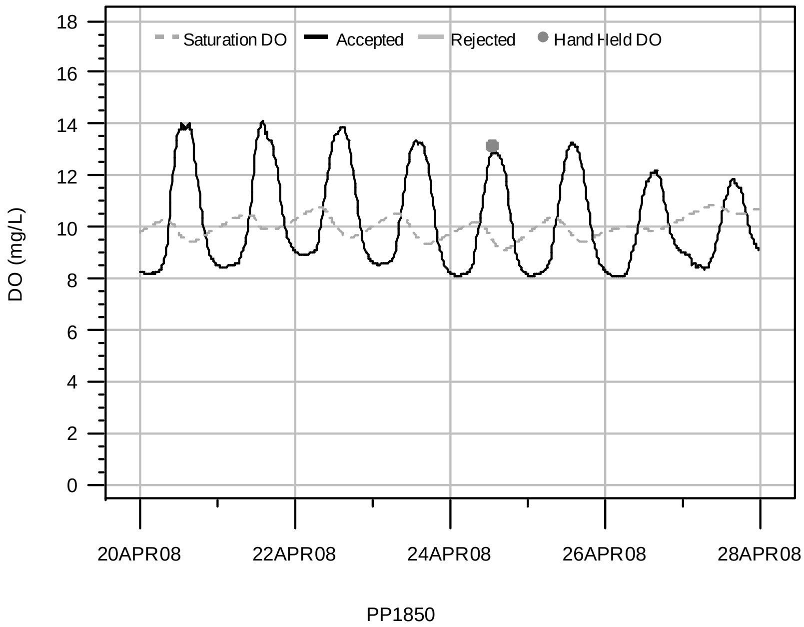

Figure D.132 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 04/20/08 to 04/28/08

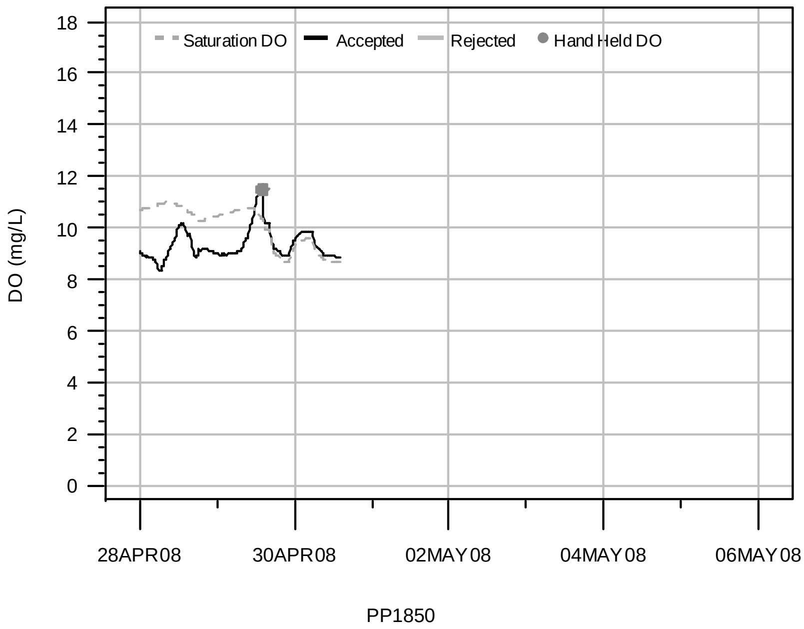

Figure D.133 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 04/28/08 to 05/06/08

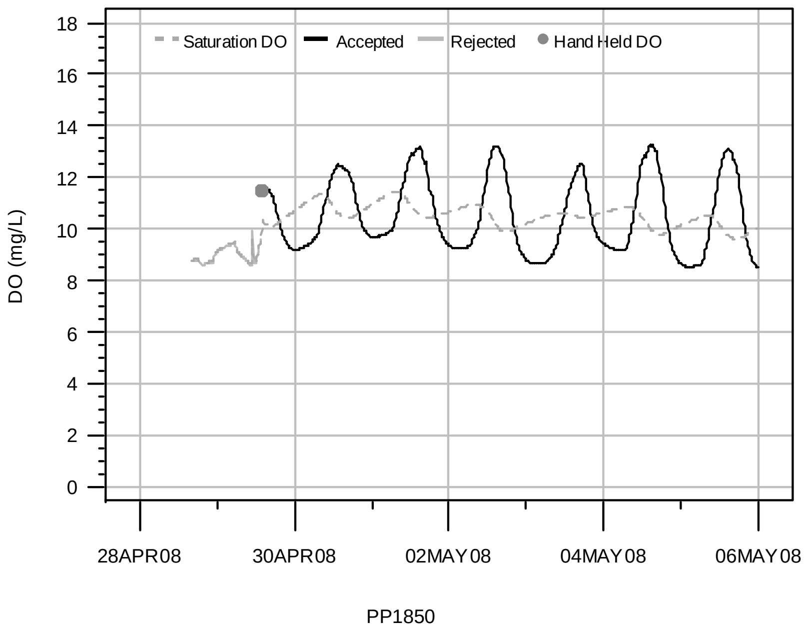

Figure D.134 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 04/28/08 to 05/06/08

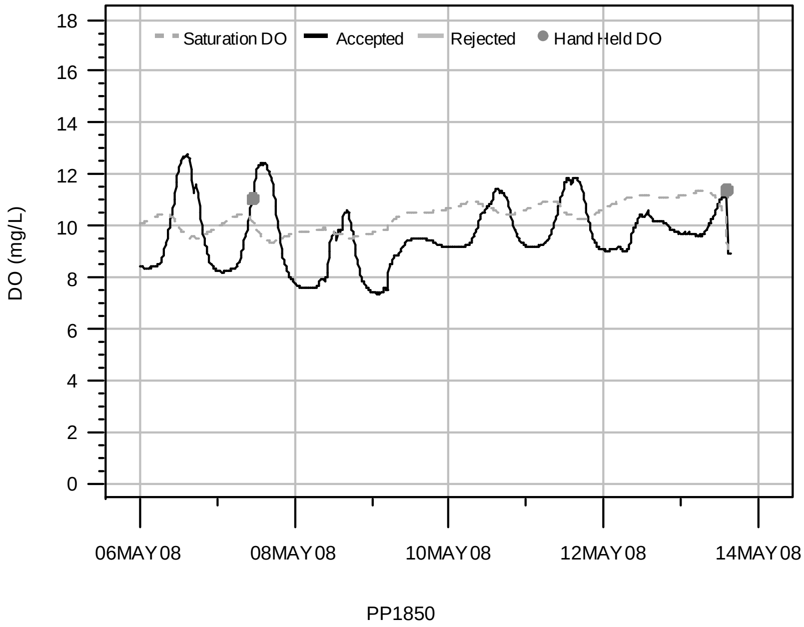

Figure D.135 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 05/06/08 to 05/14/08

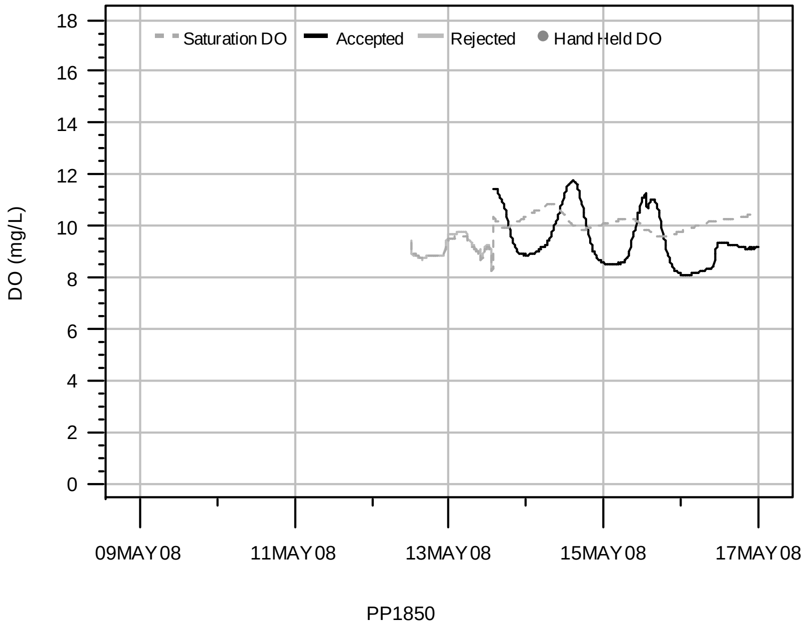

Figure D.136 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 05/09/08 to 05/17/08

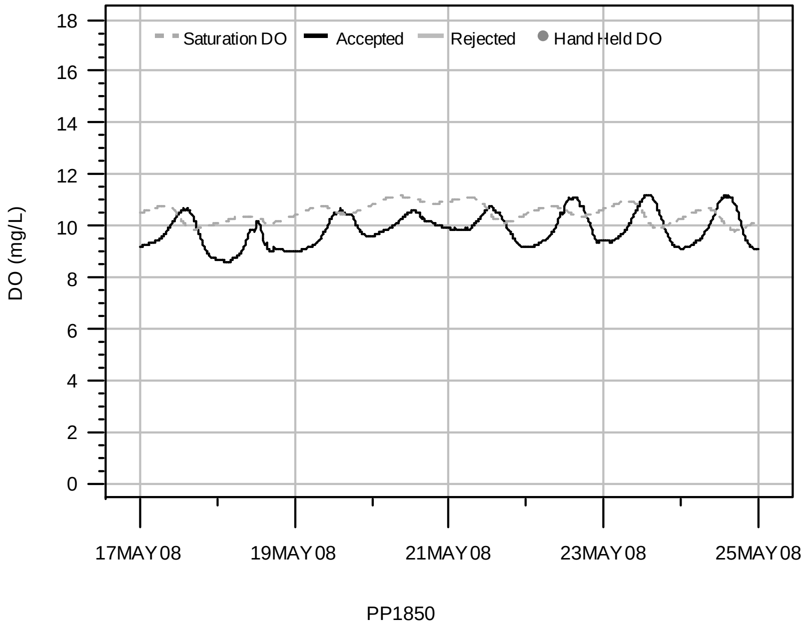

Figure D.137 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 05/17/08 to 05/25/08

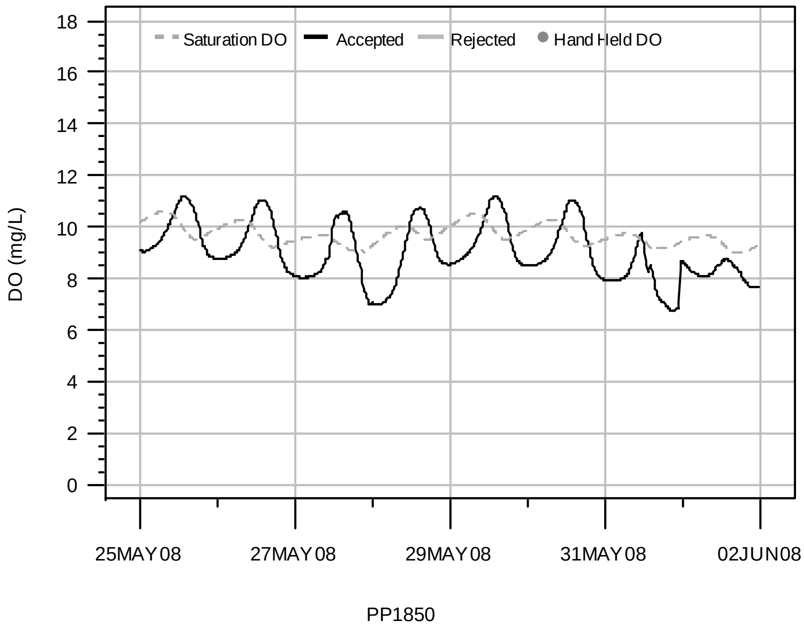

Figure D.138 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 05/25/08 to 06/02/08

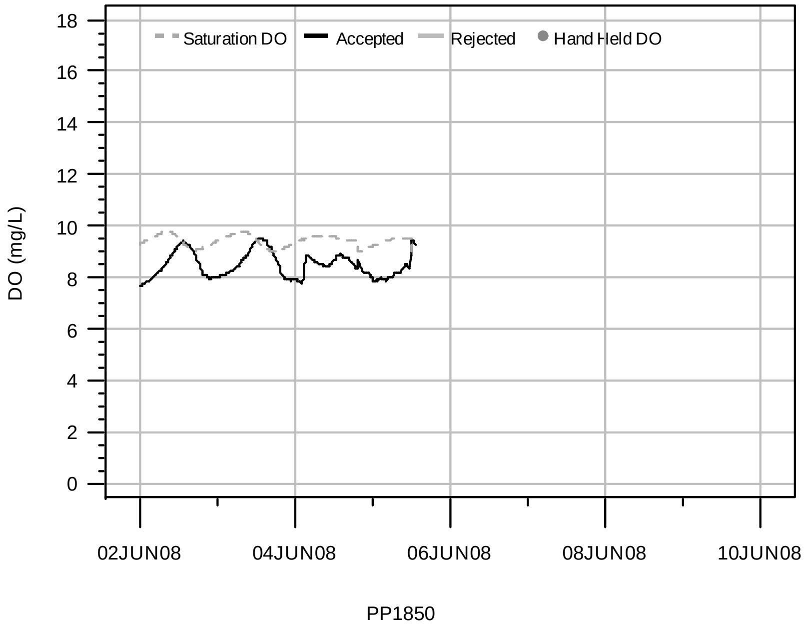

Figure D.139 Continuous Dissolved Oxygen (DO) with Calculated DO Saturation at site PP1850, 06/02/08 to 06/10/08

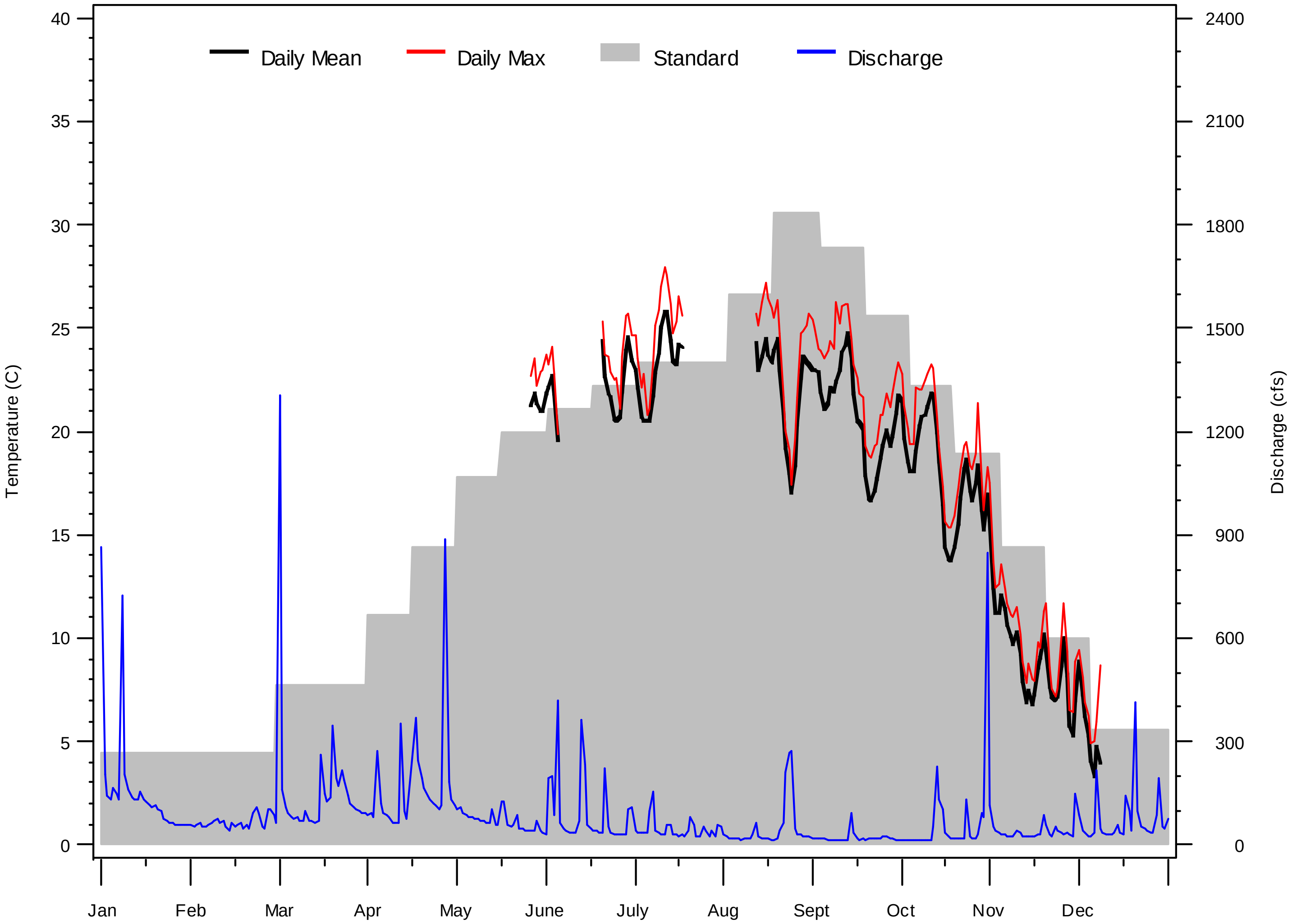

Figure E.1 2007 Continuous Temperature Data at Site PP340 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

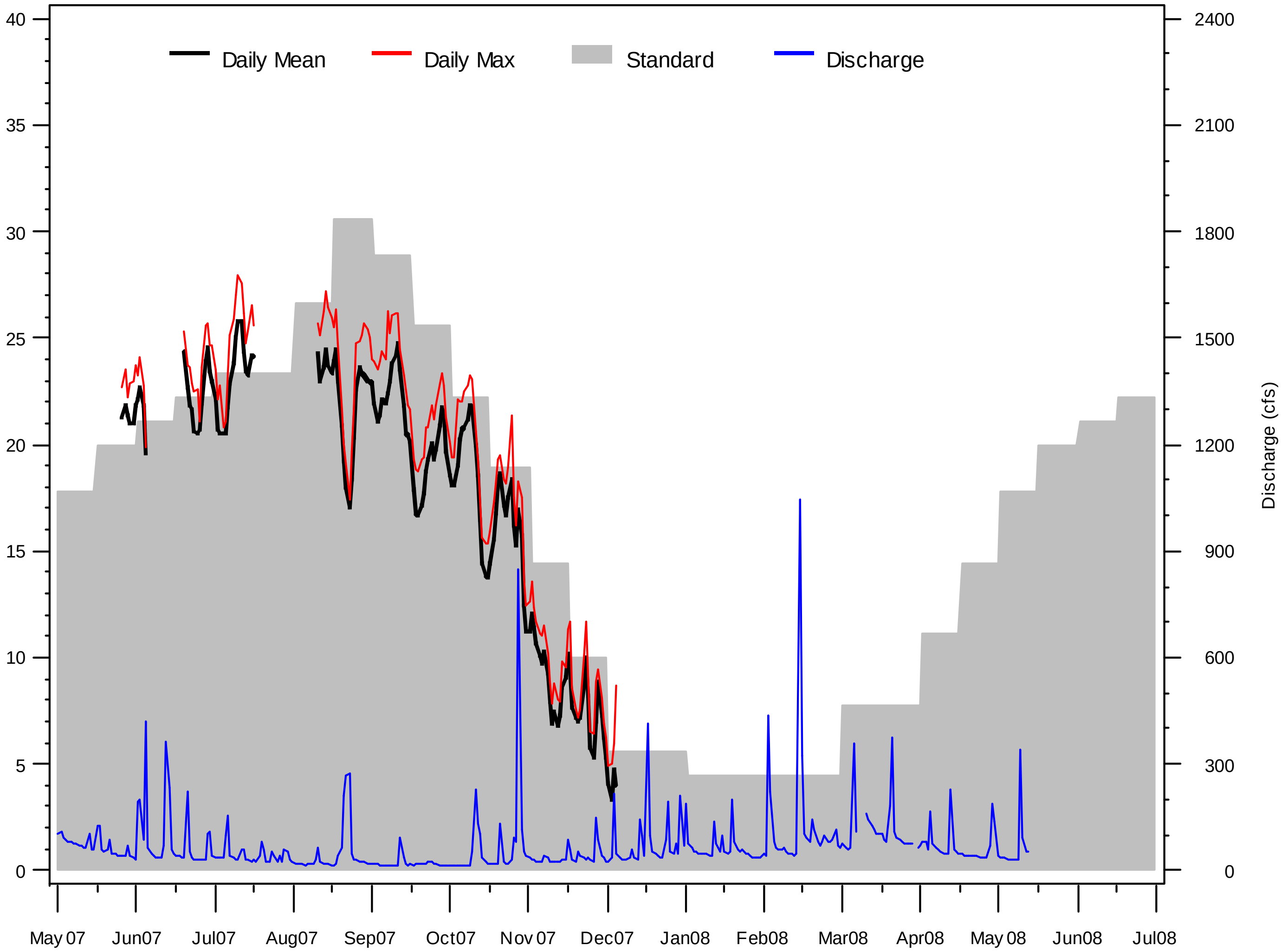

Figure E.2 2007 and 2008 Continuous Temperature Data at Site PP340 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

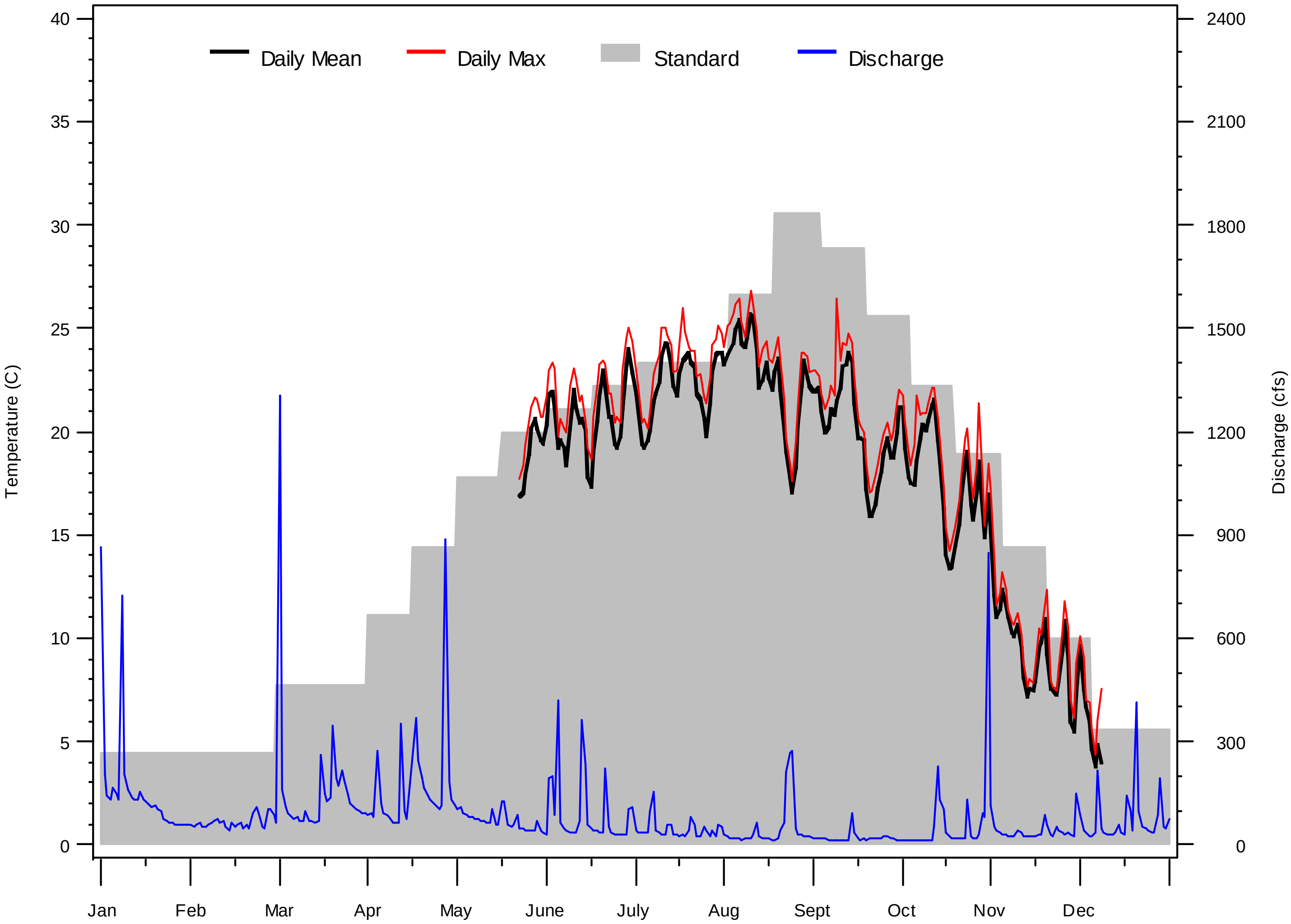

Figure E.3 2007 Continuous Temperature Data at Site PP985 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

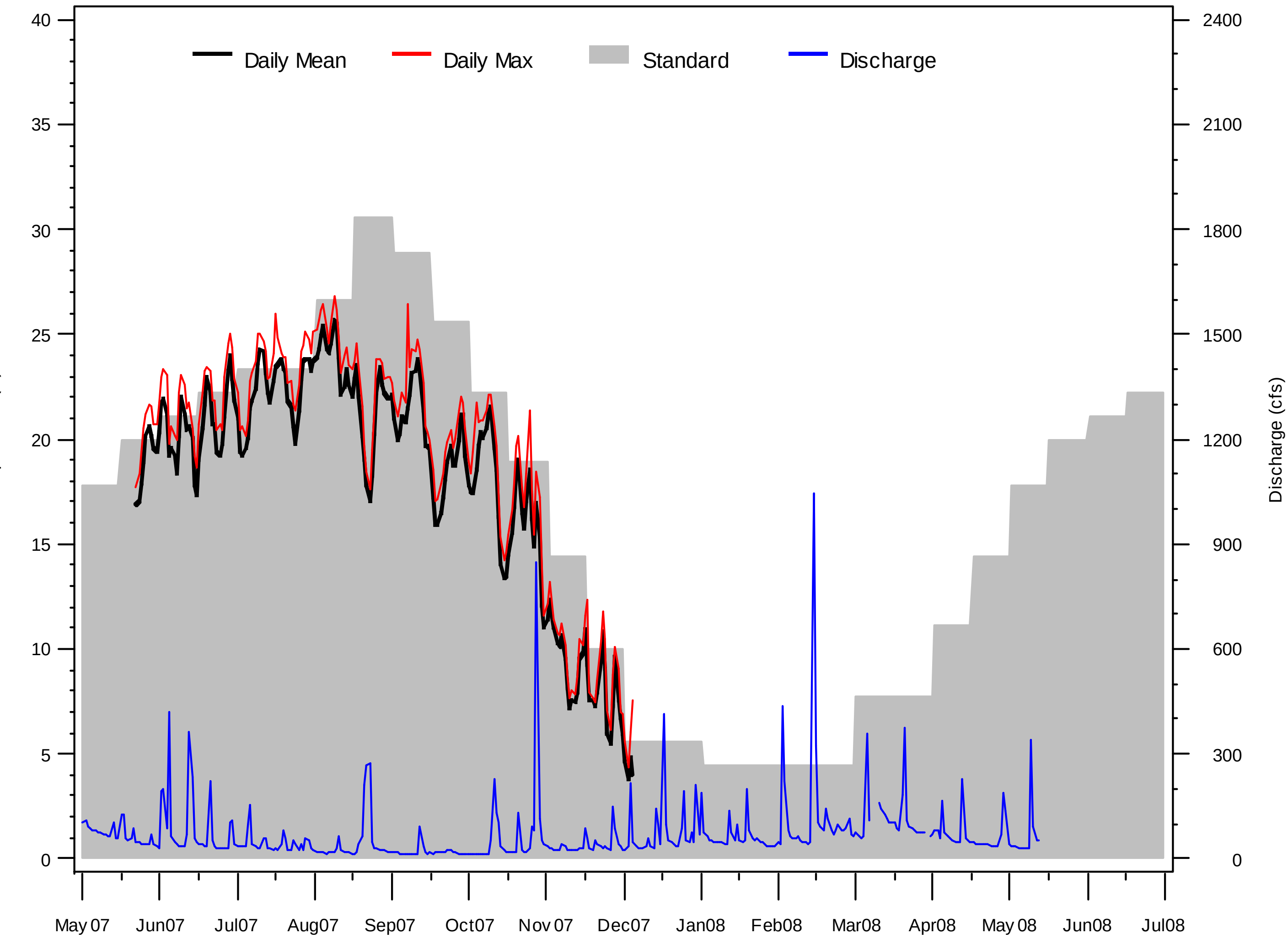

Figure E.4 2007 and 2008 Continuous Temperature Data at Site PP985 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

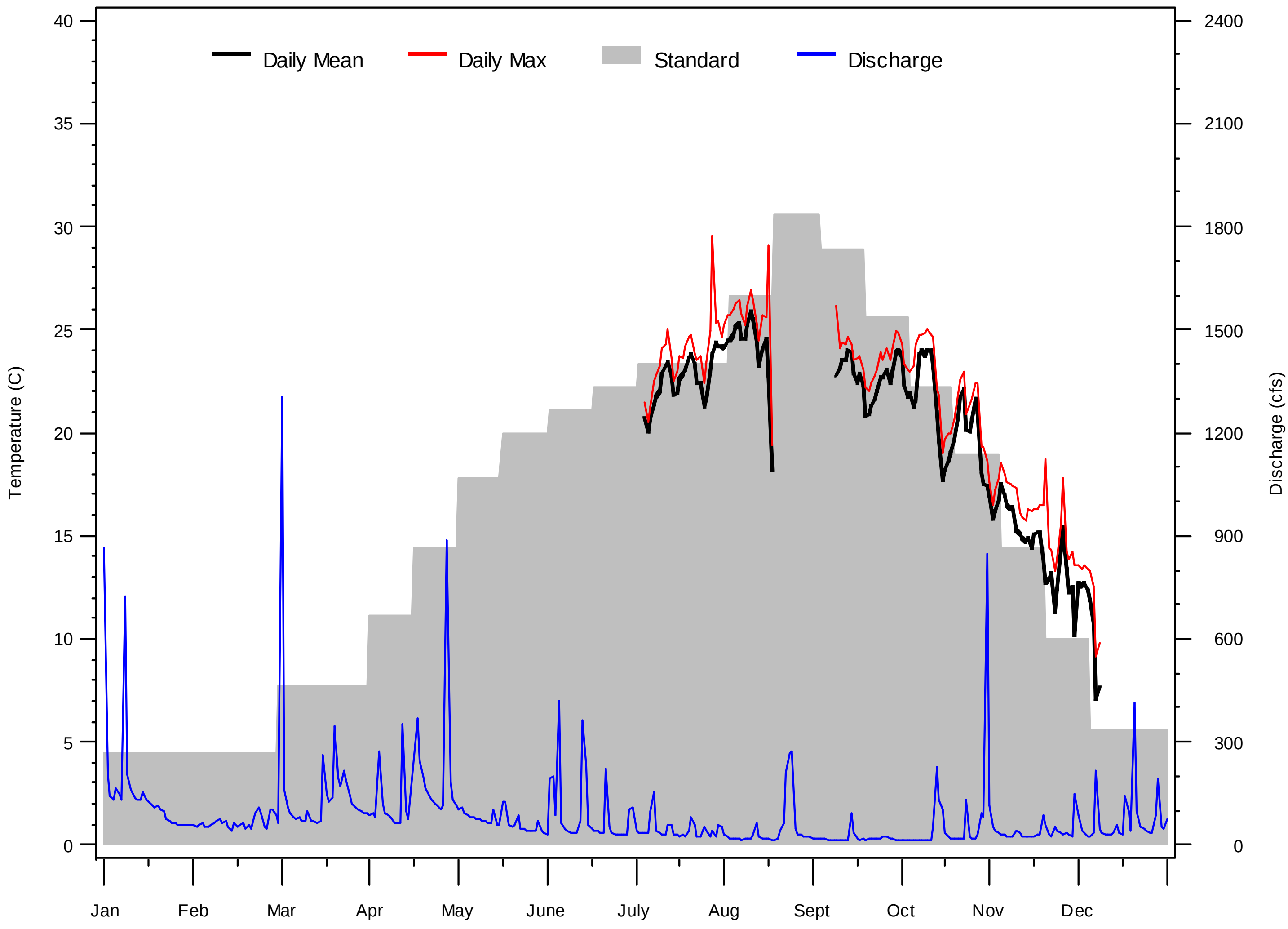

Figure E.5 2007 Continuous Temperature Data at Site PP1680 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

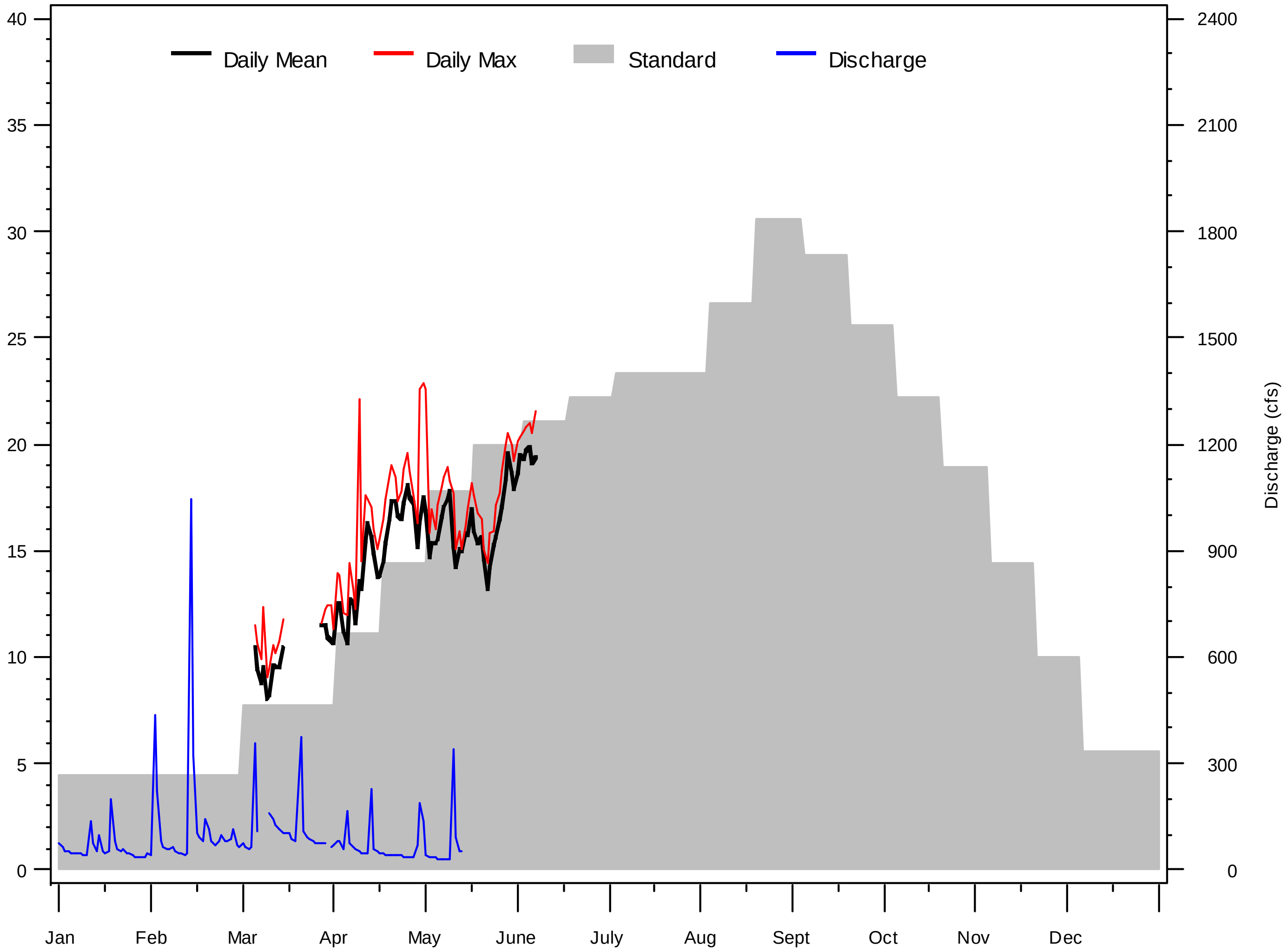

Figure E.6 2008 Continuous Temperature Data at Site PP1680 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

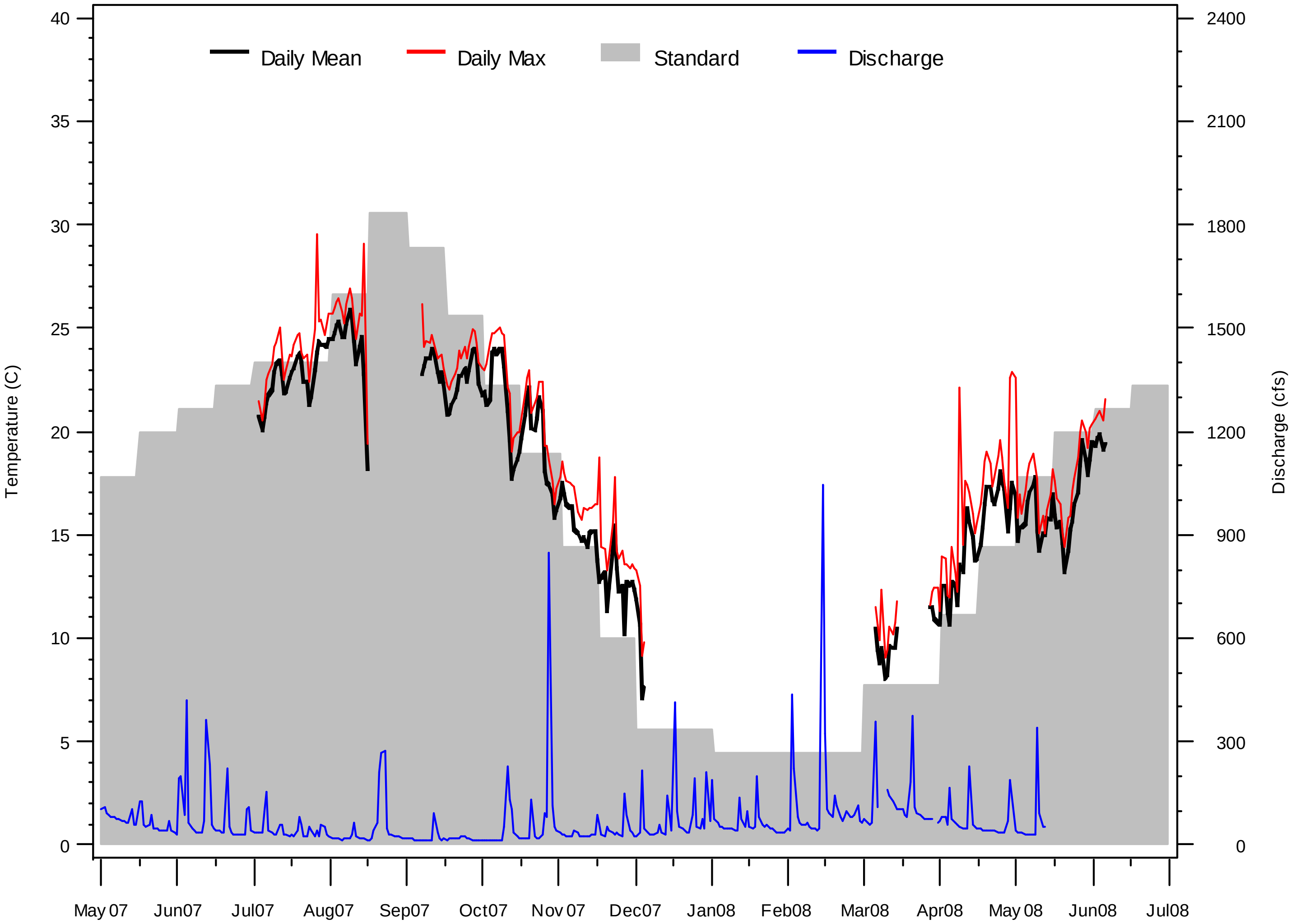

Figure E.7 2007 and 2008 Continuous Temperature Data at Site PP1680 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

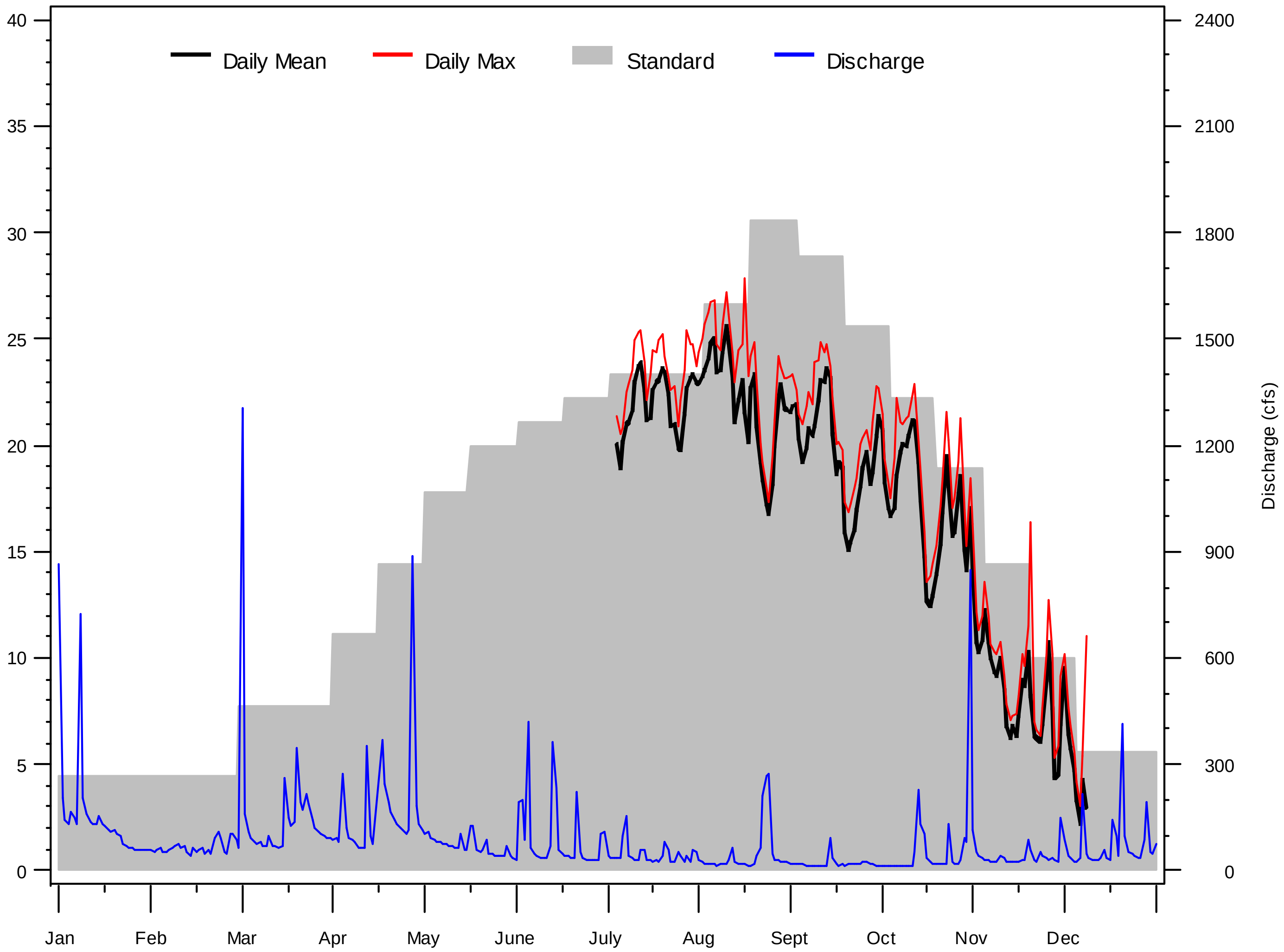

Figure E.8 2007 Continuous Temperature Data at Site PP1850 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

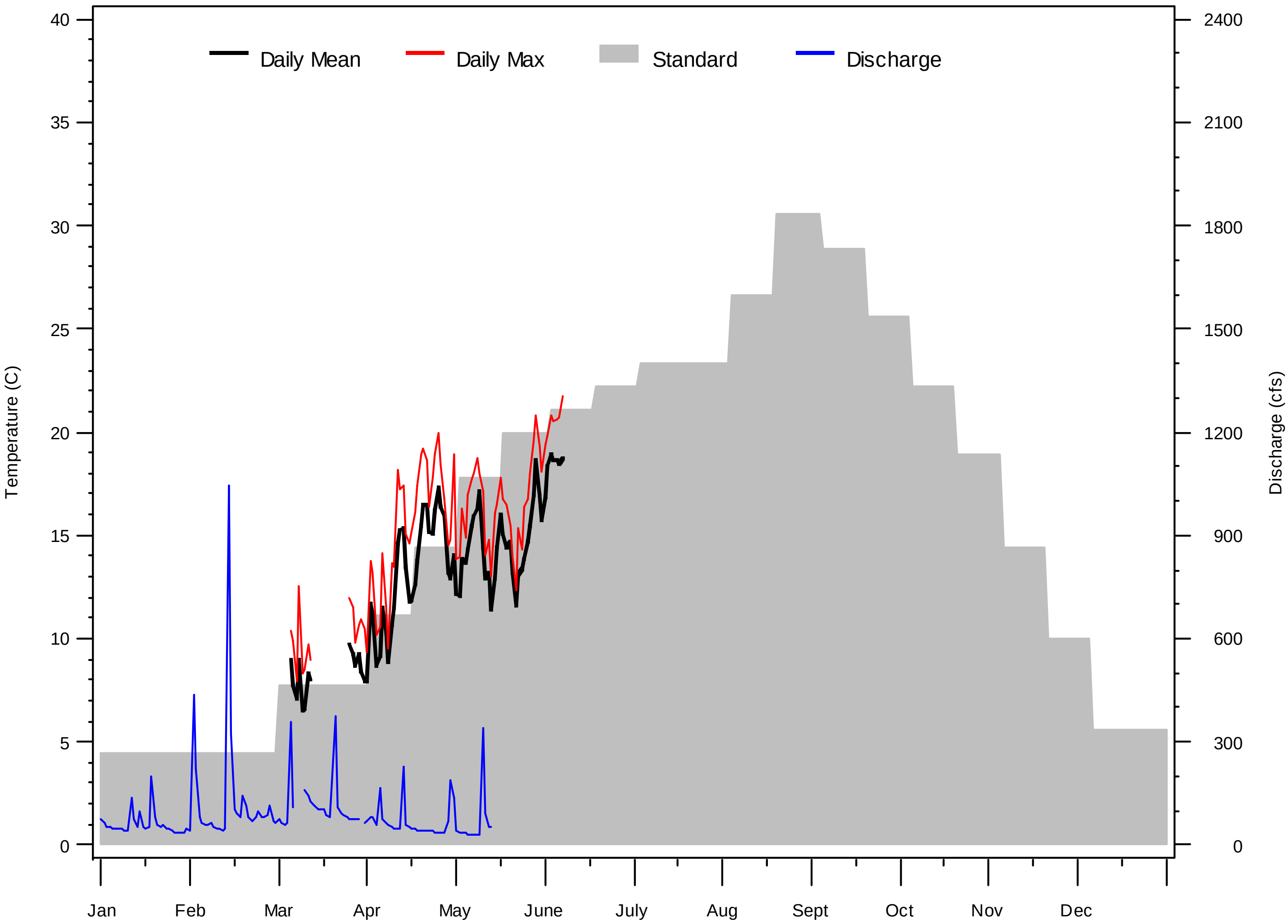

Figure E.9 2008 Continuous Temperature Data at Site PP1850 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

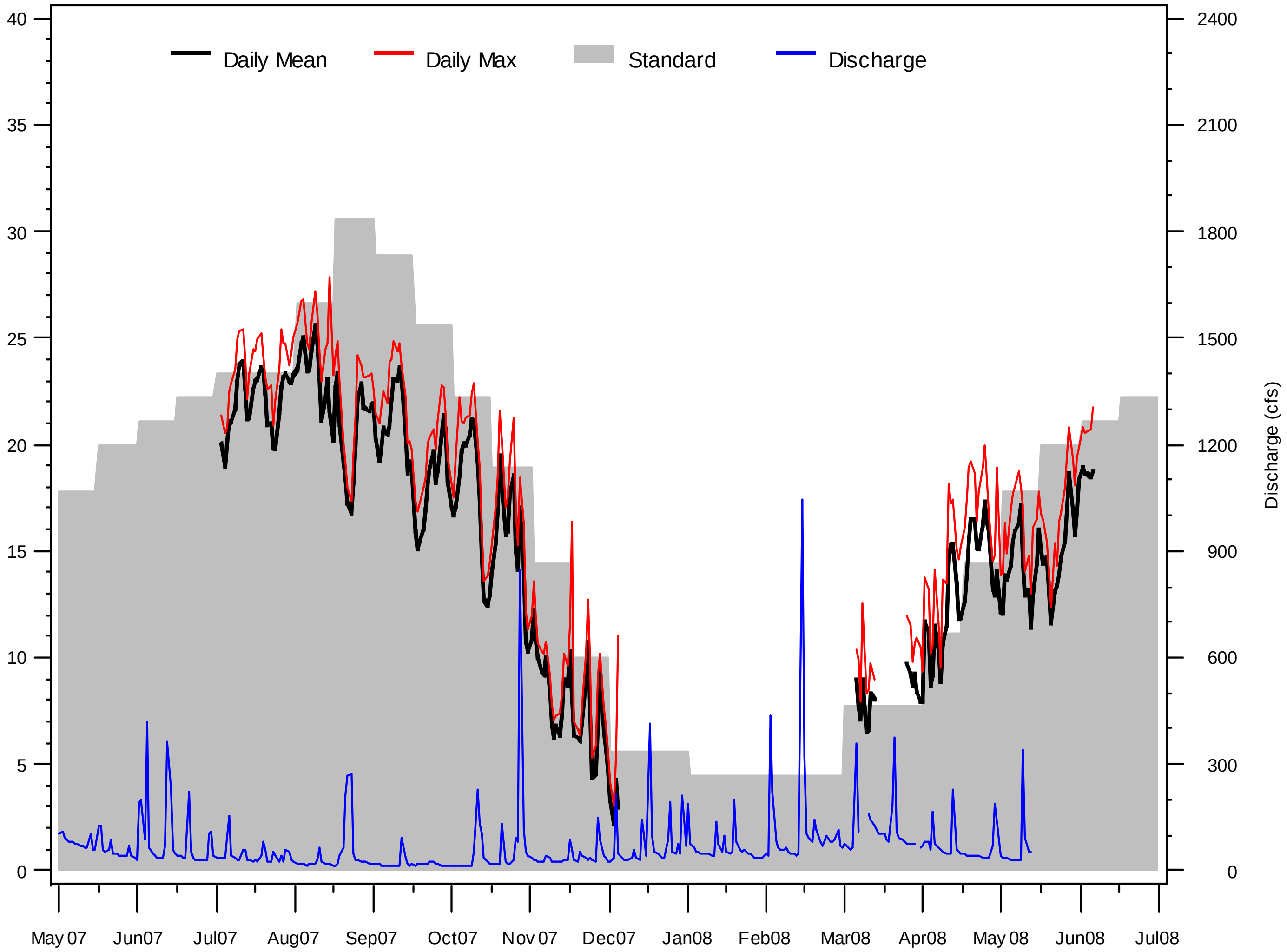

Figure E.10 2007 and 2008 Continuous Temperature Data at Site PP1850 with Comparison to PA Ch. 96 Water Quality Standards for Trout Stocking Fishery

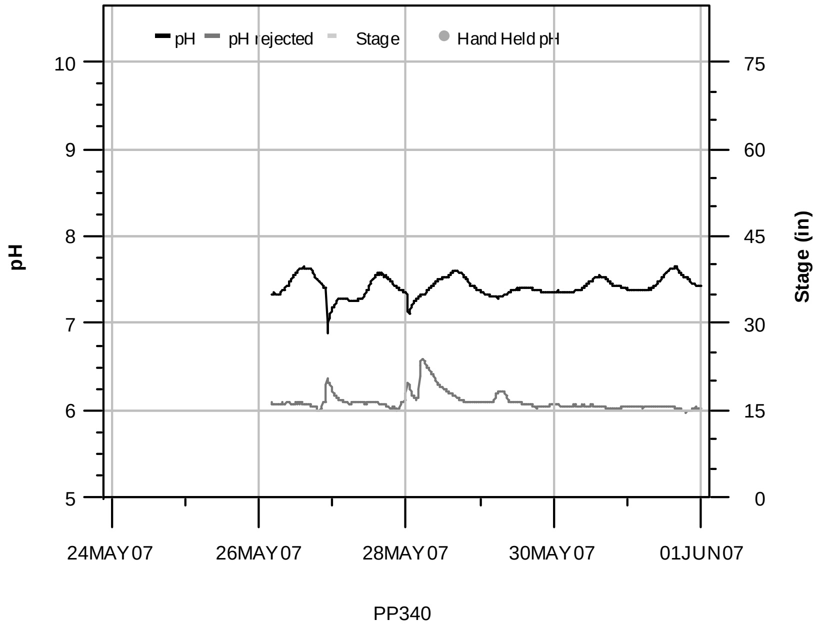

Figure F.1 Continuous pH at Site PP340, 05/24/07 to 06/01/07

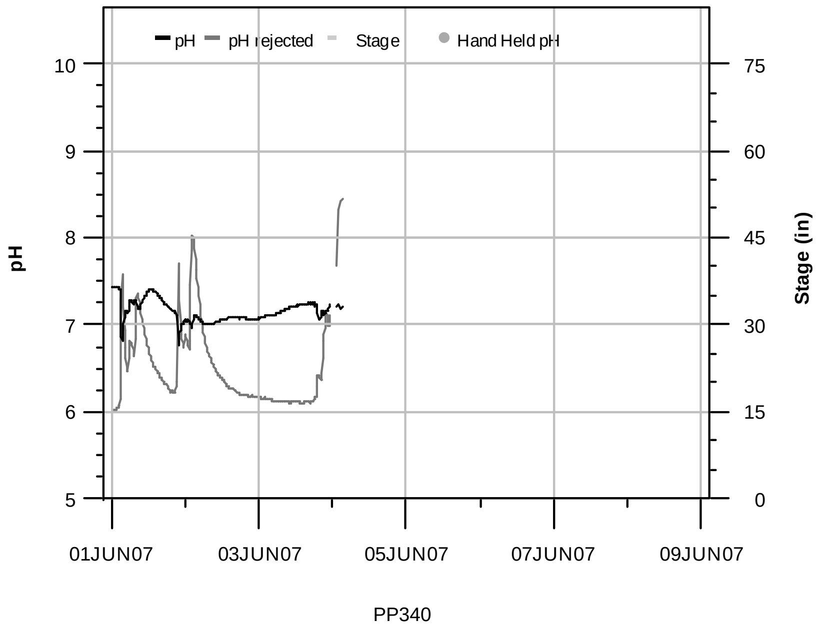

Figure F.2 Continuous pH at Site PP340, 06/01/07 to 06/09/07

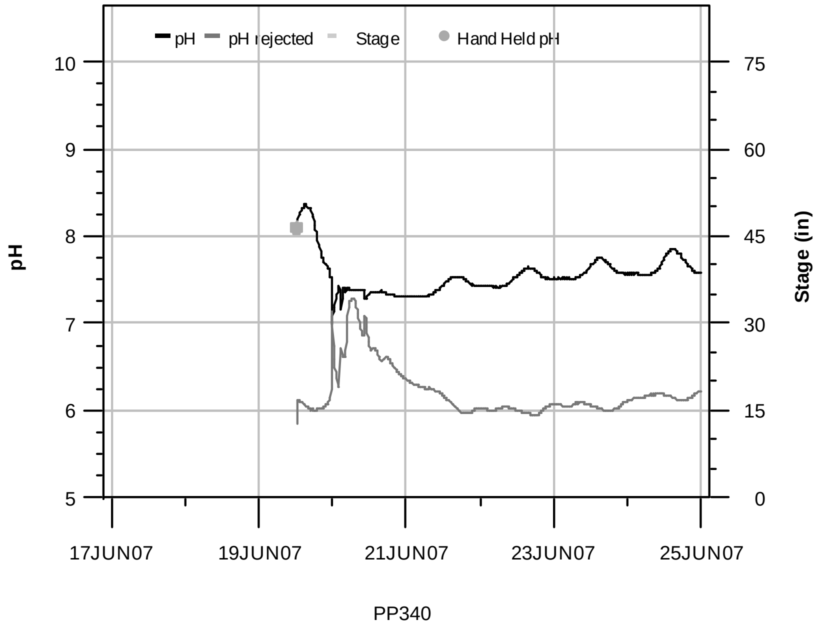

Figure F.3 Continuous pH at Site PP340, 06/17/07 to 06/25/07

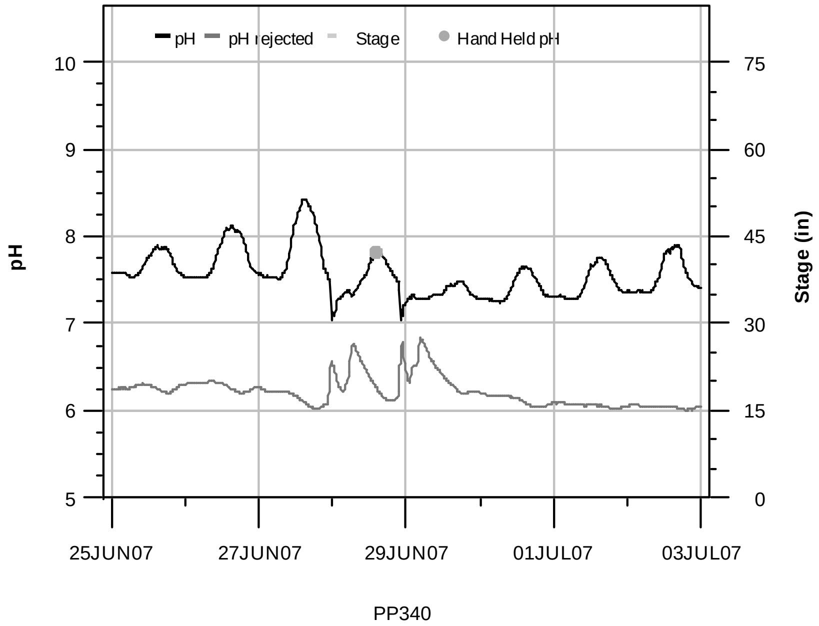

Figure F.4 Continuous pH at Site PP340, 06/25/07 to 07/03/07

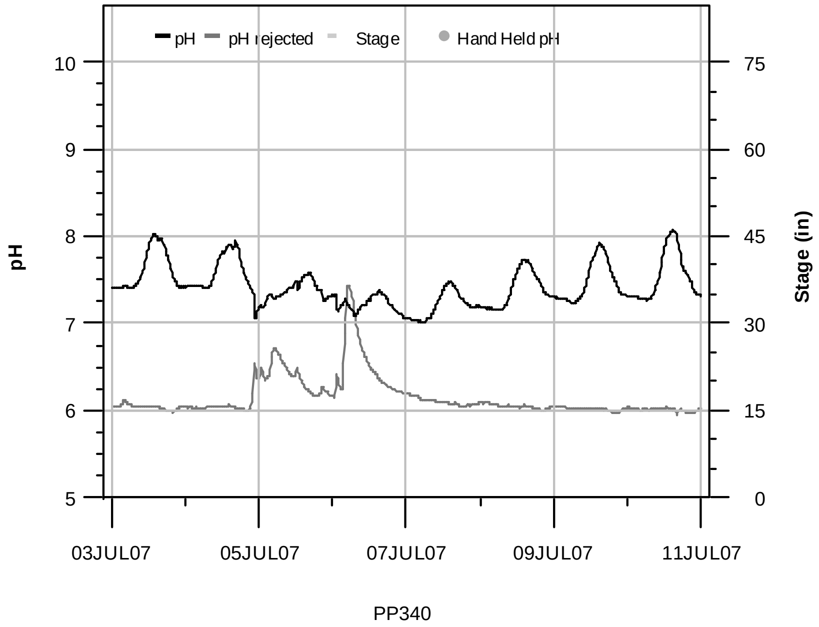

Figure F.5 Continuous pH at Site PP340, 07/03/07 to 07/11/07

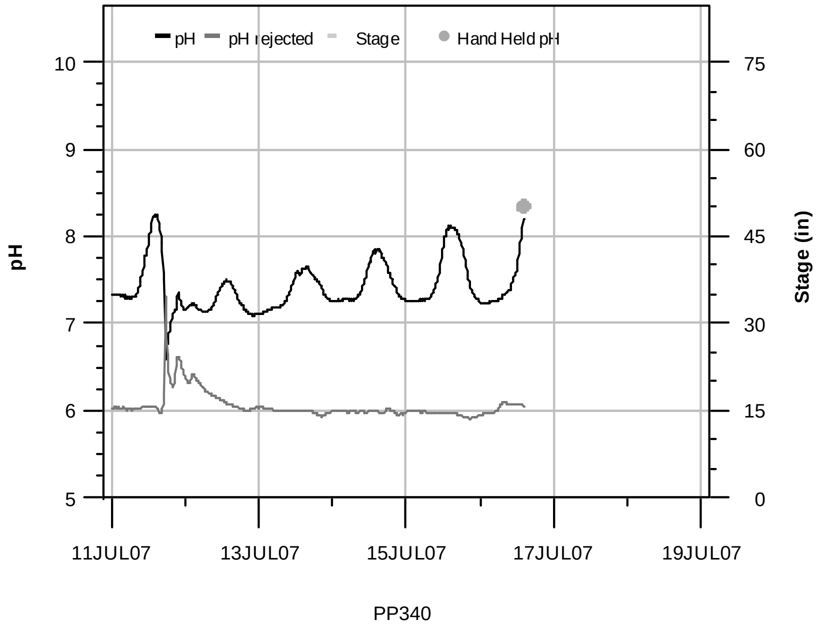

Figure F.6 Continuous pH at Site PP340, 07/11/07 to 07/19/07

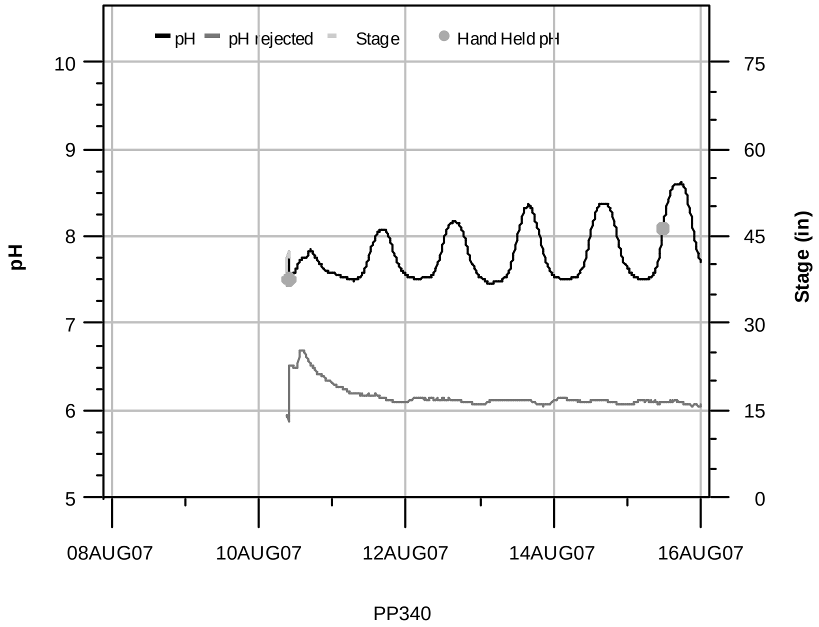

Figure F.7 Continuous pH at Site PP340, 08/08/07 to 08/16/07

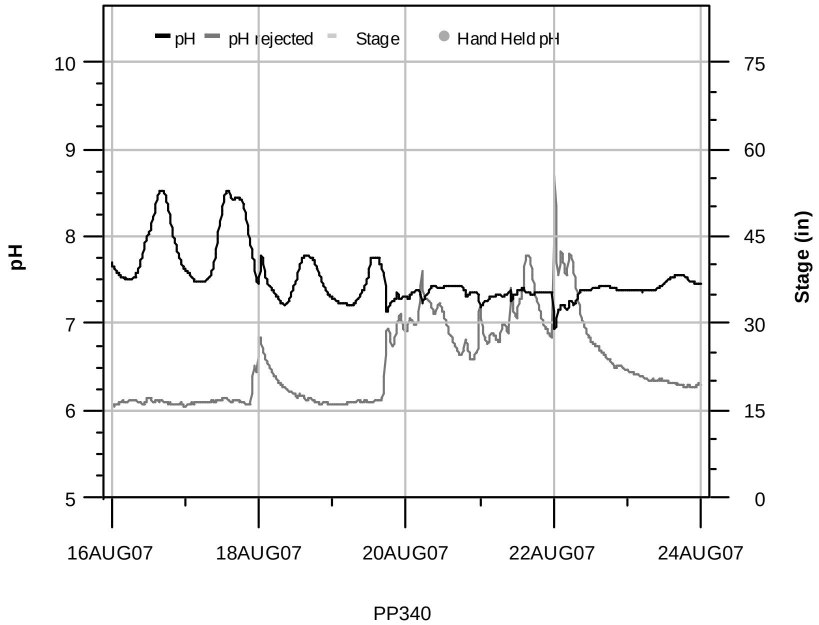

Figure F.8 Continuous pH at Site PP340, 08/16/07 to 08/24/07

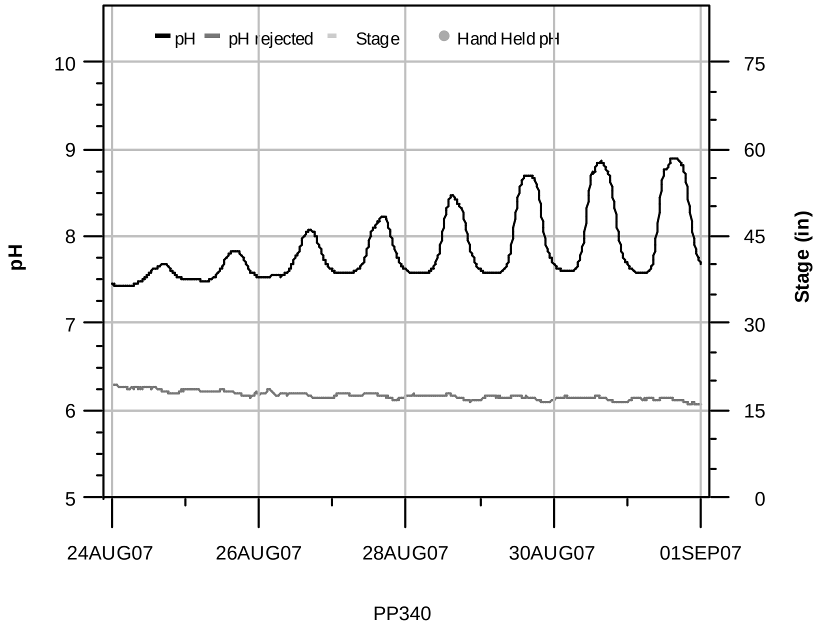

Figure F.9 Continuous pH at Site PP340, 08/24/07 to 09/01/07

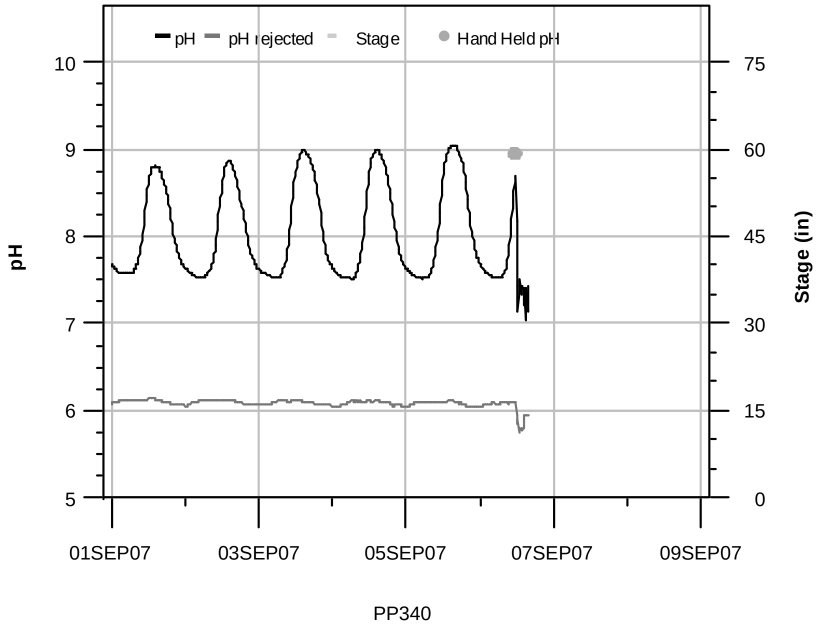

Figure F.10 Continuous pH at Site PP340, 09/01/07 to 09/09/07

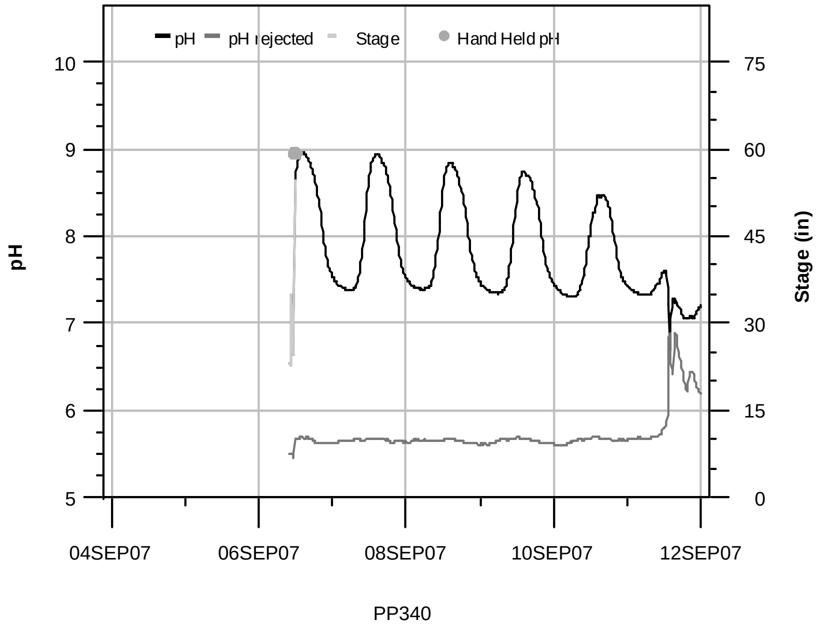

Figure F.11 Continuous pH at Site PP340, 09/04/07 to 09/12/07

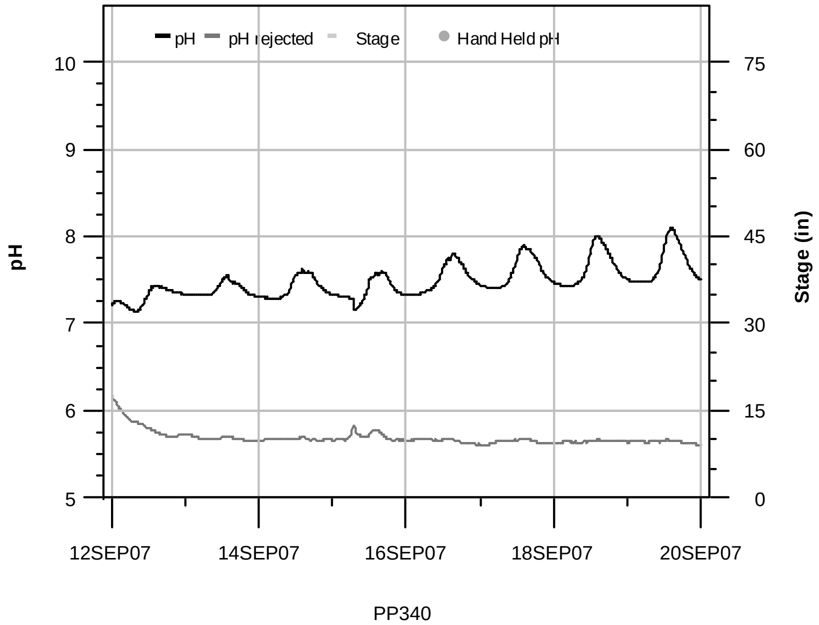

Figure F.12 Continuous pH at Site PP340, 09/12/07 to 09/20/07

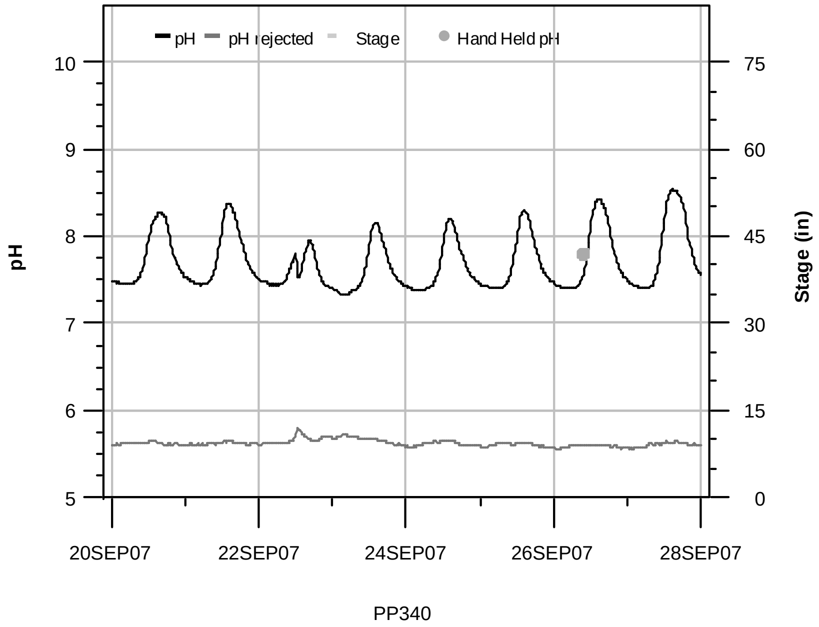

Figure F.13 Continuous pH at Site PP340, 09/20/07 to 09/28/07

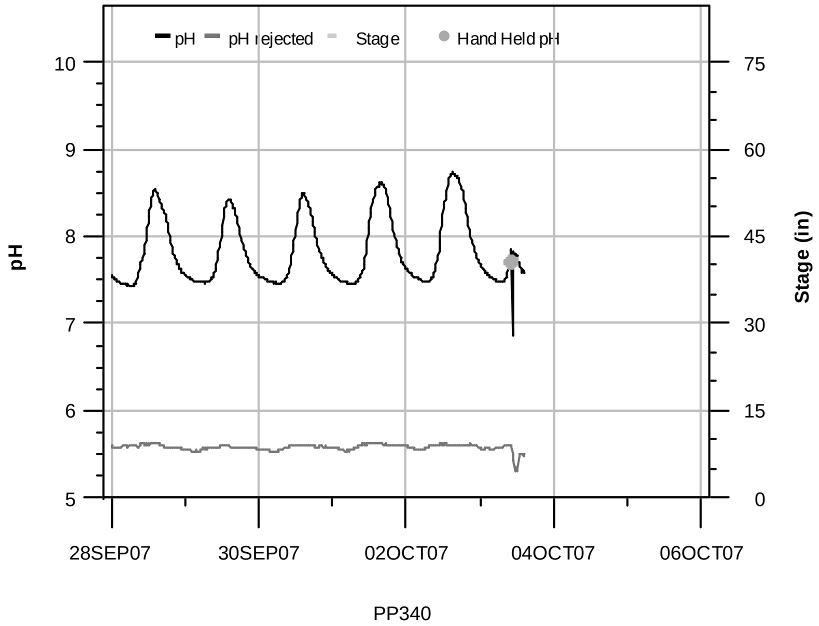

Figure F.14 Continuous pH at Site PP340, 09/28/07 to 10/06/07

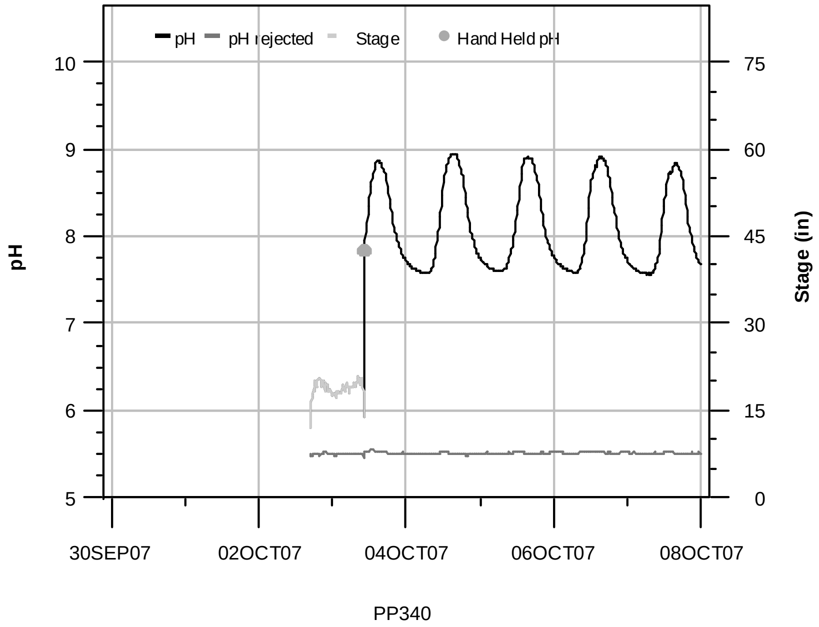

Figure F.15 Continuous pH at Site PP340, 09/30/07 to 10/08/07

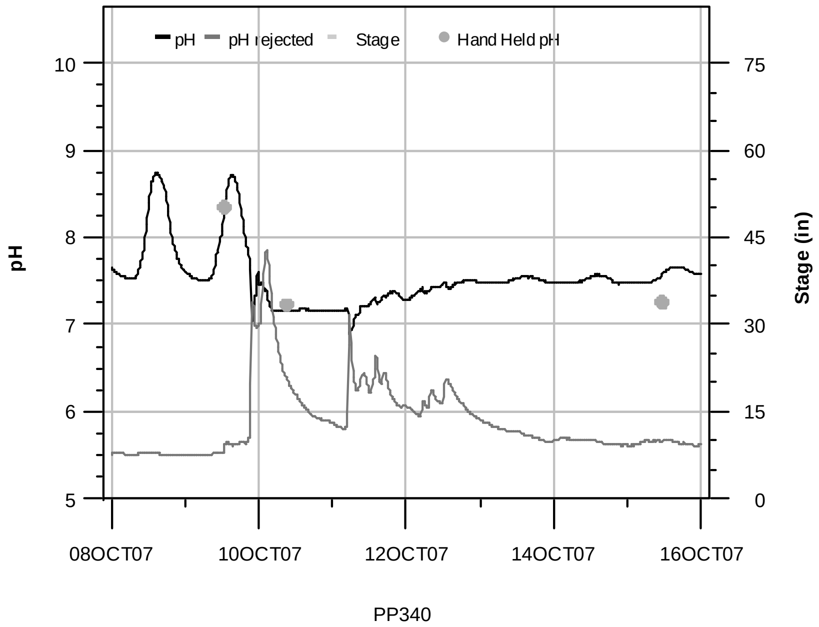

Figure F.16 Continuous pH at Site PP340, 10/08/07 to 10/16/07

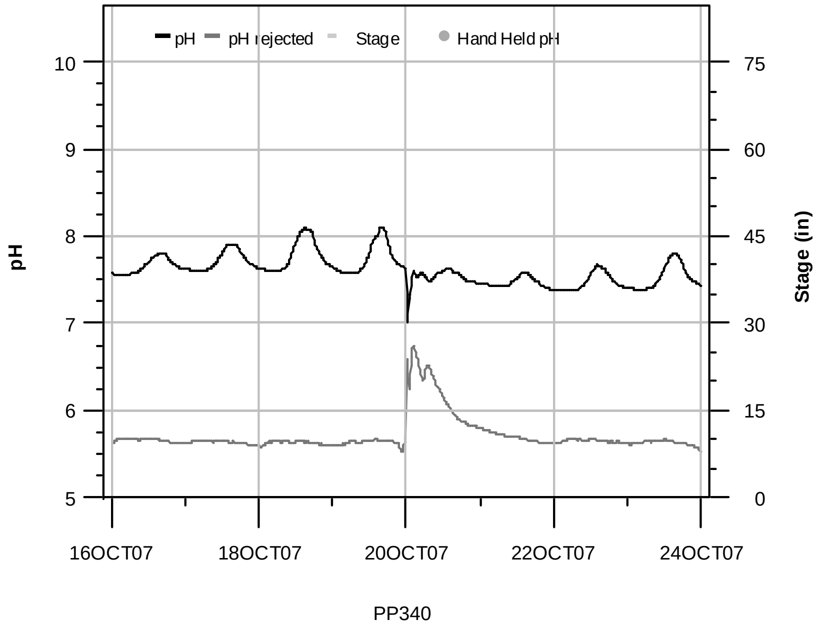

Figure F.17 Continuous pH at Site PP340, 10/16/07 to 10/24/07

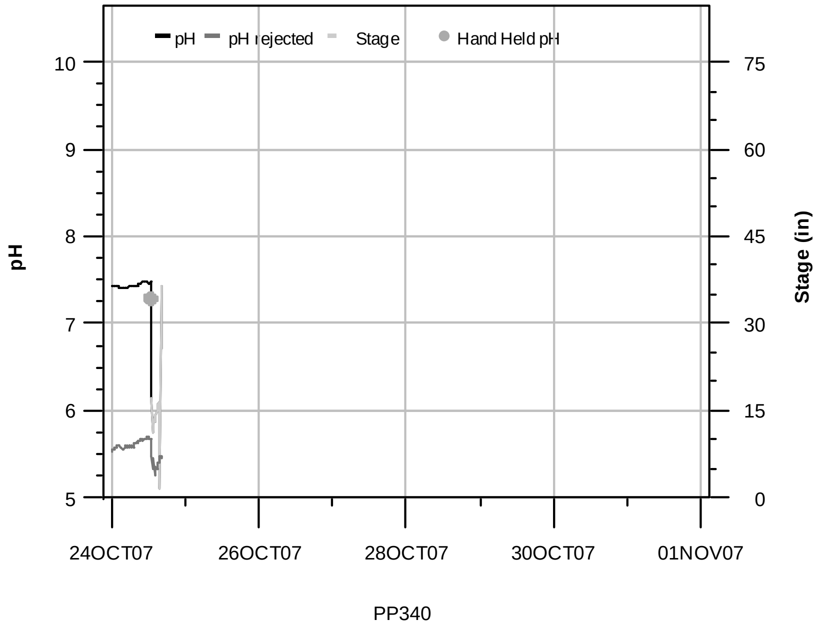

Figure F.18 Continuous pH at Site PP340, 10/24/07 to 11/01/07

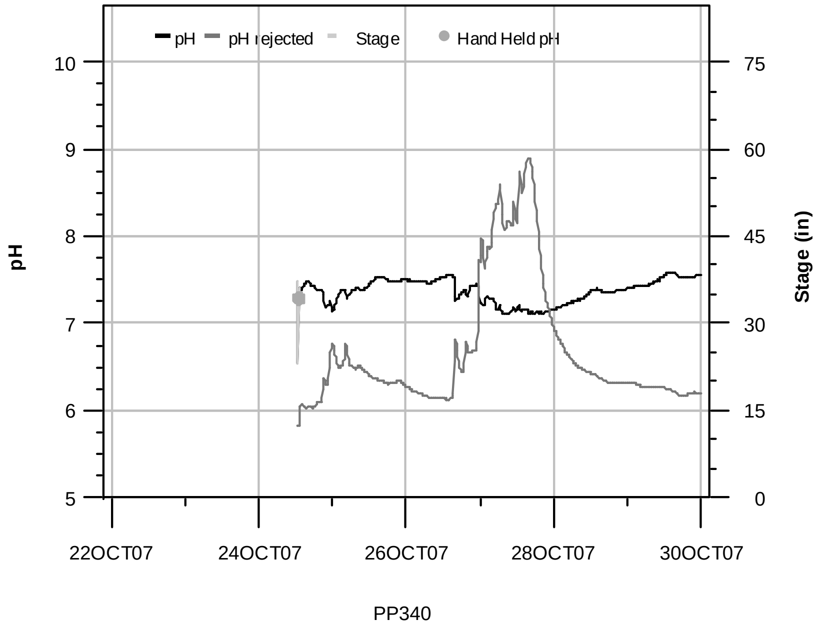

Figure F.19 Continuous pH at Site PP340, 10/22/07 to 10/30/07

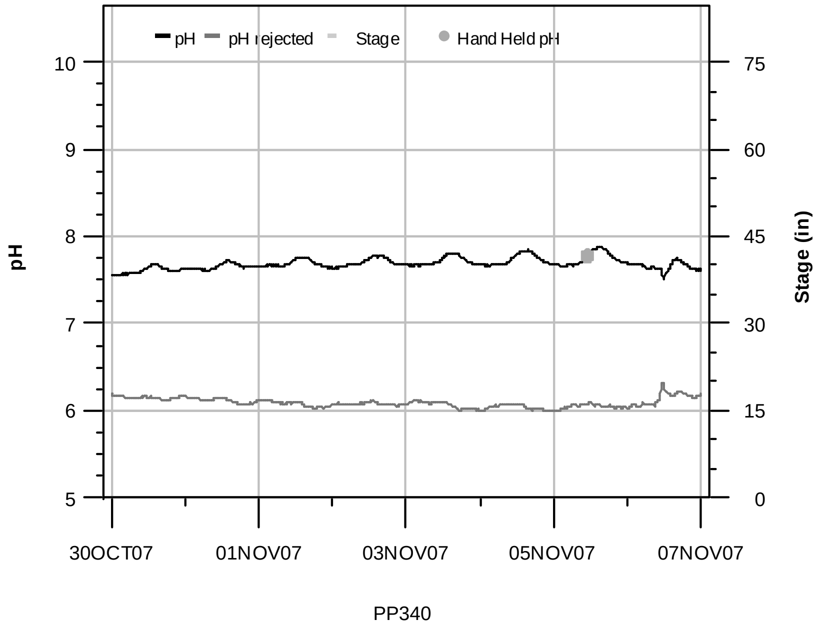

Figure F.20 Continuous pH at Site PP340, 10/30/07 to 11/07/07

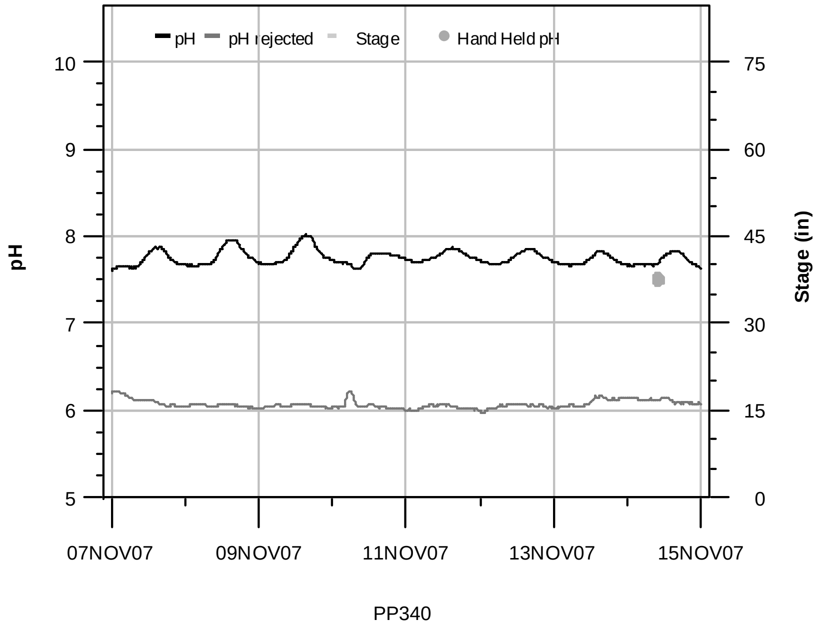

Figure F.21 Continuous pH at Site PP340, 11/07/07 to 11/15/07

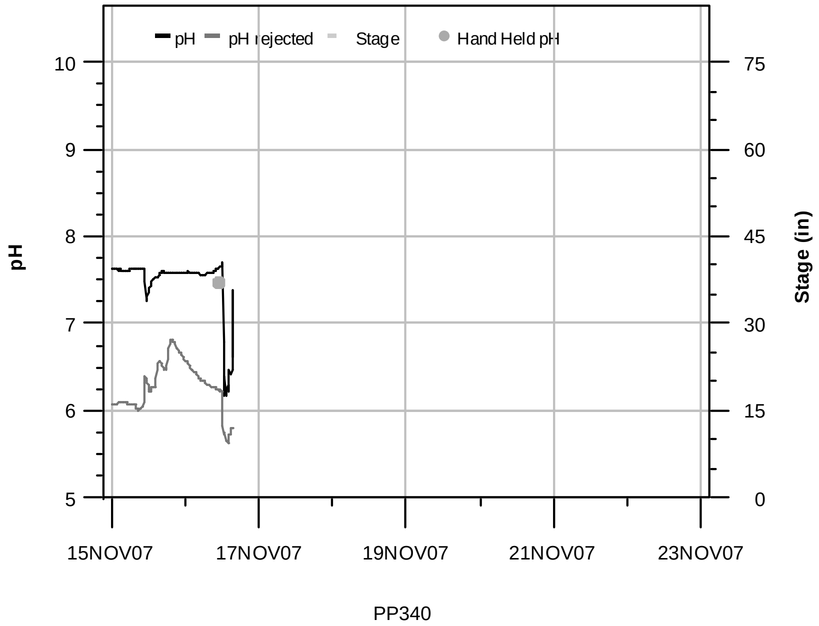

Figure F.22 Continuous pH at Site PP340, 11/15/07 to 11/23/07

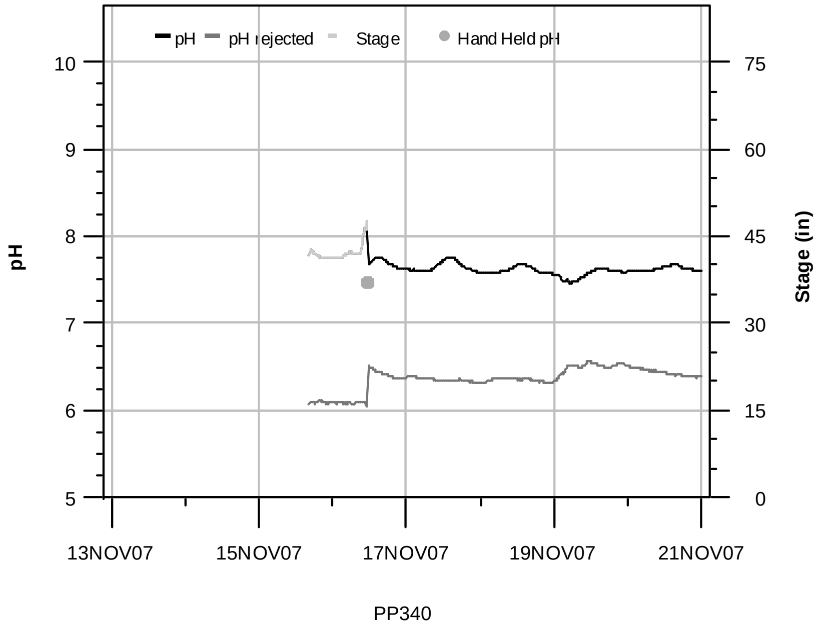

Figure F.23 Continuous pH at Site PP340, 11/13/07 to 11/21/07

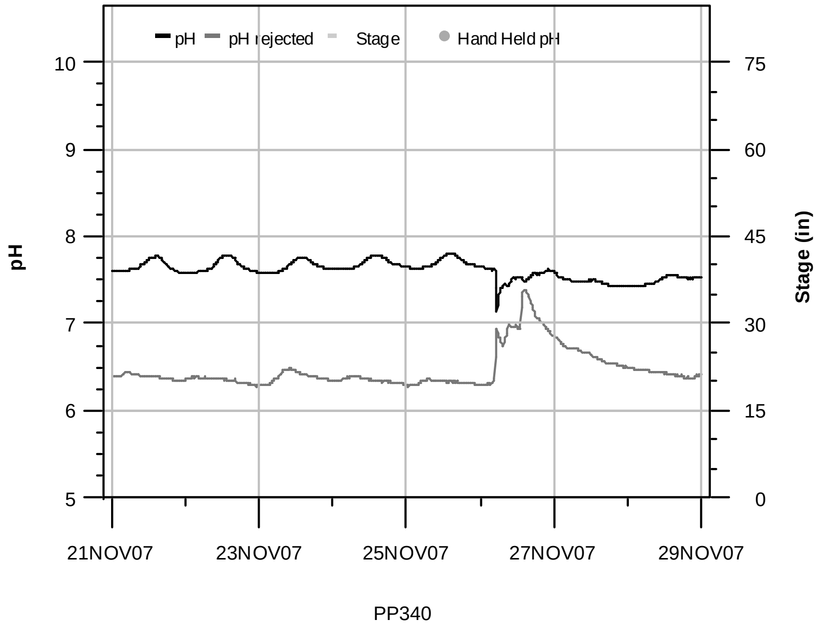

Figure F.24 Continuous pH at Site PP340, 11/21/07 to 11/29/07

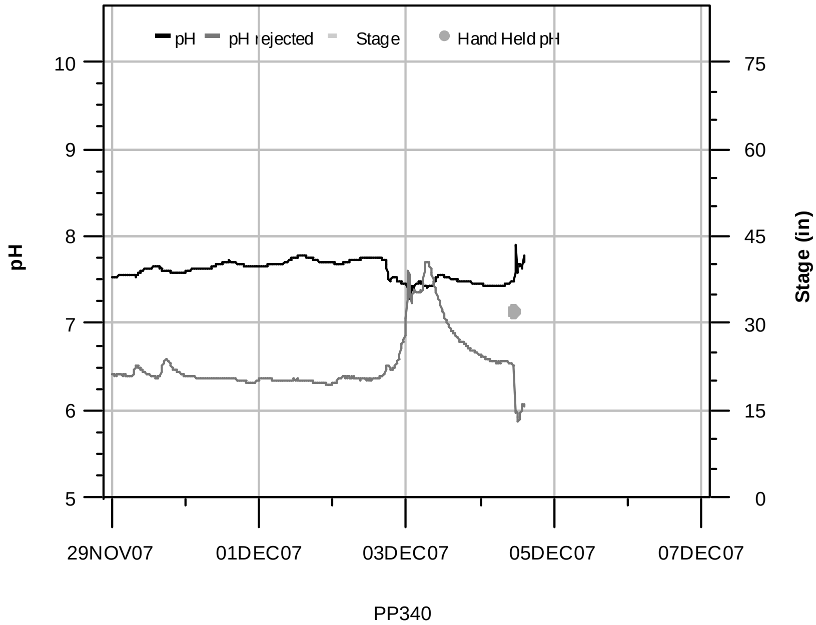

Figure F.25 Continuous pH at Site PP340, 11/29/07 to 12/07/07

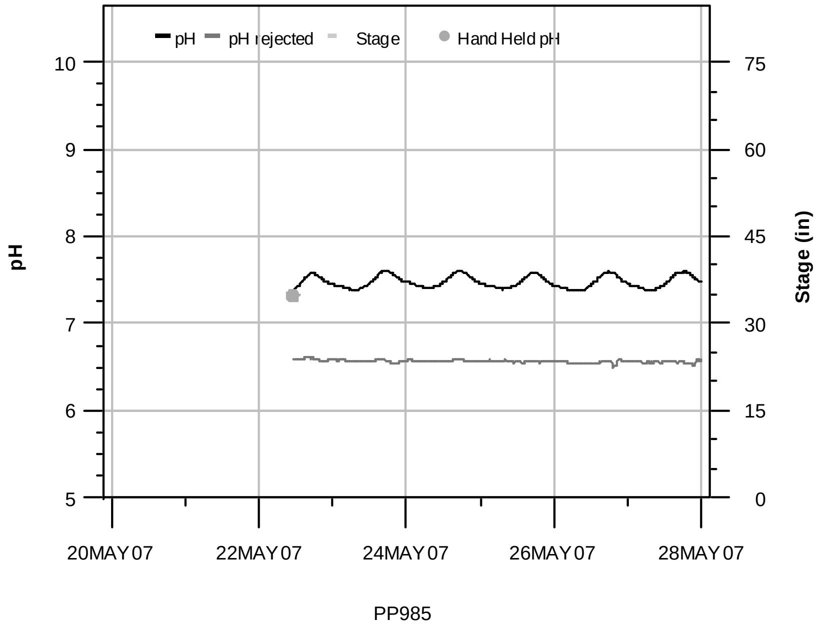

Figure F.26 Continuous pH at Site PP985, 05/20/07 to 05/28/07

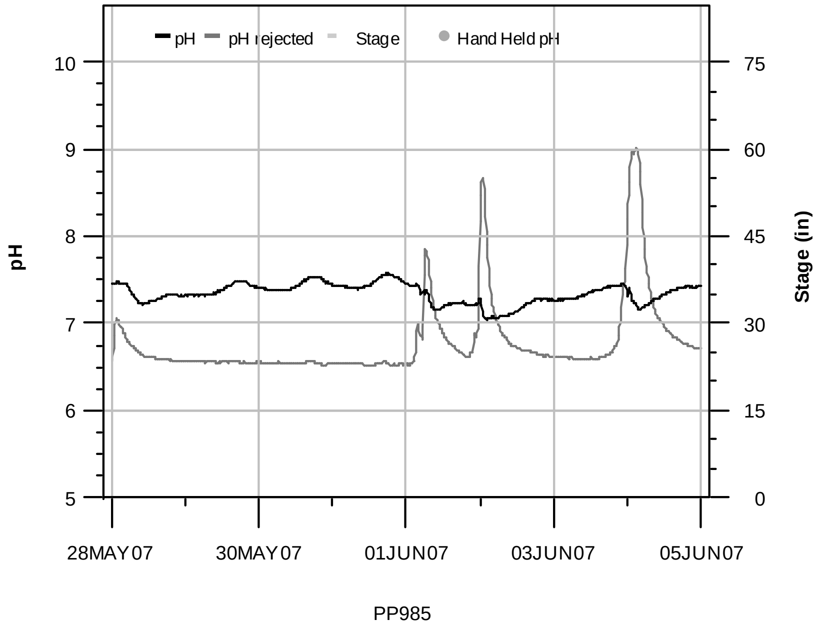

Figure F.27 Continuous pH at Site PP985, 05/28/07 to 06/05/07

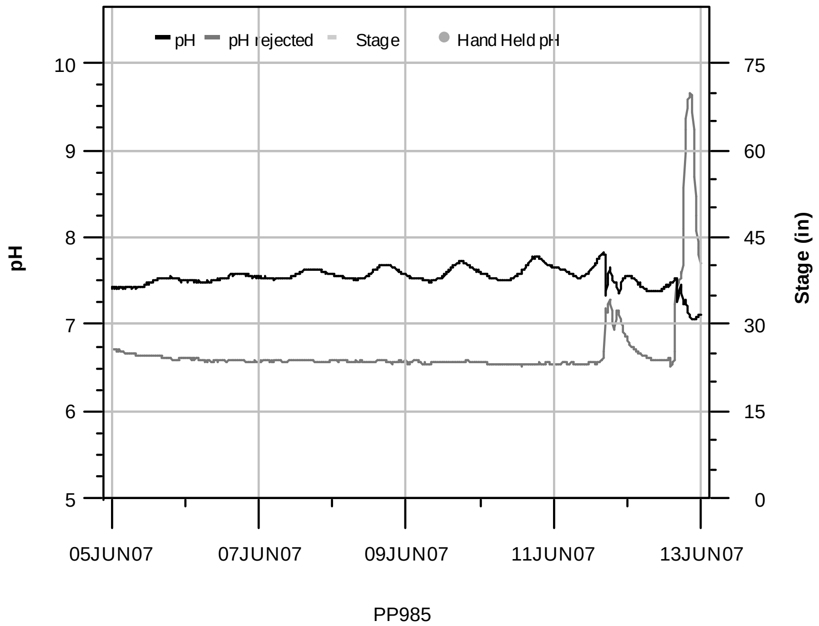

Figure F.28 Continuous pH at Site PP985, 06/05/07 to 06/13/07

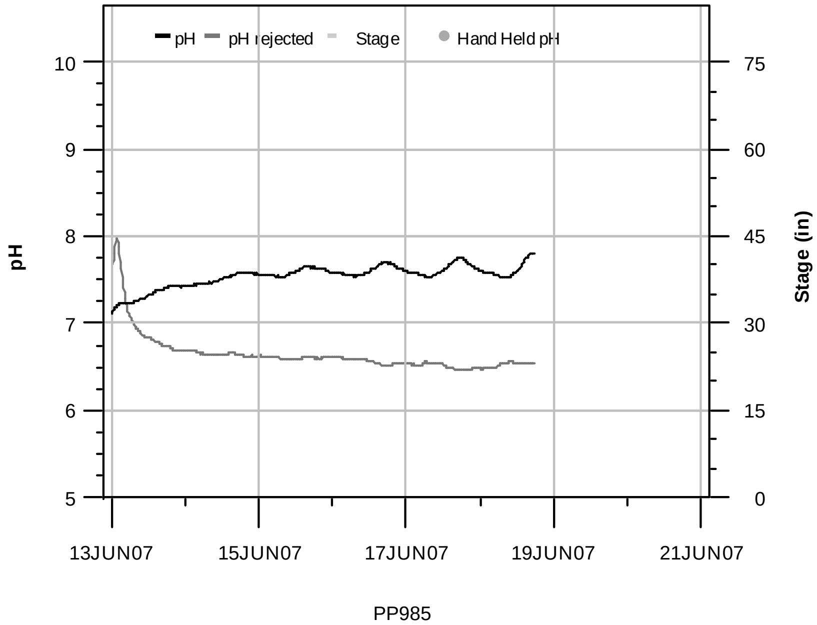

Figure F.29 Continuous pH at Site PP985, 06/13/07 to 06/21/07

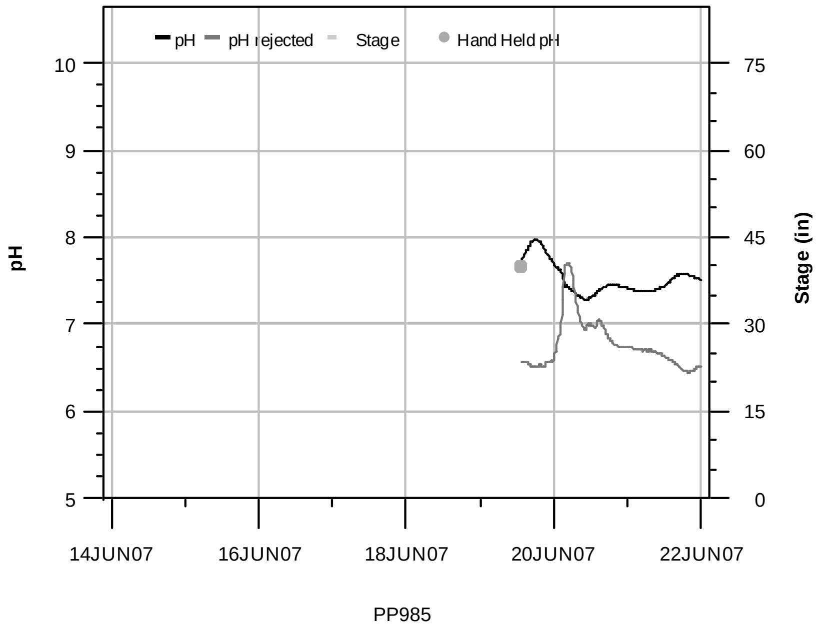

Figure F.30 Continuous pH at Site PP985, 06/14/07 to 06/22/07

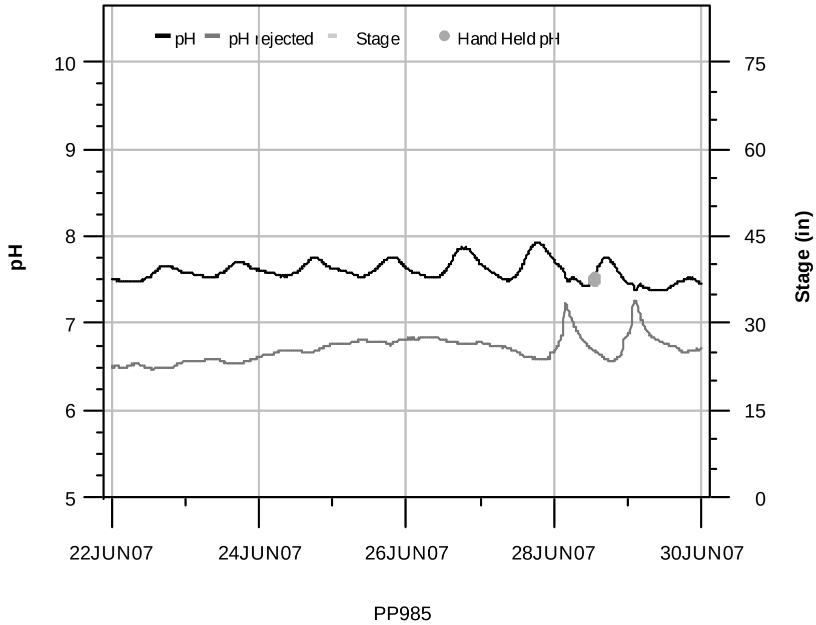

Figure F.31 Continuous pH at Site PP985, 06/22/07 to 06/30/07

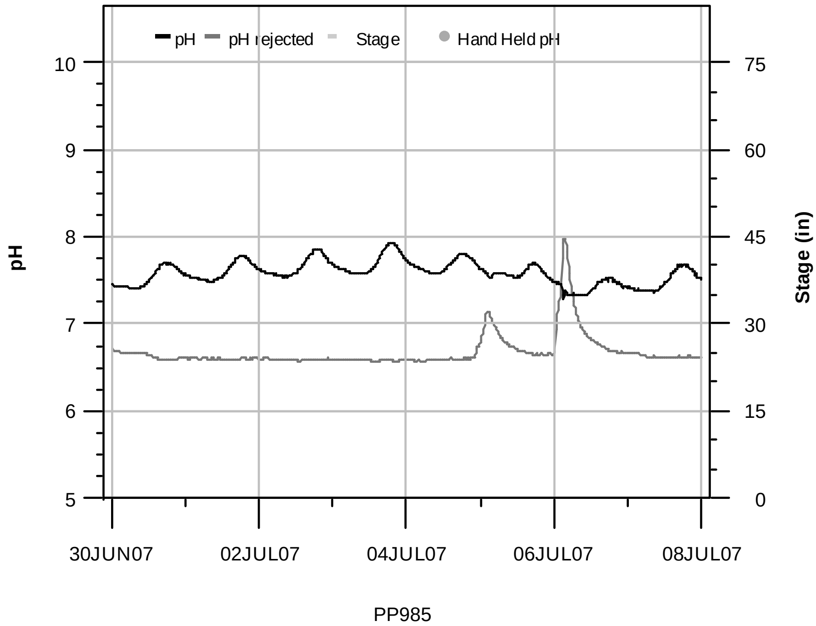

Figure F.32 Continuous pH at Site PP985, 06/30/07 to 07/08/07

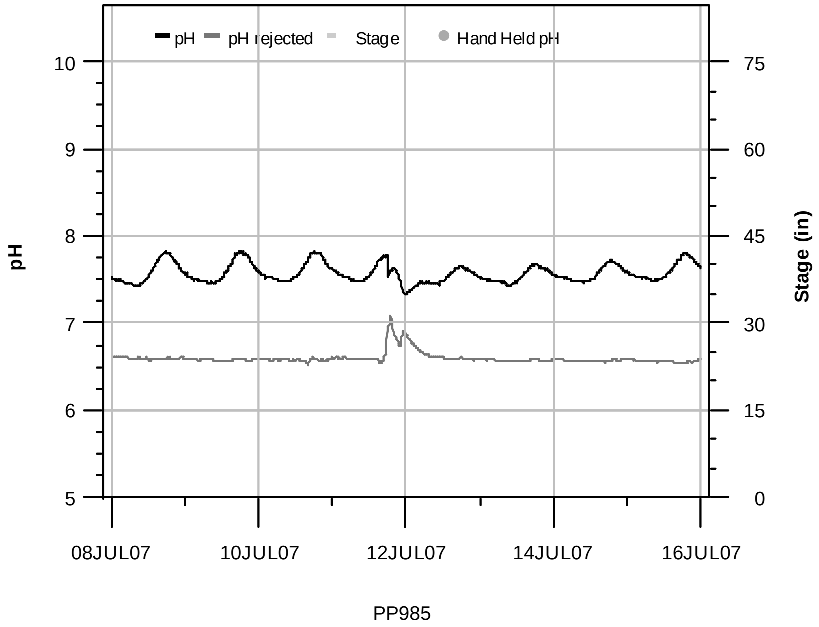

Figure F.33 Continuous pH at Site PP985, 07/08/07 to 07/16/07

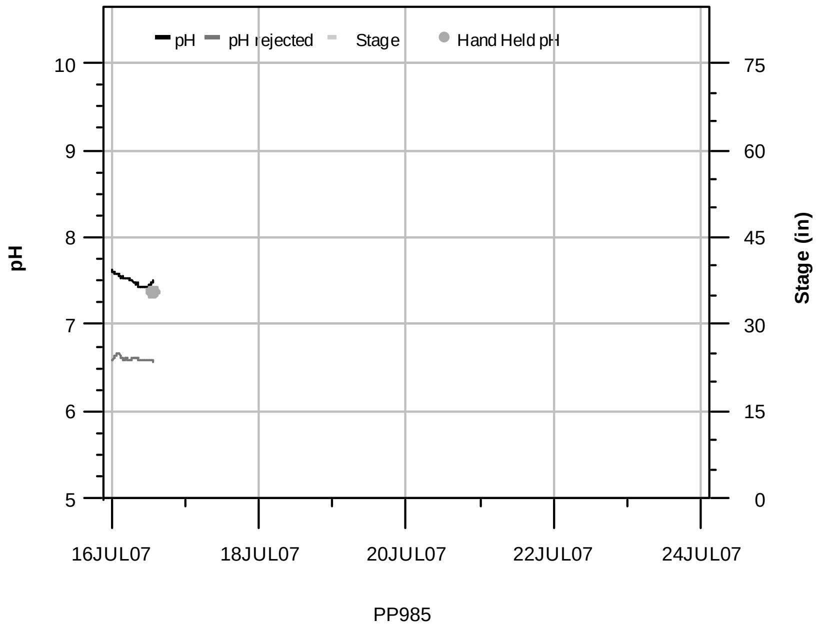

Figure F.34 Continuous pH at Site PP985, 07/16/07 to 07/24/07

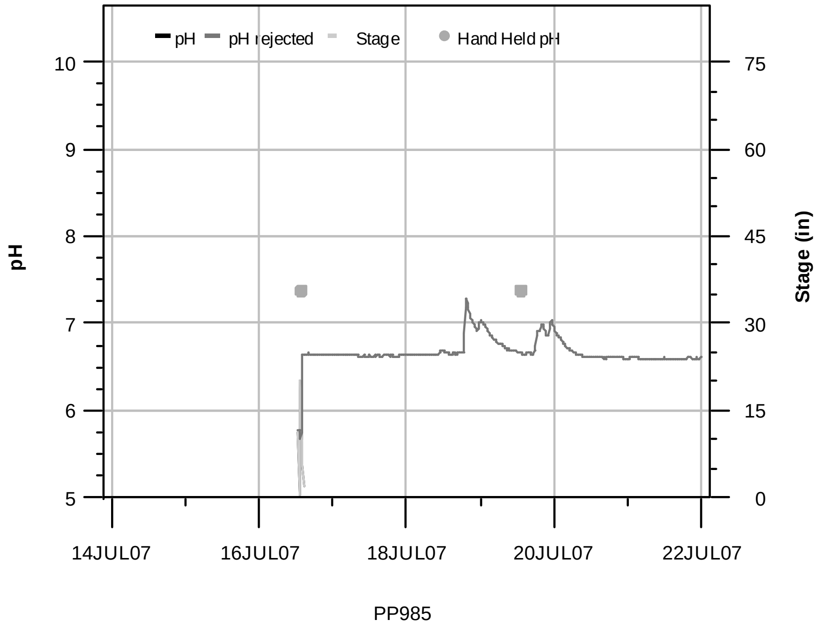

Figure F.35 Continuous pH at Site PP985, 07/14/07 to 07/22/07

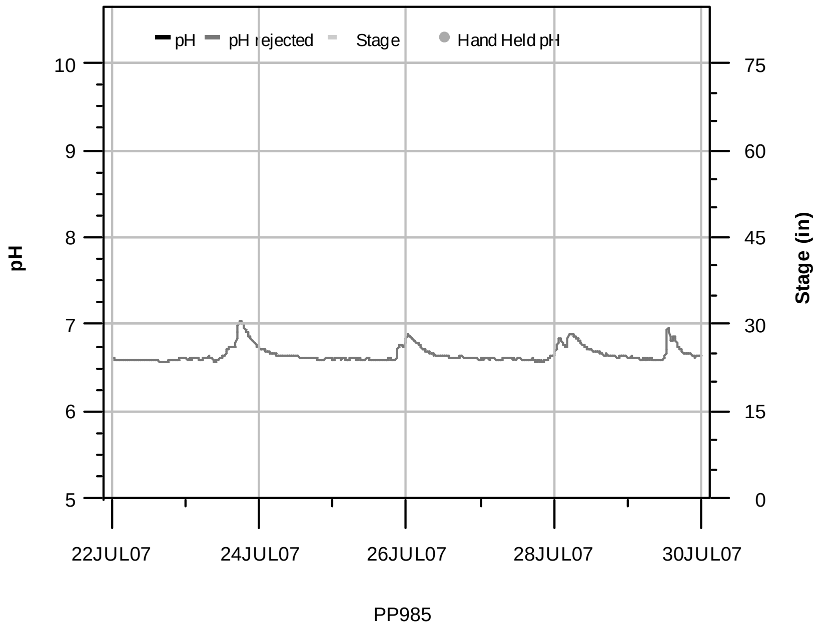

Figure F.36 Continuous pH at Site PP985, 07/22/07 to 07/30/07

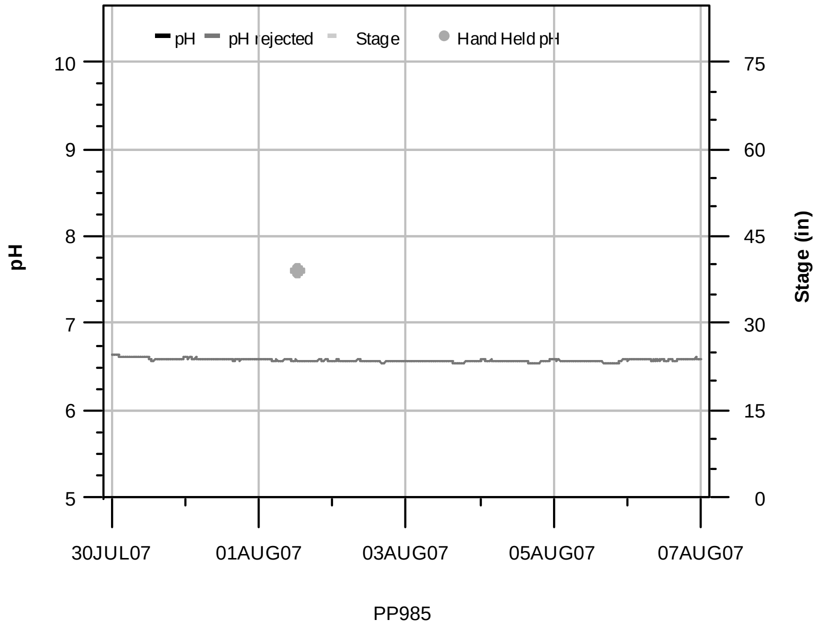

Figure F.37 Continuous pH at Site PP985, 07/30/07 to 08/07/07

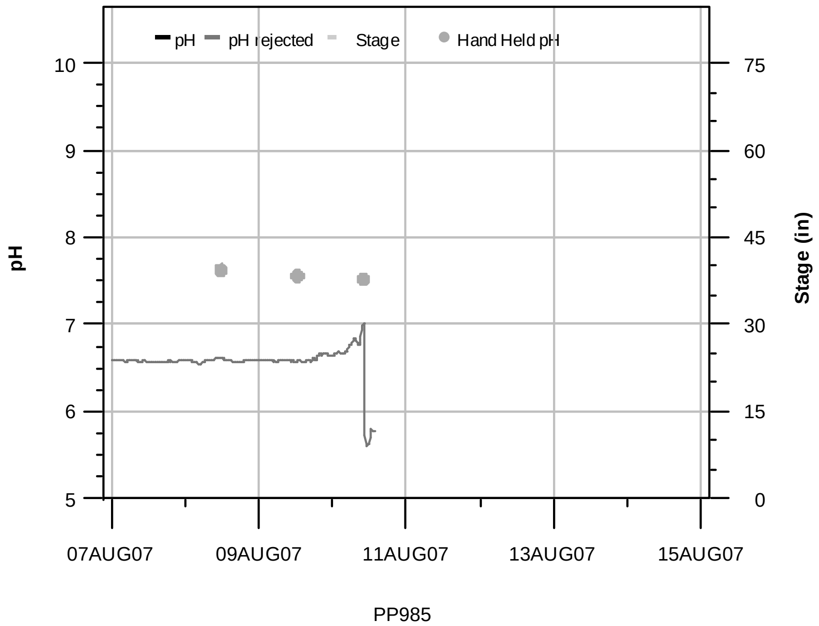

Figure F.38 Continuous pH at Site PP985, 08/07/07 to 08/15/07

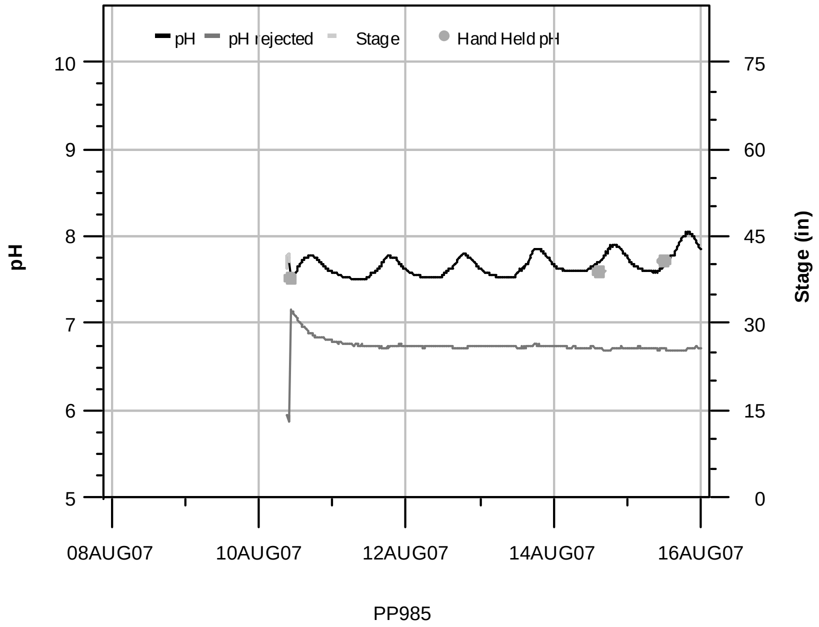

Figure F.39 Continuous pH at Site PP985, 08/08/07 to 08/16/07

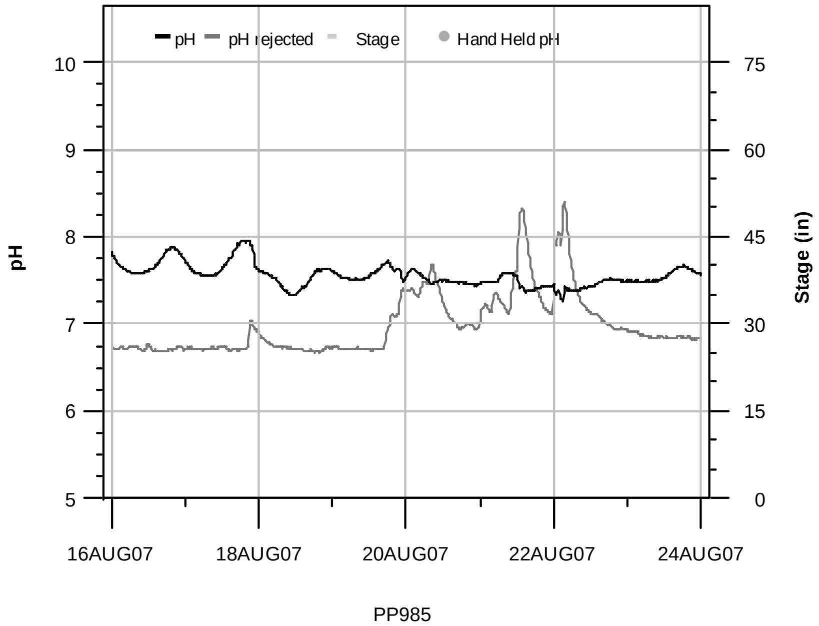

Figure F.40 Continuous pH at Site PP985, 08/16/07 to 08/24/07

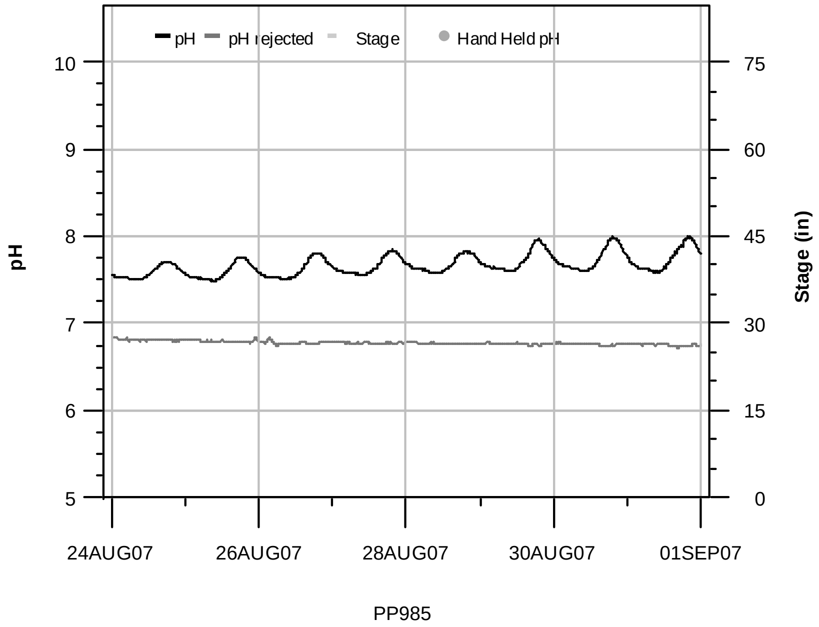

Figure F.41 Continuous pH at Site PP985, 08/24/07 to 09/01/07

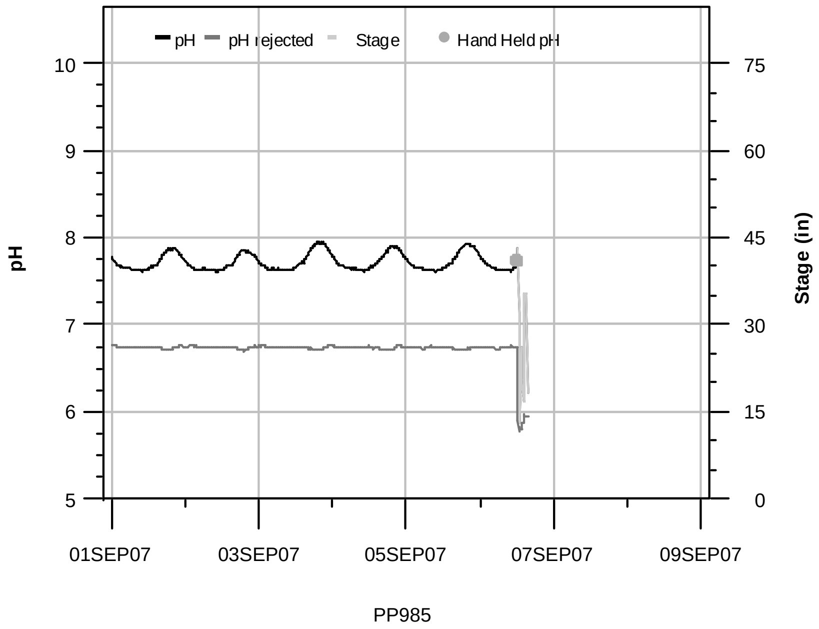

Figure F.42 Continuous pH at Site PP985, 09/01/07 to 09/09/07

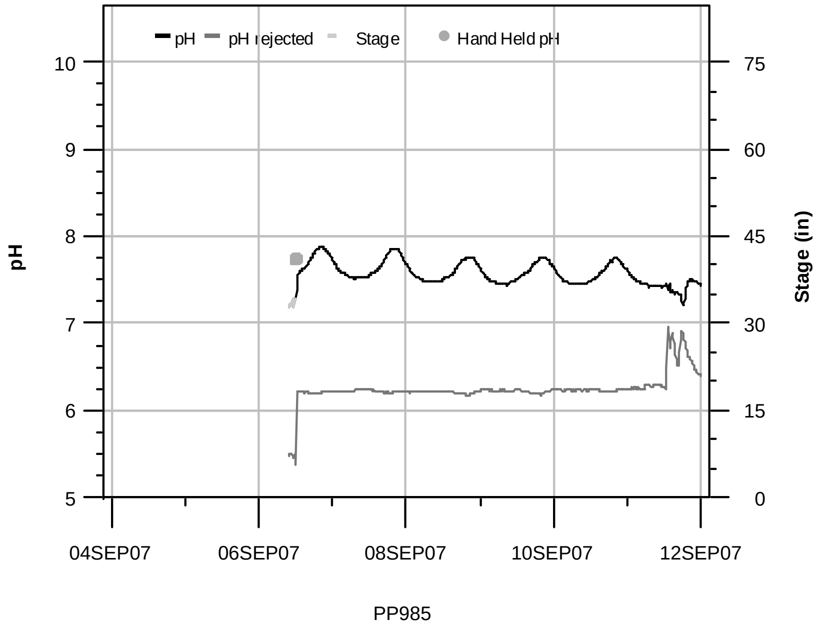

Figure F.43 Continuous pH at Site PP985, 09/04/07 to 09/12/07

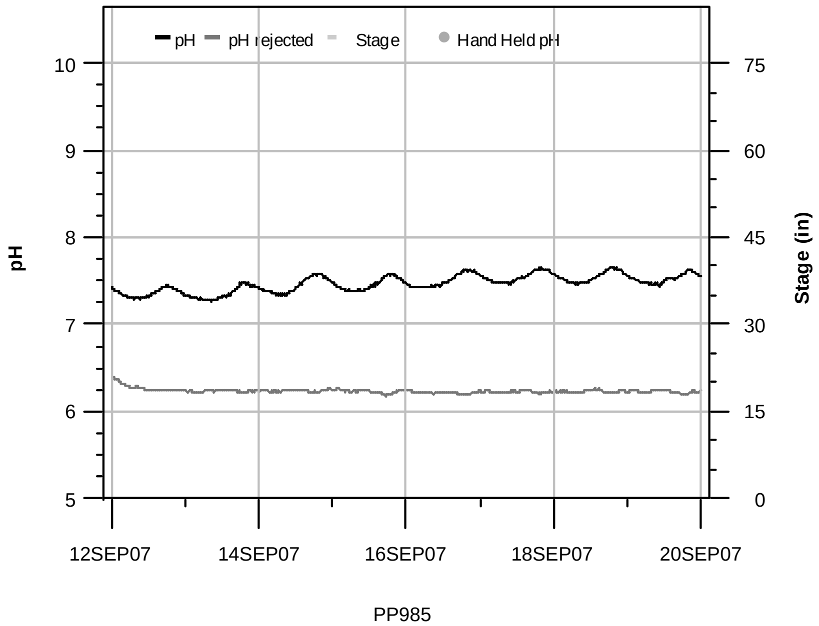

Figure F.44 Continuous pH at Site PP985, 09/12/07 to 09/20/07

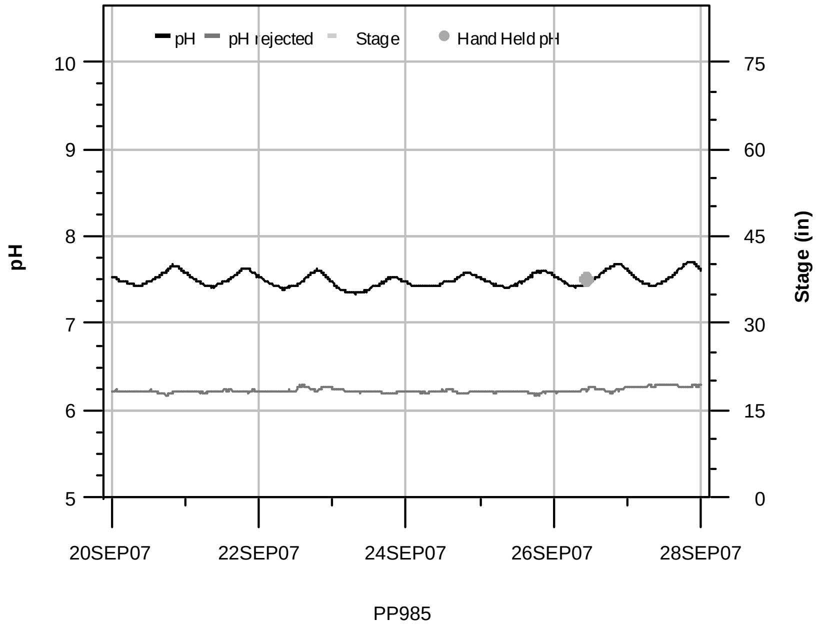

Figure F.45 Continuous pH at Site PP985, 09/20/07 to 09/28/07

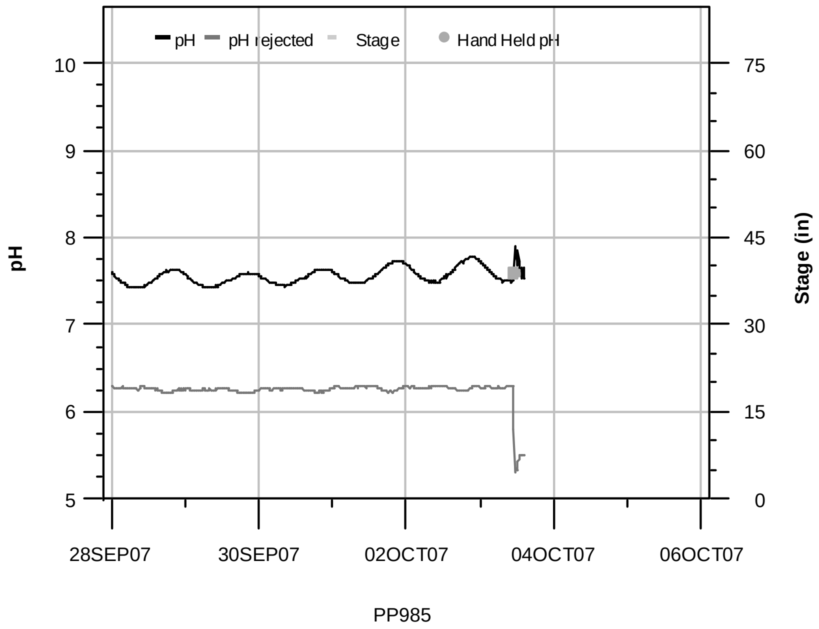

Figure F.46 Continuous pH at Site PP985, 09/28/07 to 10/06/07

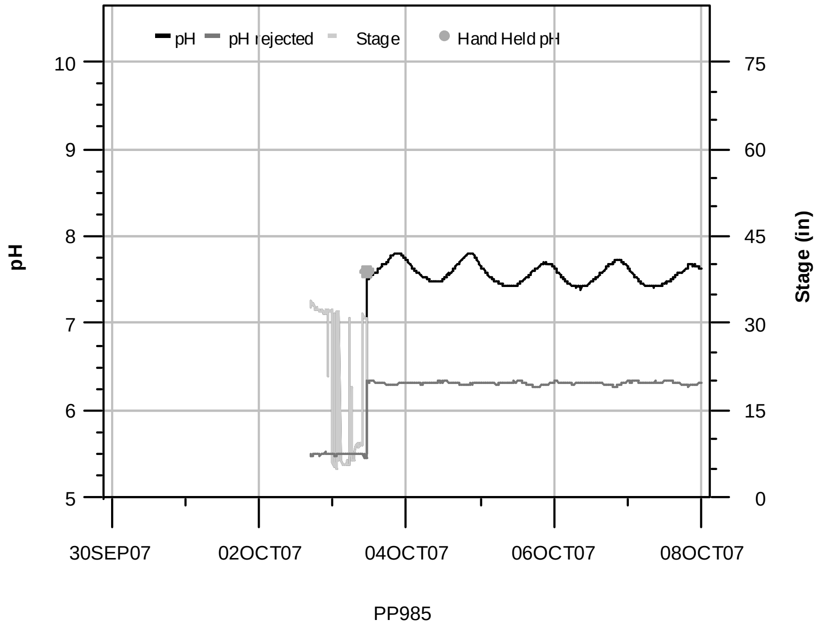

Figure F.47 Continuous pH at Site PP985, 09/30/07 to 10/08/07

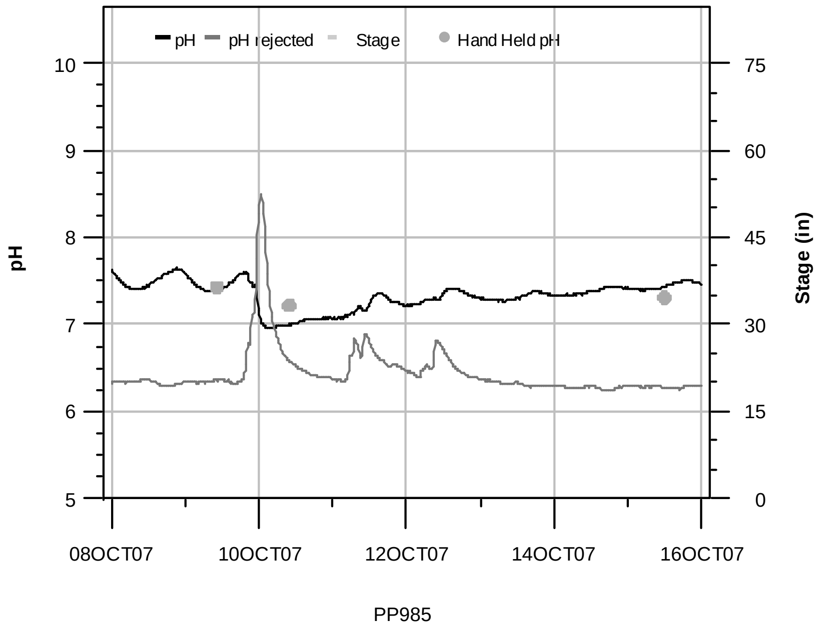

Figure F.48 Continuous pH at Site PP985, 10/08/07 to 10/16/07

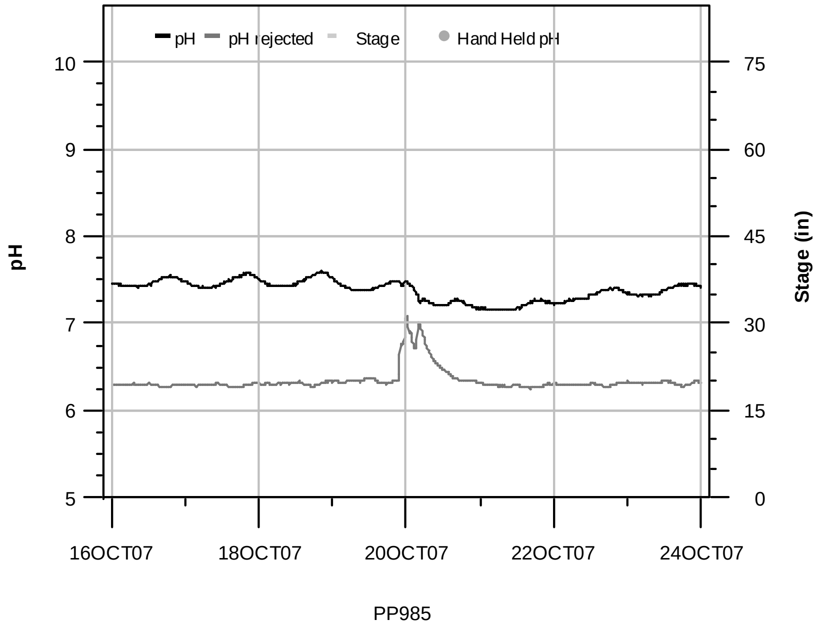

Figure F.49 Continuous pH at Site PP985, 10/16/07 to 10/24/07

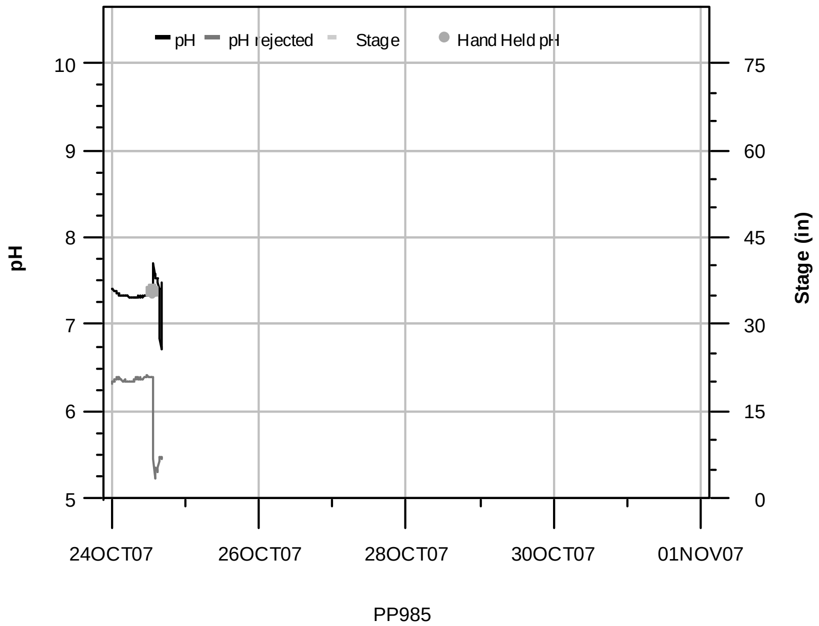

Figure F.50 Continuous pH at Site PP985, 10/24/07 to 11/01/07

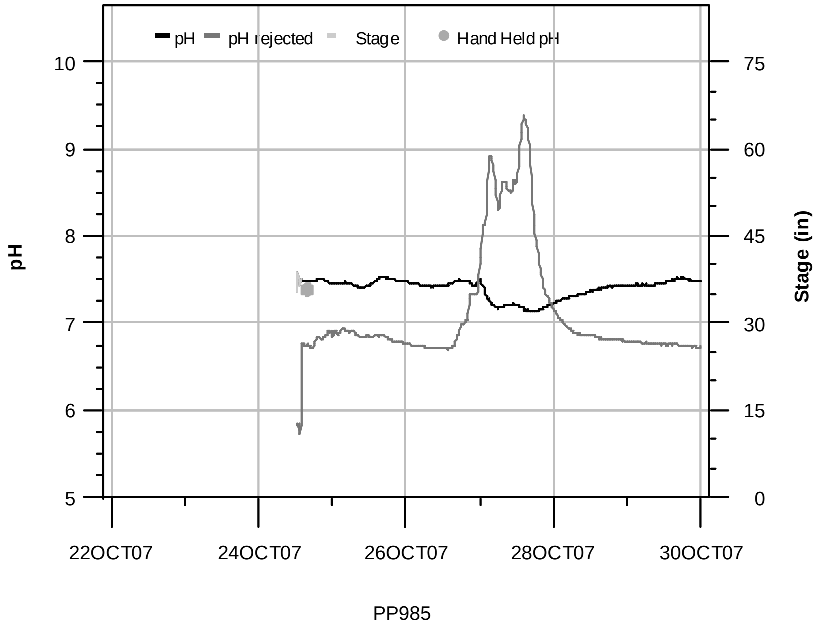

Figure F.51 Continuous pH at Site PP985, 10/22/07 to 10/30/07

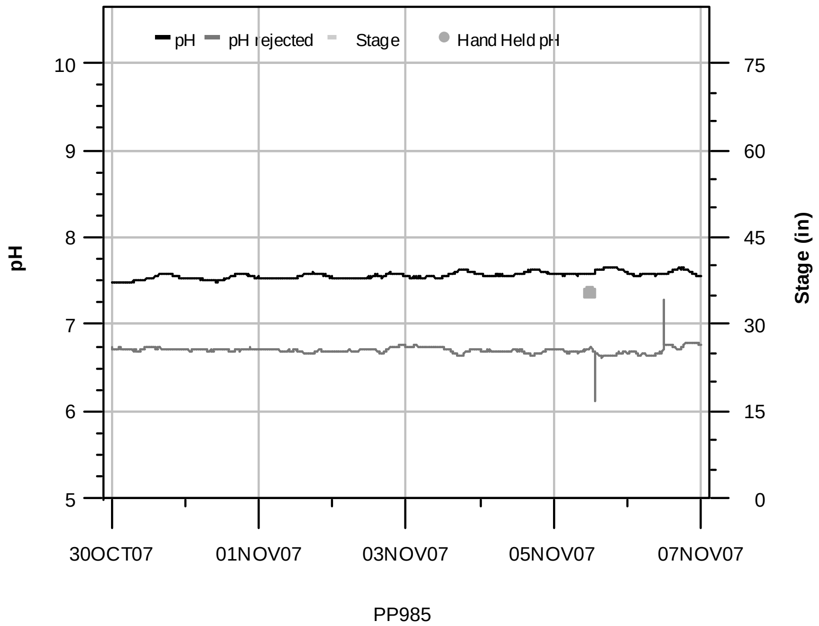

Figure F.52 Continuous pH at Site PP985, 10/30/07 to 11/07/07

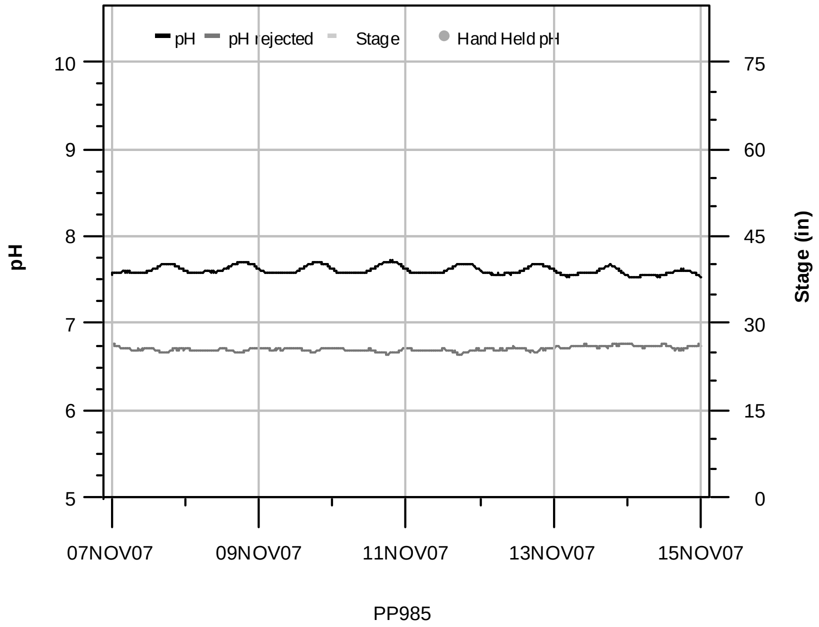

Figure F.53 Continuous pH at Site PP985, 11/07/07 to 11/15/07

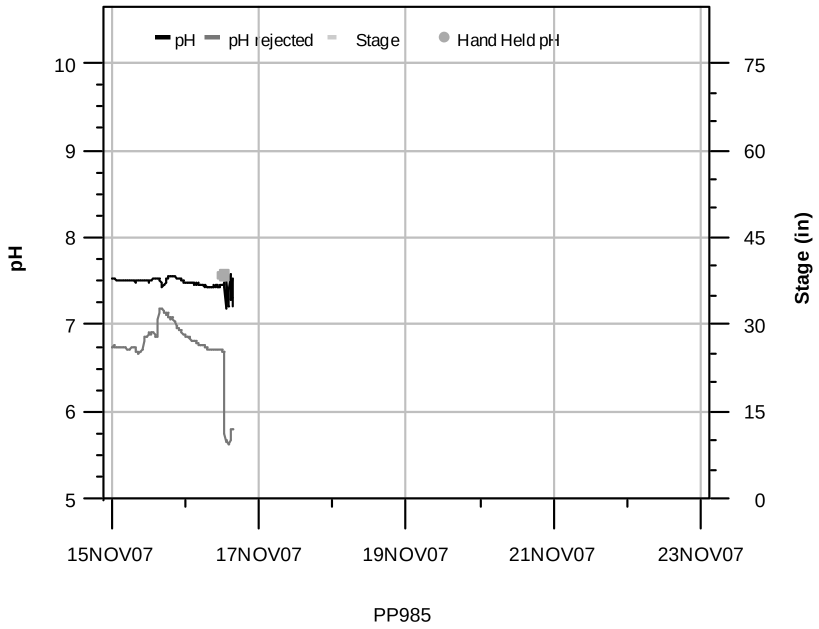

Figure F.54 Continuous pH at Site PP985, 11/15/07 to 11/23/07

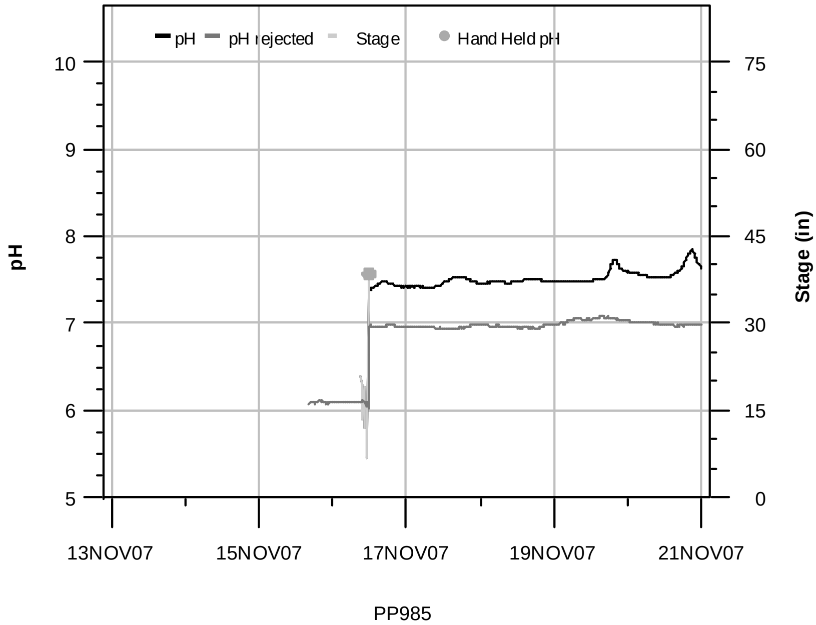

Figure F.55 Continuous pH at Site PP985, 11/13/07 to 11/21/07

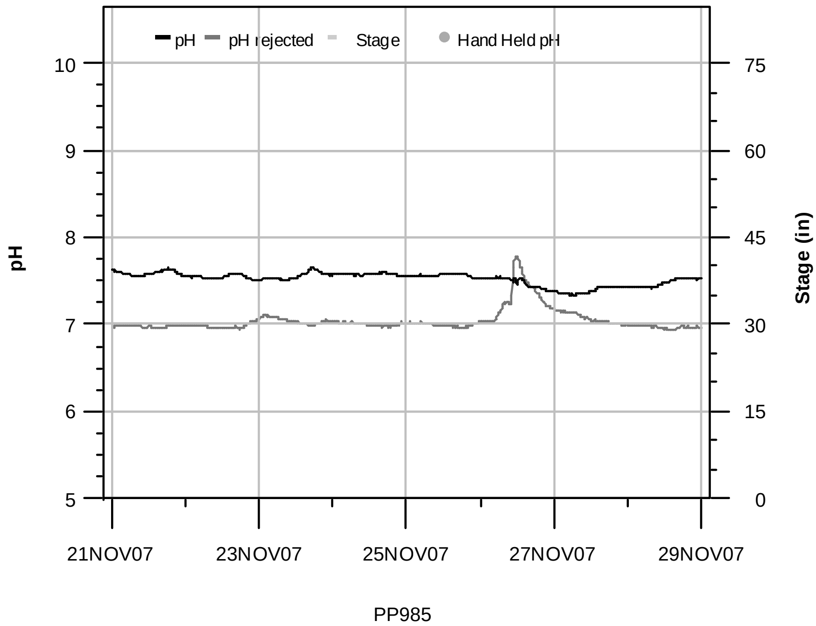

Figure F.56 Continuous pH at Site PP985, 11/21/07 to 11/29/07

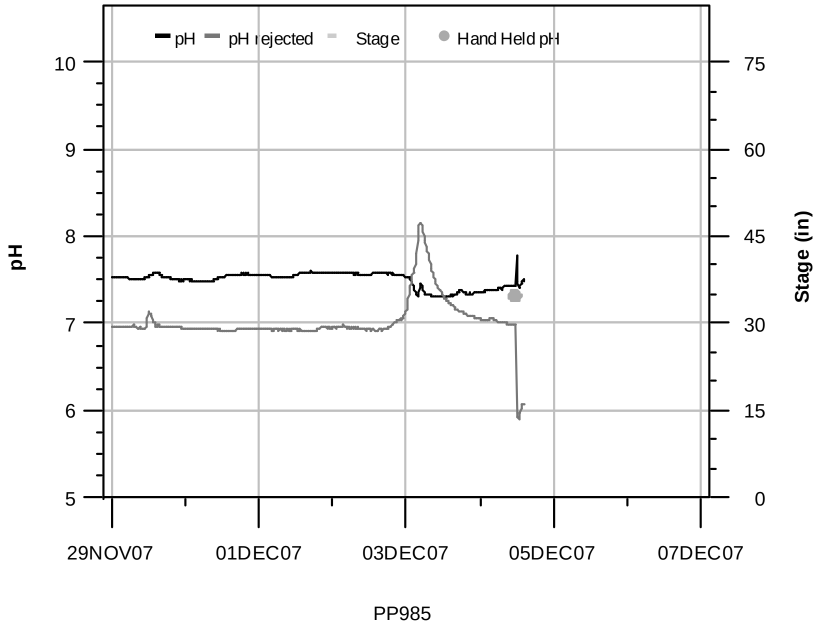

Figure F.57 Continuous pH at Site PP985, 11/29/07 to 12/07/07

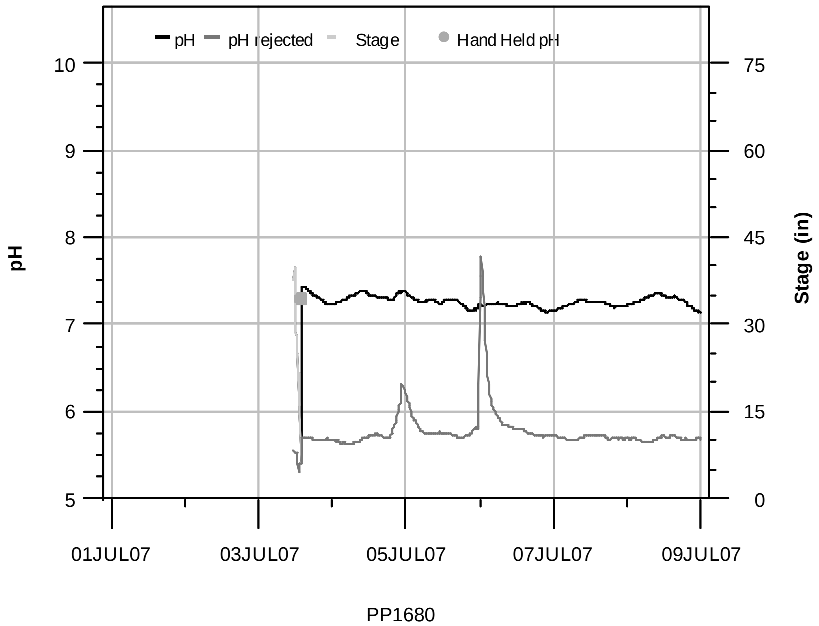

Figure F.58 Continuous pH at Site PP1680, 07/01/07 to 07/09/07

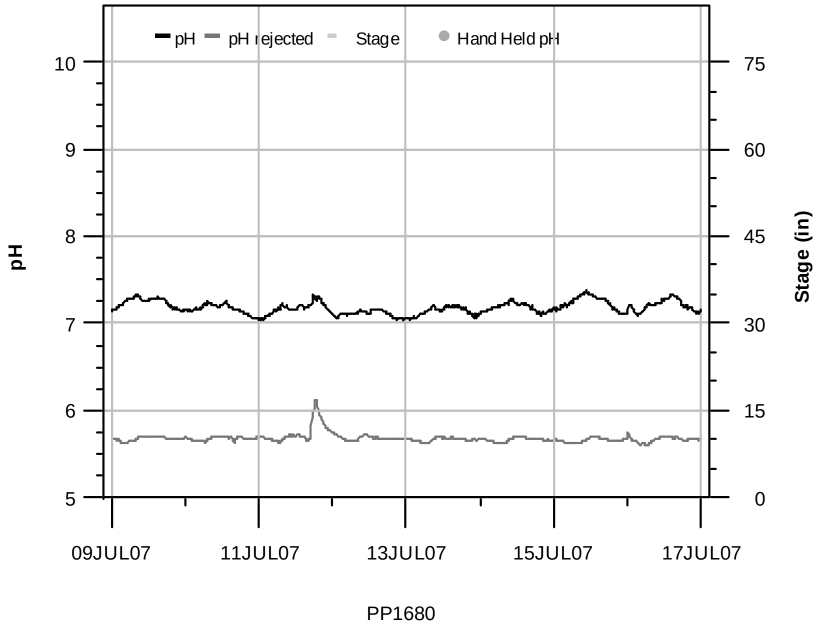

Figure F.59 Continuous pH at Site PP1680, 07/09/07 to 07/17/07

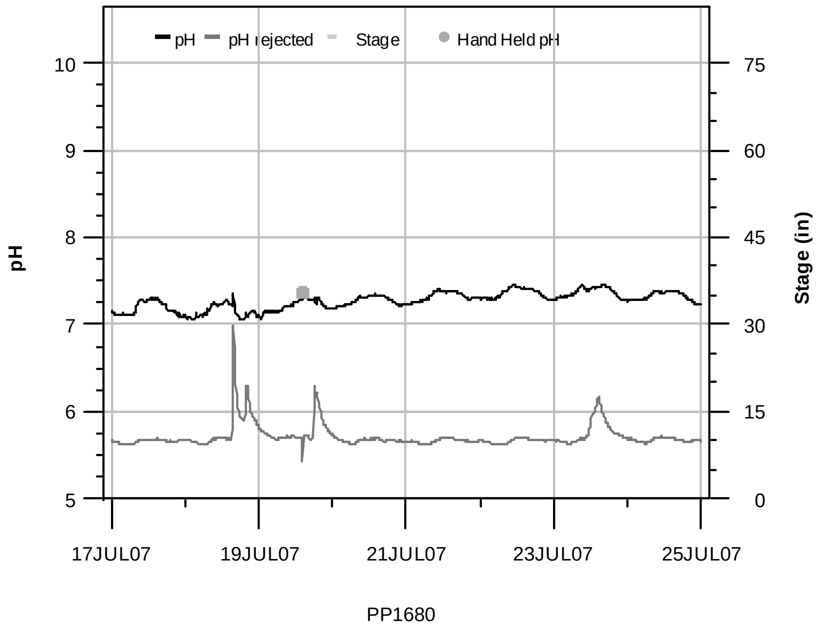

Figure F.60 Continuous pH at Site PP1680, 07/17/07 to 07/25/07

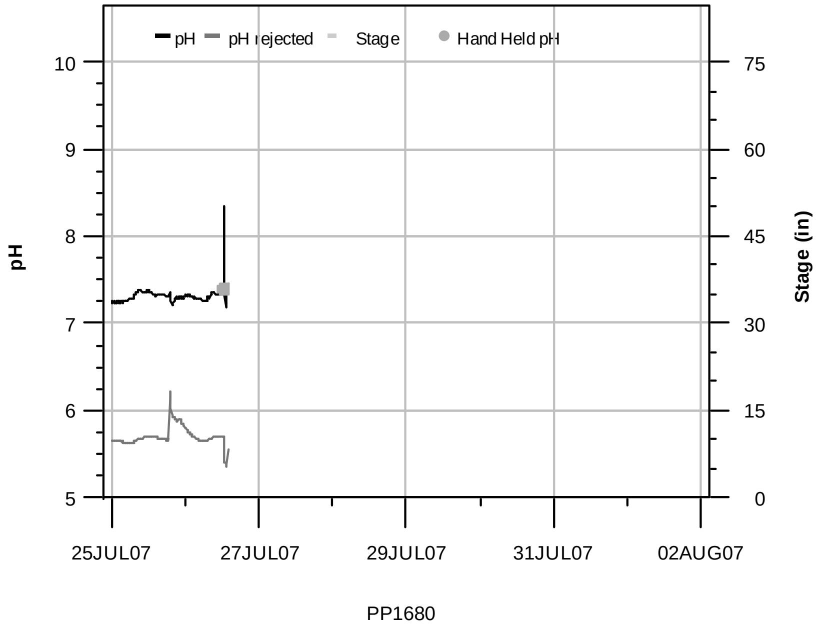

Figure F.61 Continuous pH at Site PP1680, 07/25/07 to 08/02/07

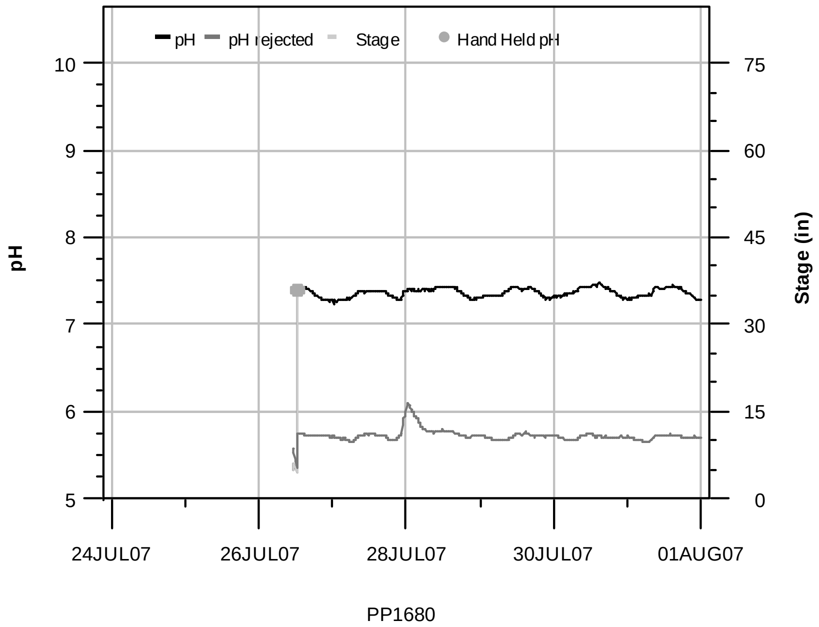

Figure F.62 Continuous pH at Site PP1680, 07/24/07 to 08/01/07

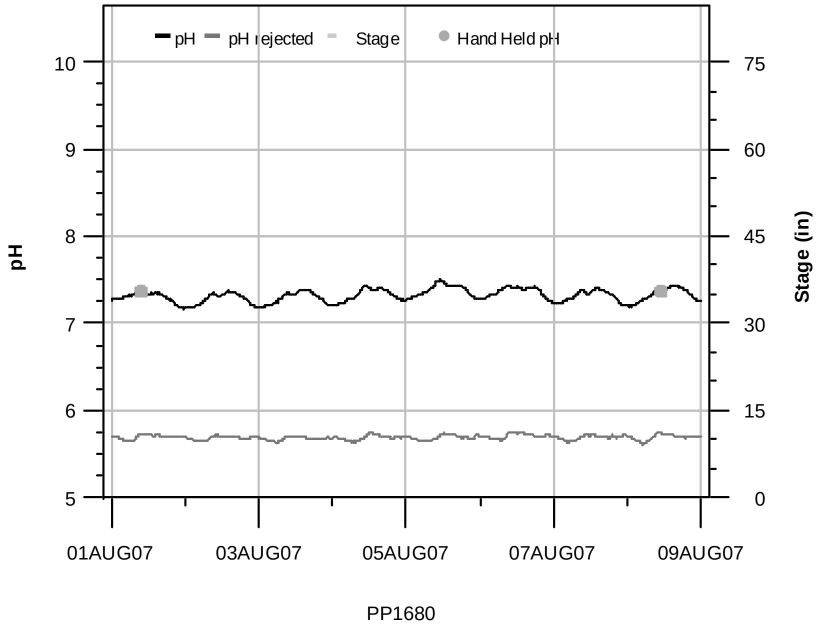

Figure F.63 Continuous pH at Site PP1680, 08/01/07 to 08/09/07

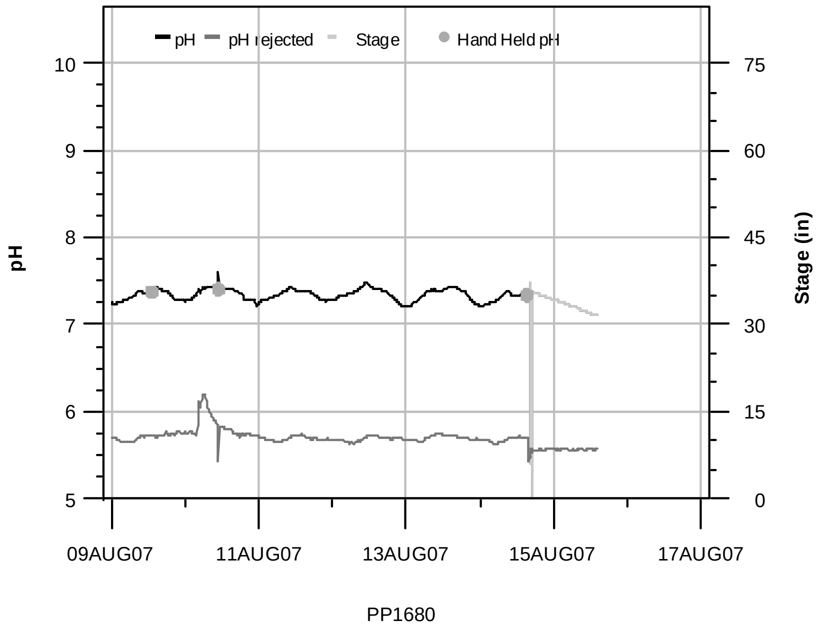

Figure F.64 Continuous pH at Site PP1680, 08/09/07 to 08/17/07

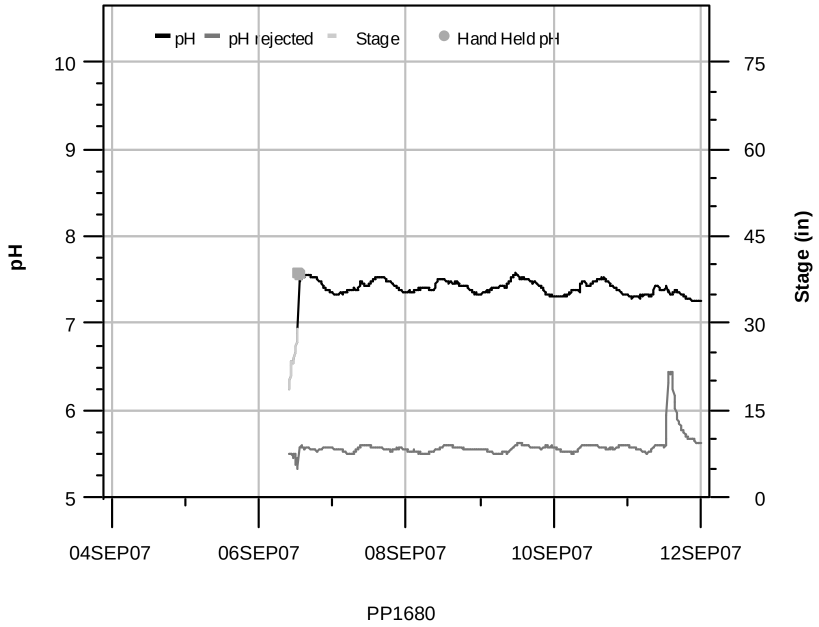

Figure F.65 Continuous pH at Site PP1680, 09/04/07 to 09/12/07

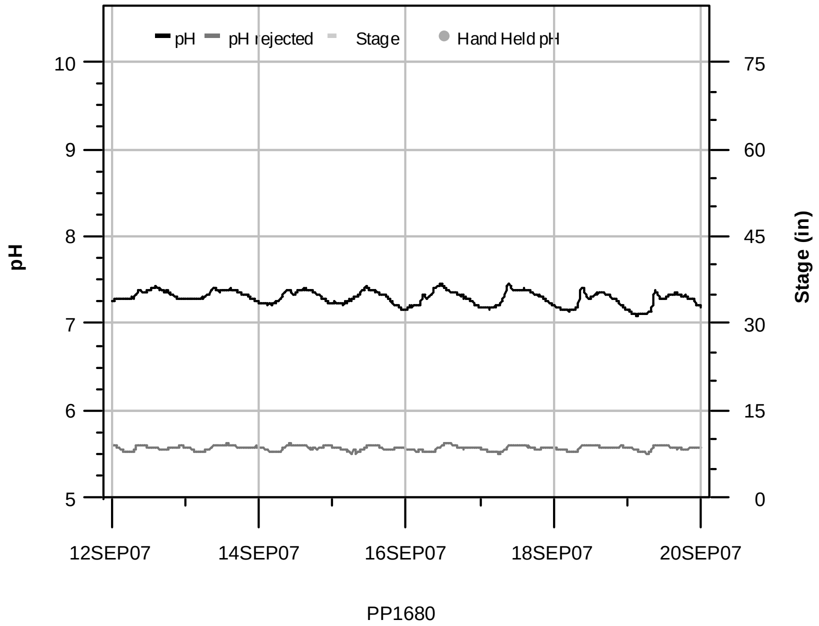

Figure F.66 Continuous pH at Site PP1680, 09/12/07 to 09/20/07

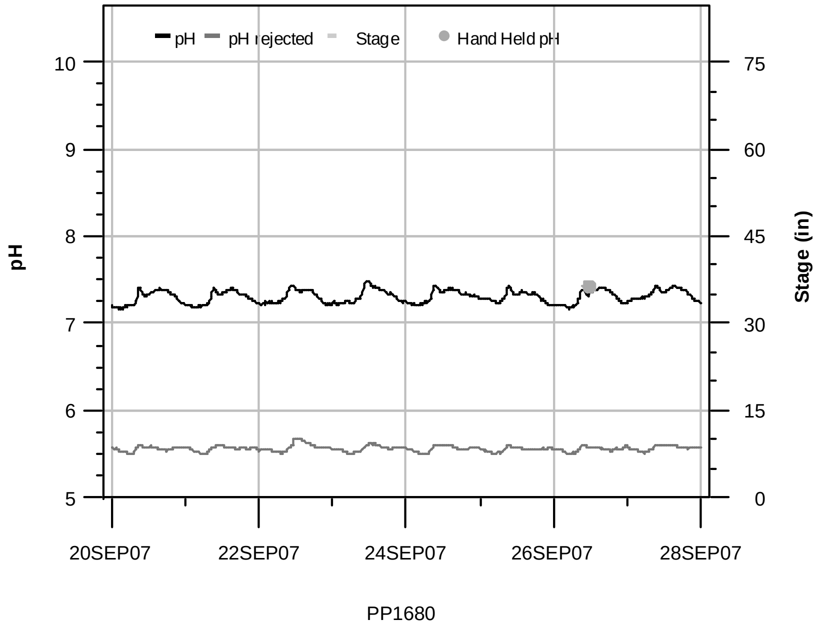

Figure F.67 Continuous pH at Site PP1680, 09/20/07 to 09/28/07

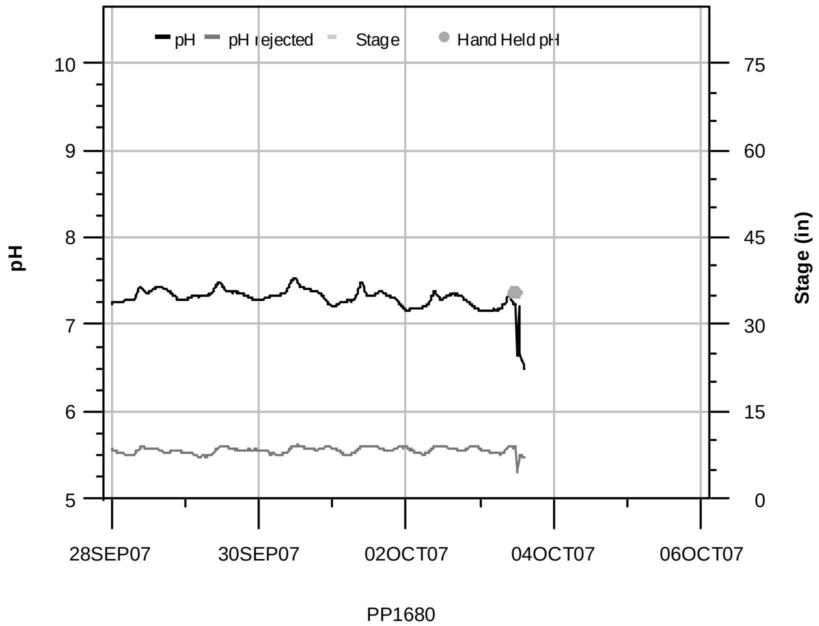

Figure F.68 Continuous pH at Site PP1680, 09/28/07 to 10/06/07

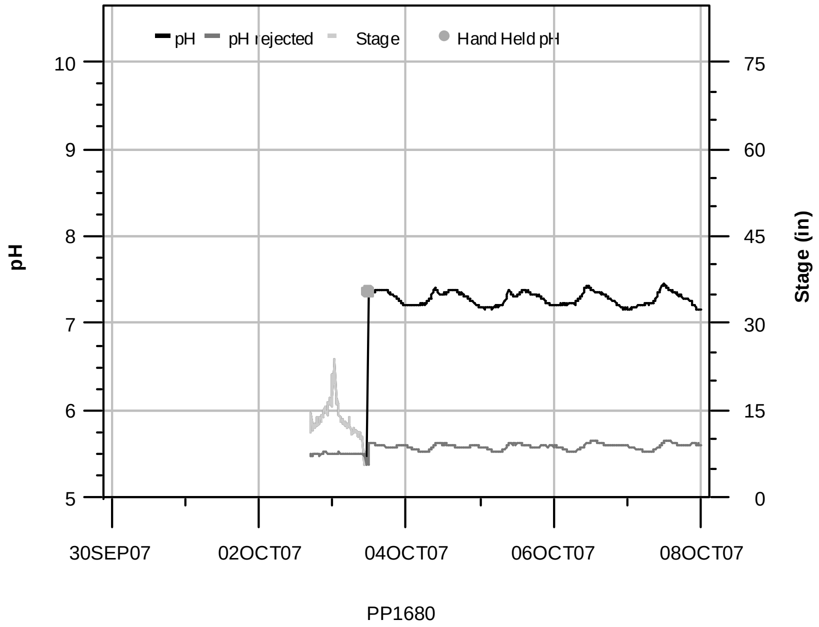

Figure F.69 Continuous pH at Site PP1680, 09/30/07 to 10/08/07

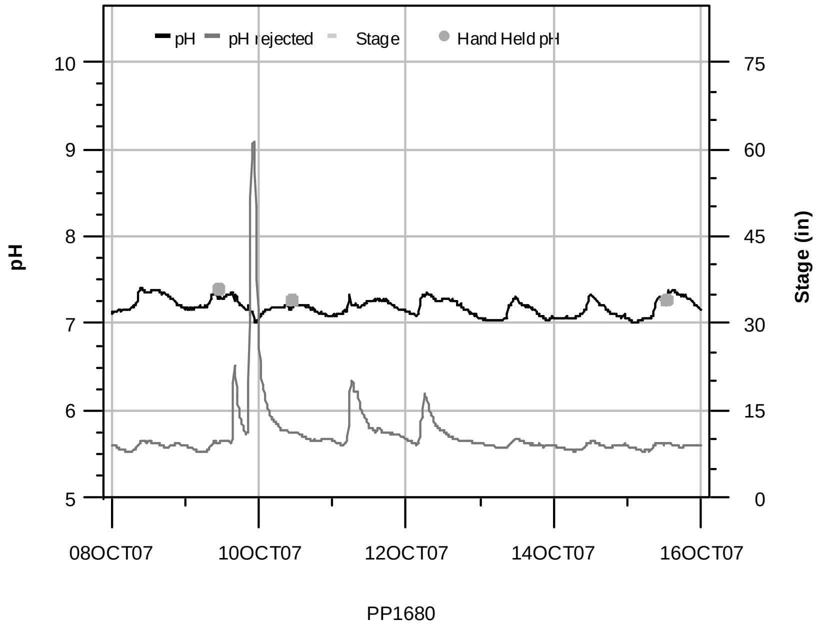

Figure F.70 Continuous pH at Site PP1680, 10/08/07 to 10/16/07

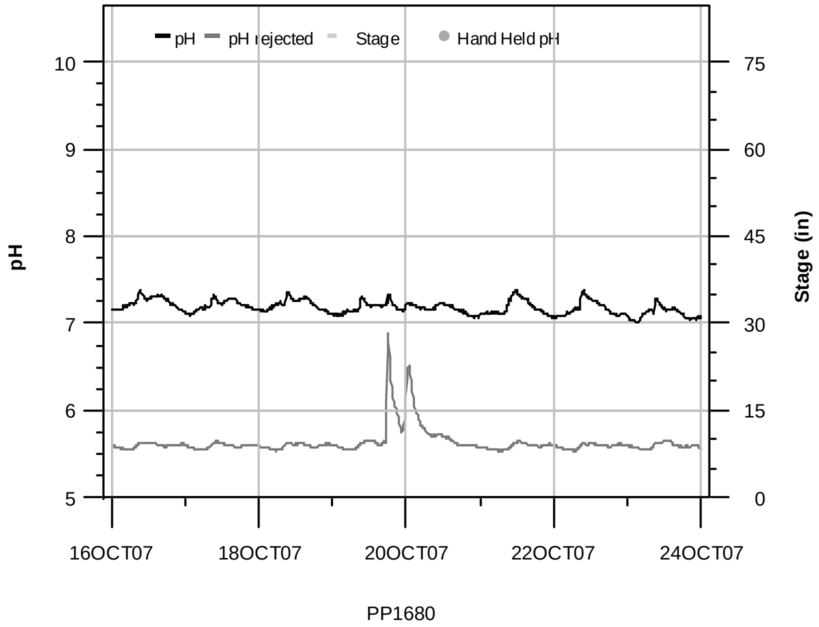

Figure F.71 Continuous pH at Site PP1680, 10/16/07 to 10/24/07

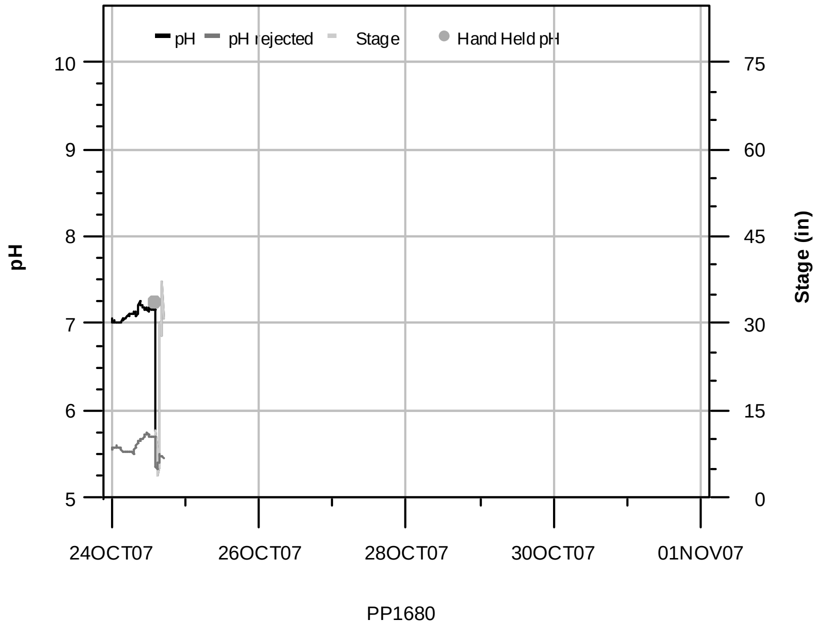

Figure F.72 Continuous pH at Site PP1680, 10/24/07 to 11/01/07

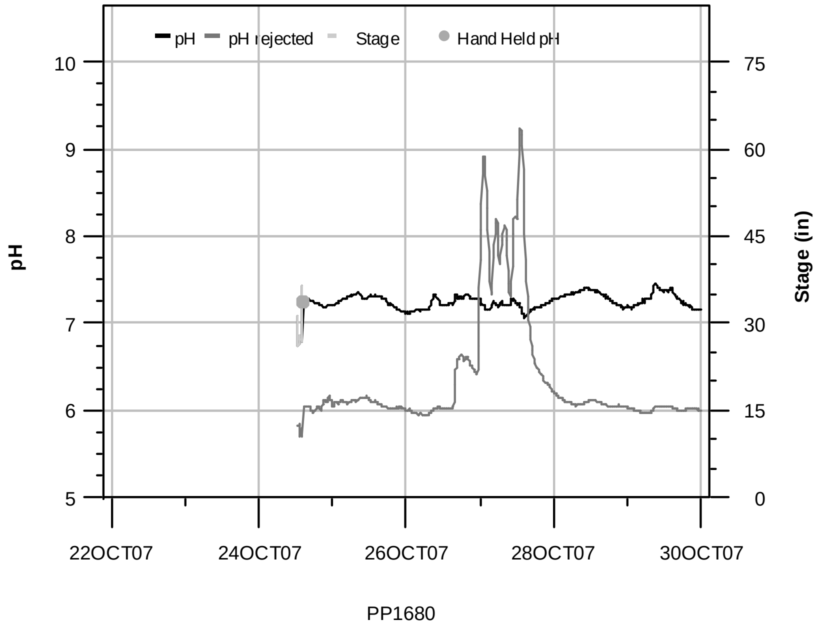

Figure F.73 Continuous pH at Site PP1680, 10/22/07 to 10/30/07

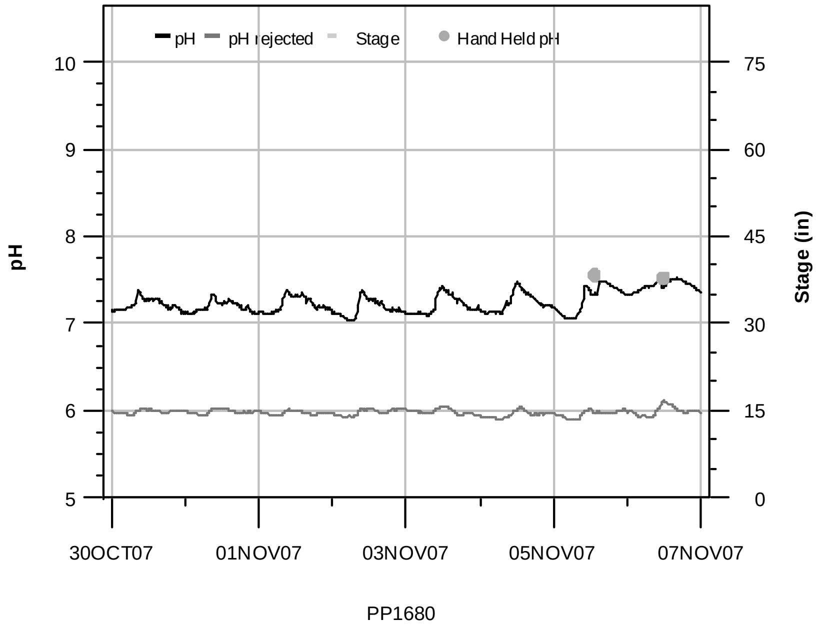

Figure F.74 Continuous pH at Site PP1680, 10/30/07 to 11/07/07

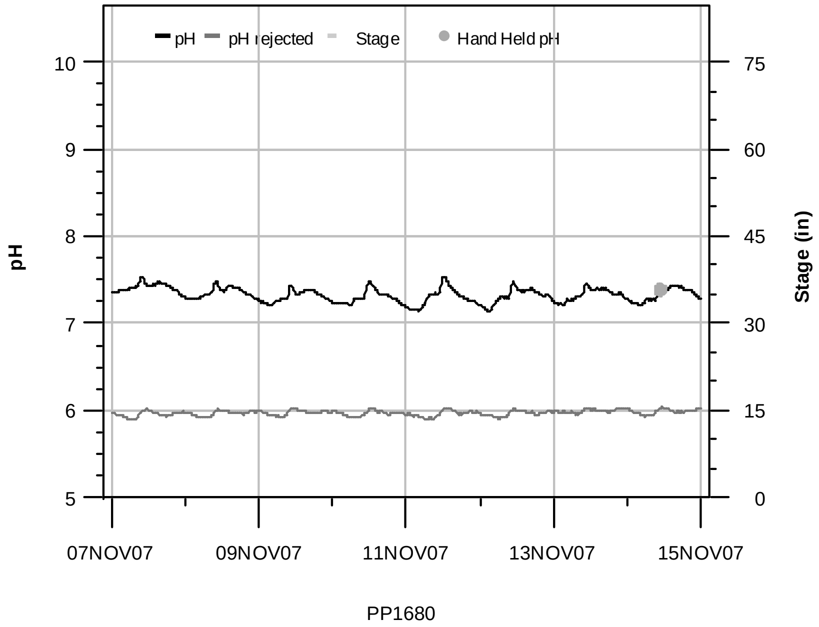

Figure F.75 Continuous pH at Site PP1680, 11/07/07 to 11/15/07

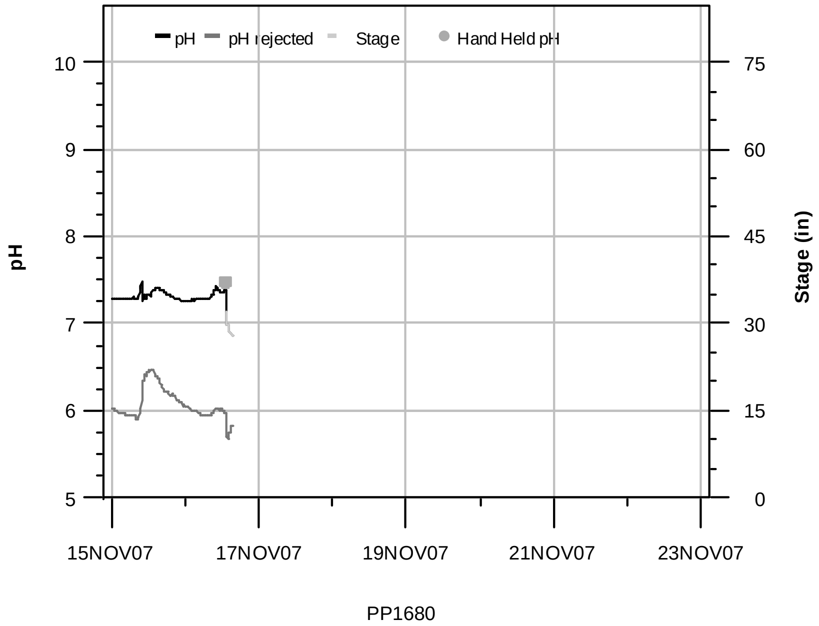

Figure F.76 Continuous pH at Site PP1680, 11/15/07 to 11/23/07

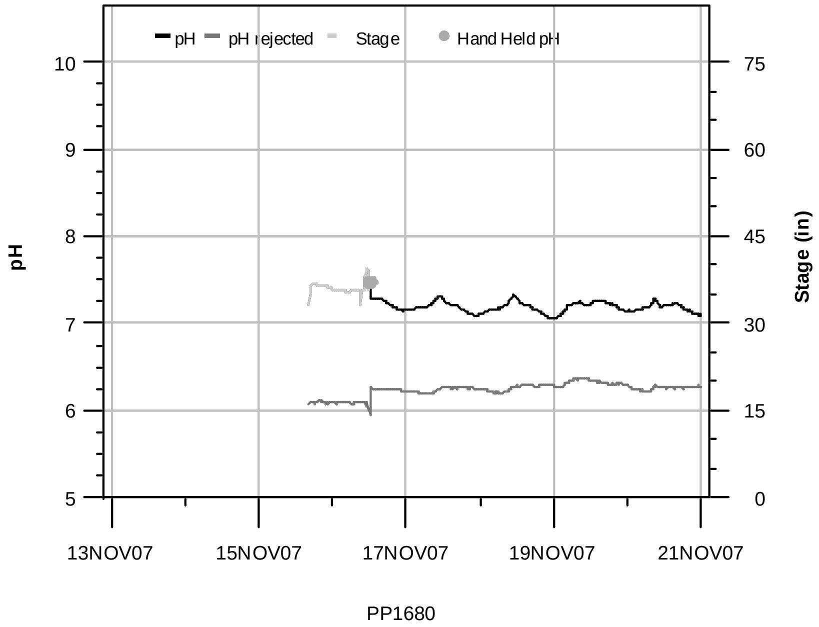

Figure F.77 Continuous pH at Site PP1680, 11/13/07 to 11/21/07

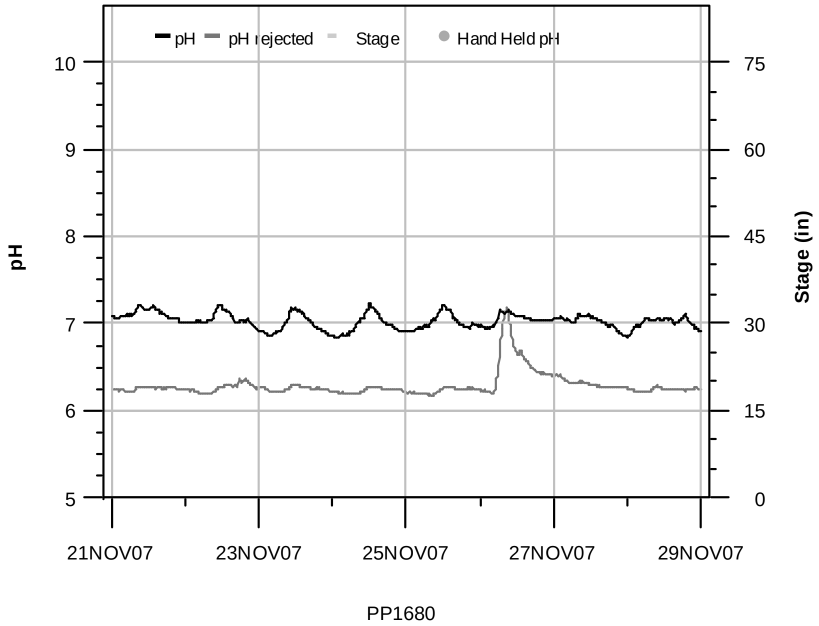

Figure F.78 Continuous pH at Site PP1680, 11/21/07 to 11/29/07

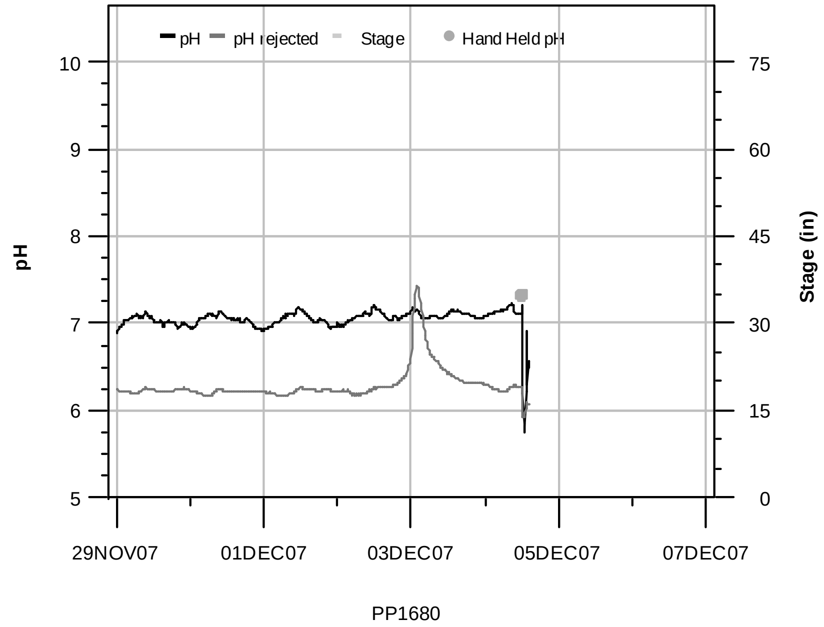

Figure F.79 Continuous pH at Site PP1680, 11/29/07 to 12/07/07

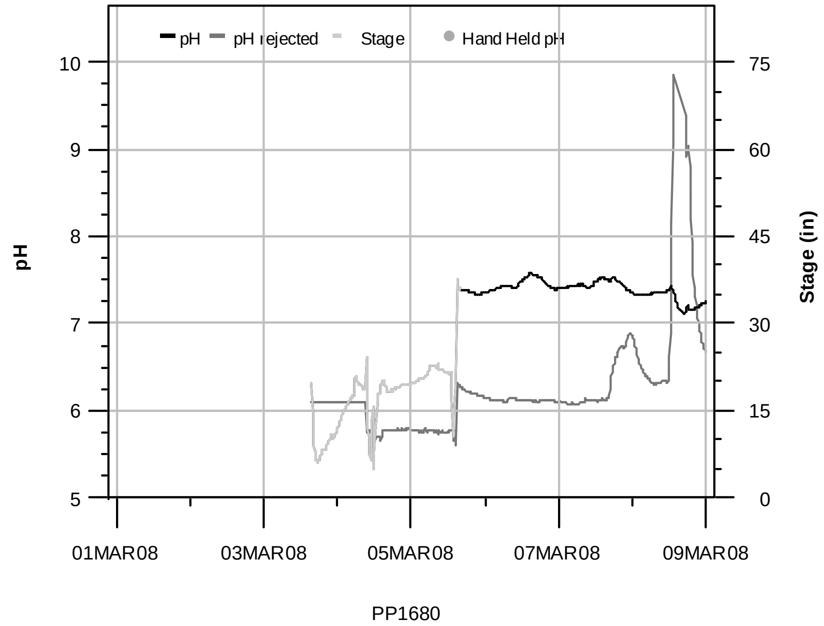

Figure F.80 Continuous pH at Site PP1680, 03/01/08 to 03/09/08

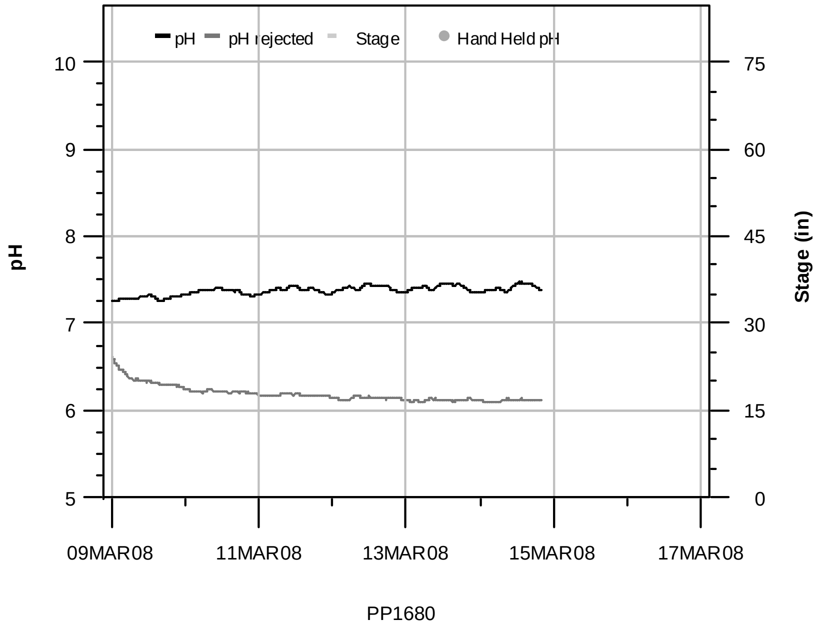

Figure F.81 Continuous pH at Site PP1680, 03/09/08 to 03/17/08

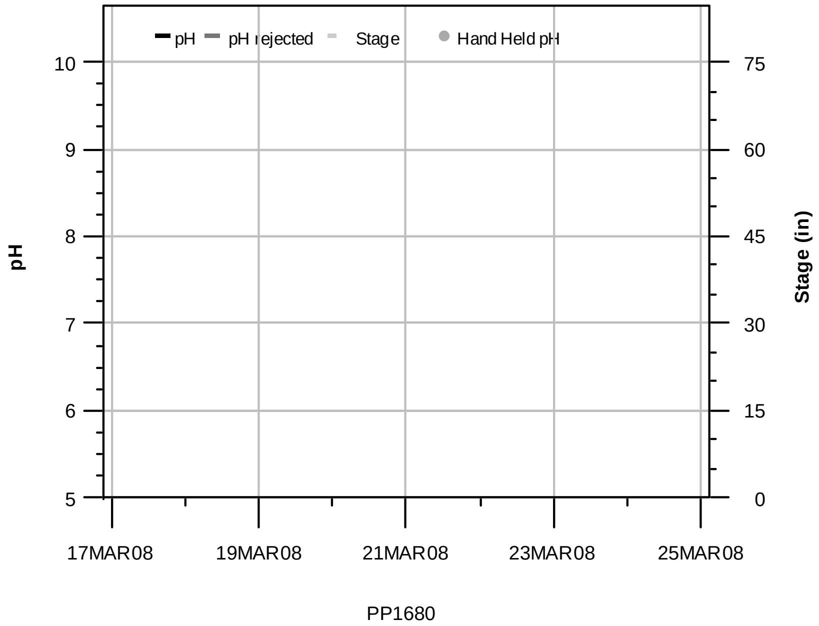

Figure F.82 Continuous pH at Site PP1680, 03/17/08 to 03/25/08

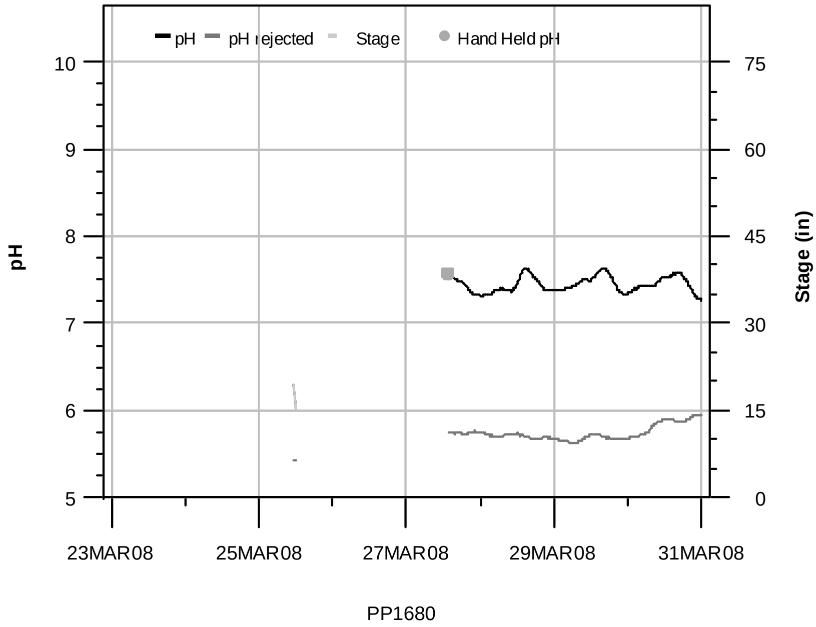

Figure F.83 Continuous pH at Site PP1680, 03/23/08 to 03/31/08

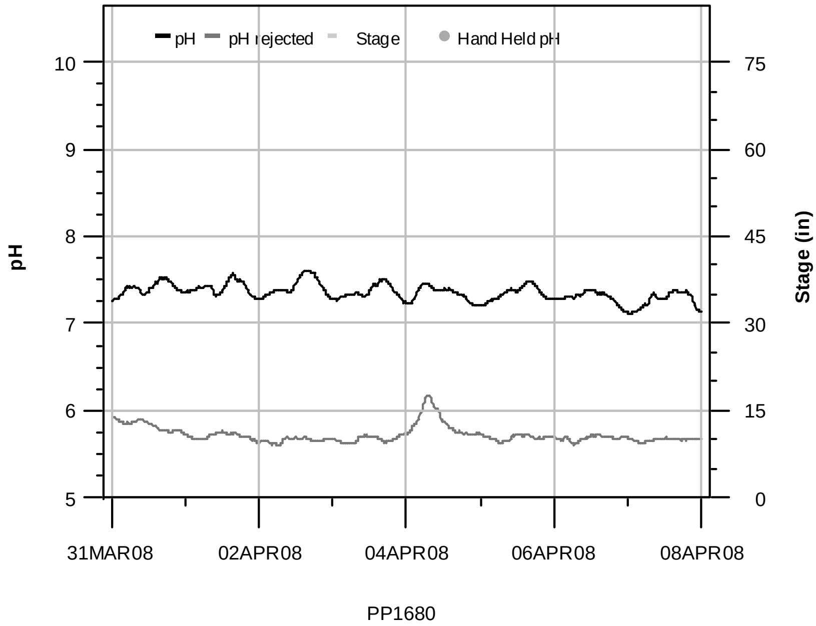

Figure F.84 Continuous pH at Site PP1680, 03/31/08 to 04/08/08

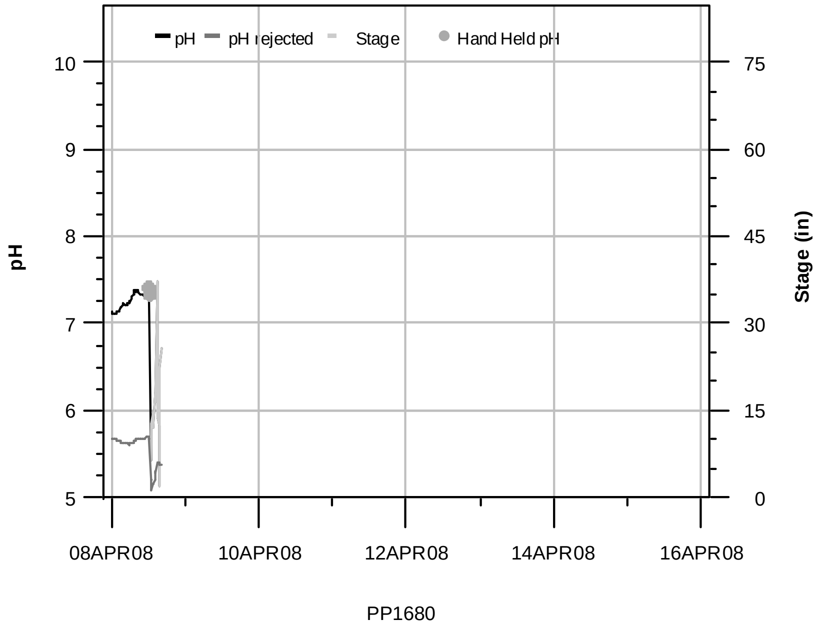

Figure F.85 Continuous pH at Site PP1680, 04/08/08 to 04/16/08

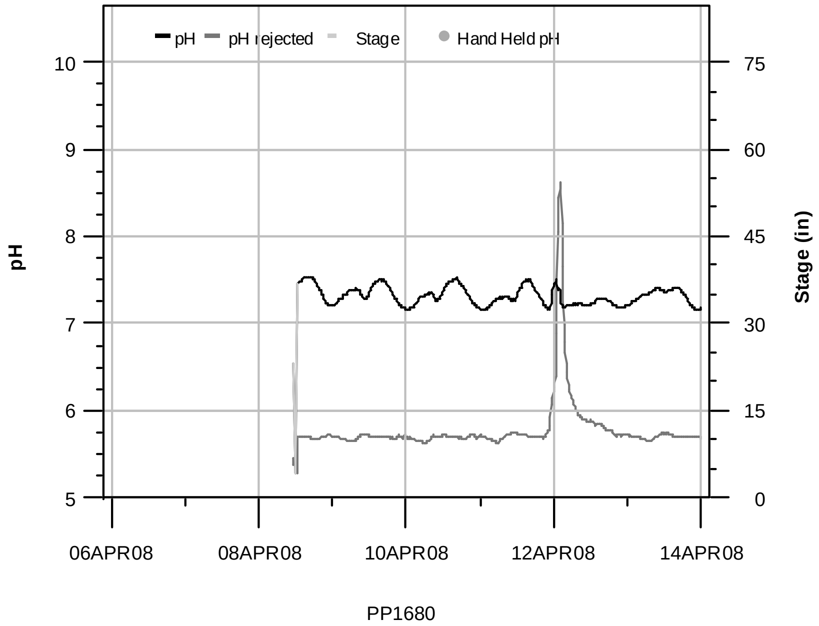

Figure F.86 Continuous pH at Site PP1680, 04/06/08 to 04/14/08

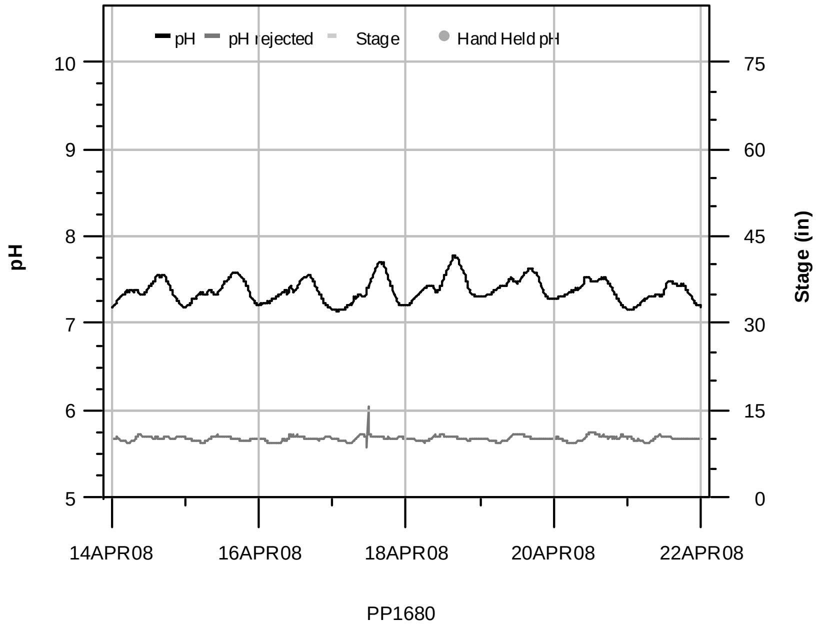

Figure F.87 Continuous pH at Site PP1680, 04/14/08 to 04/22/08

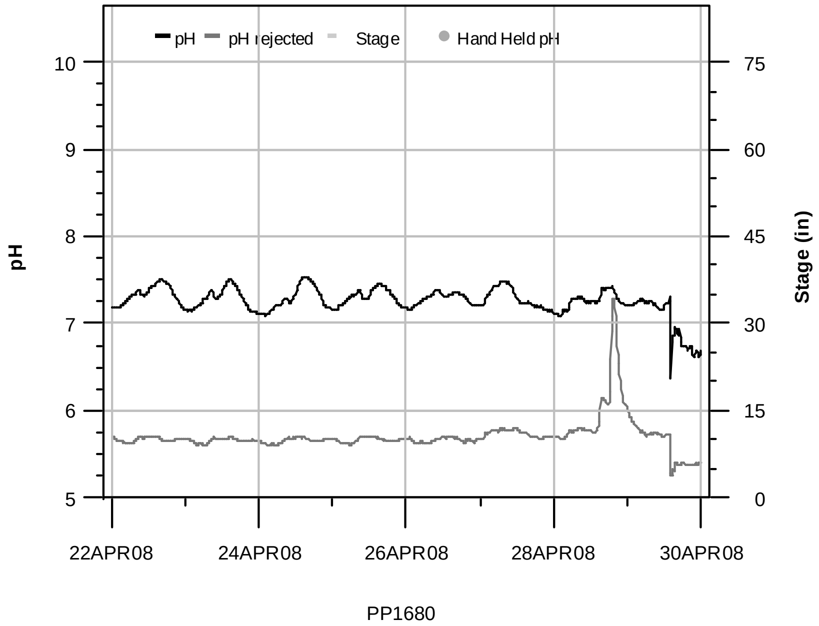

Figure F.88 Continuous pH at Site PP1680, 04/22/08 to 04/30/08

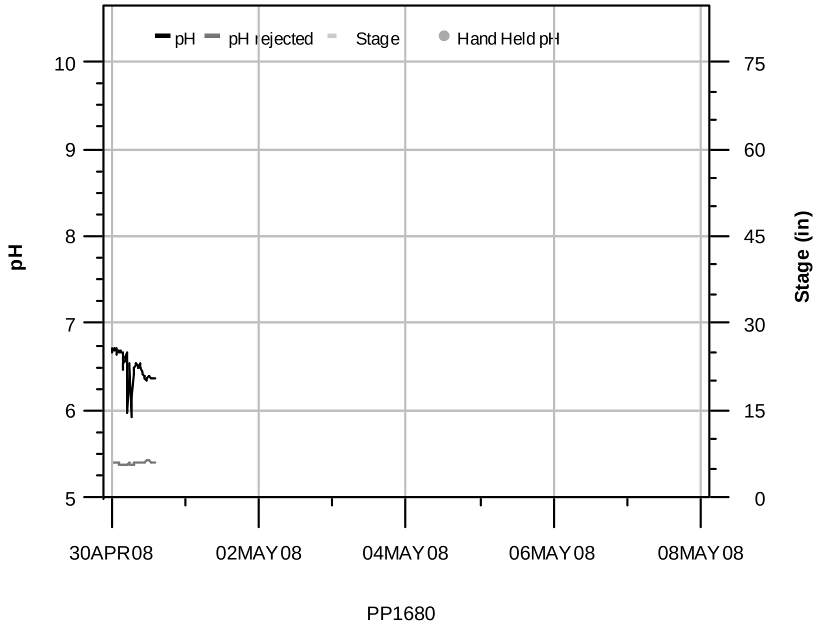

Figure F.89 Continuous pH at Site PP1680, 04/30/08 to 05/08/08

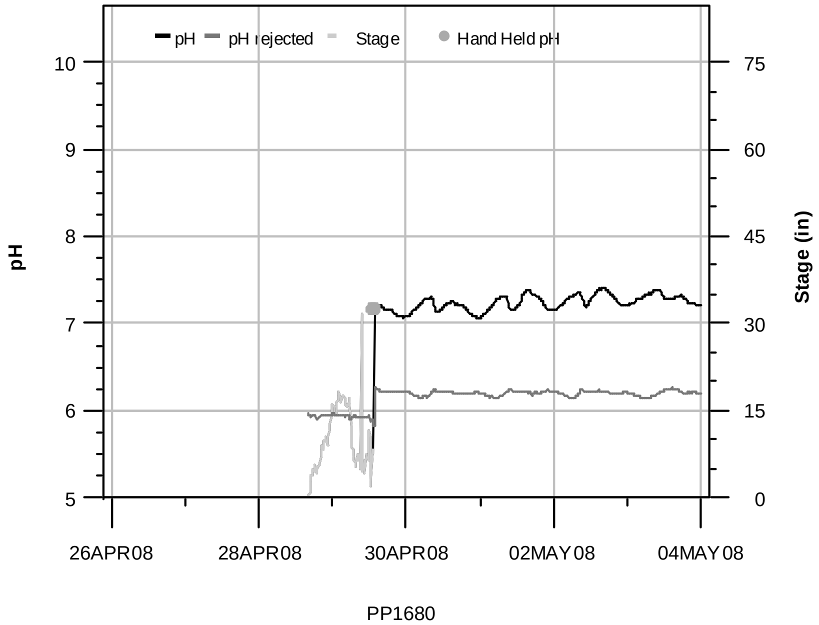

Figure F.90 Continuous pH at Site PP1680, 04/26/08 to 05/04/08

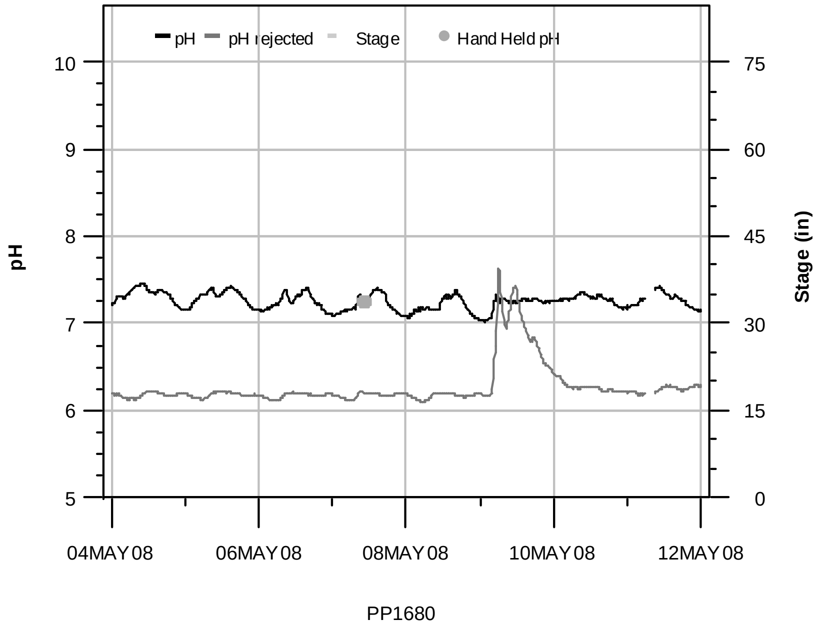

Figure F.91 Continuous pH at Site PP1680, 05/04/08 to 05/12/08

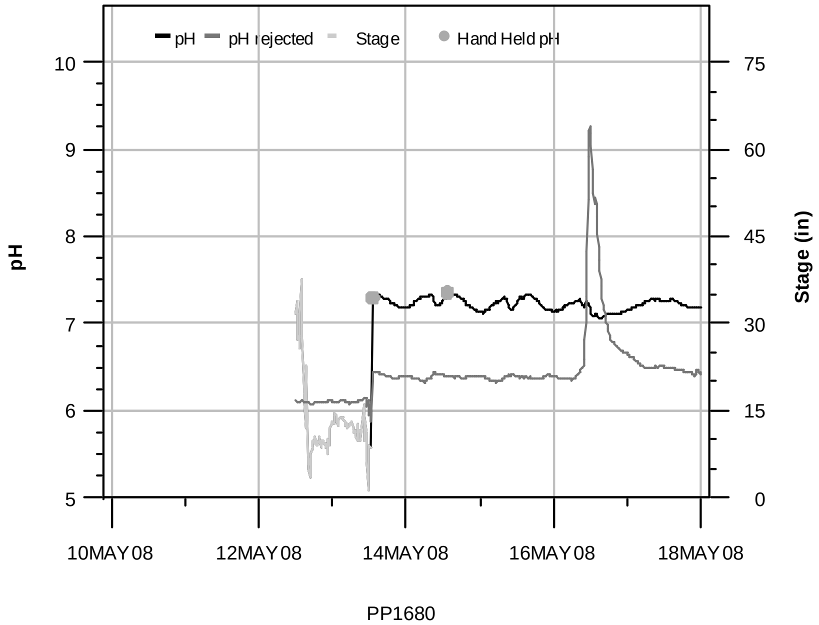

Figure F.92 Continuous pH at Site PP1680, 05/10/08 to 05/18/08

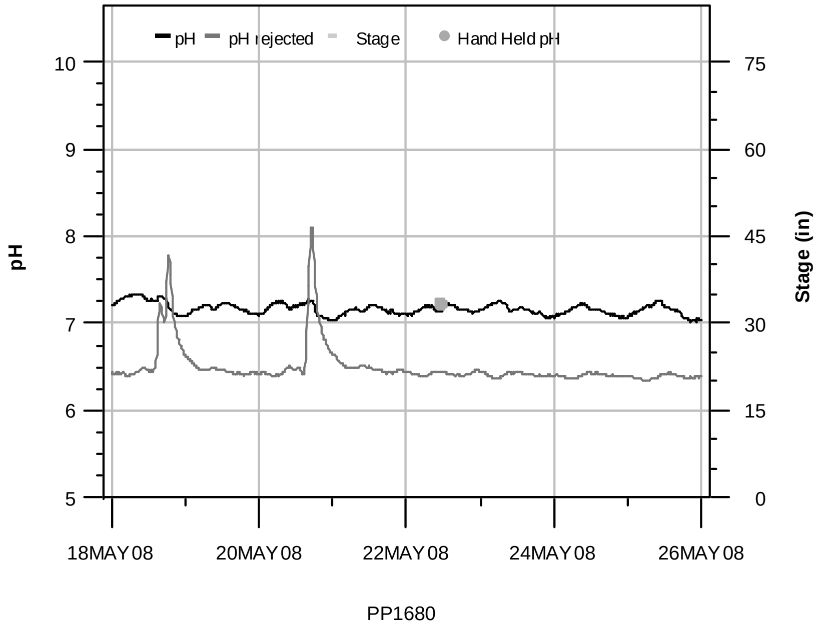

Figure F.93 Continuous pH at Site PP1680, 05/18/08 to 05/26/08

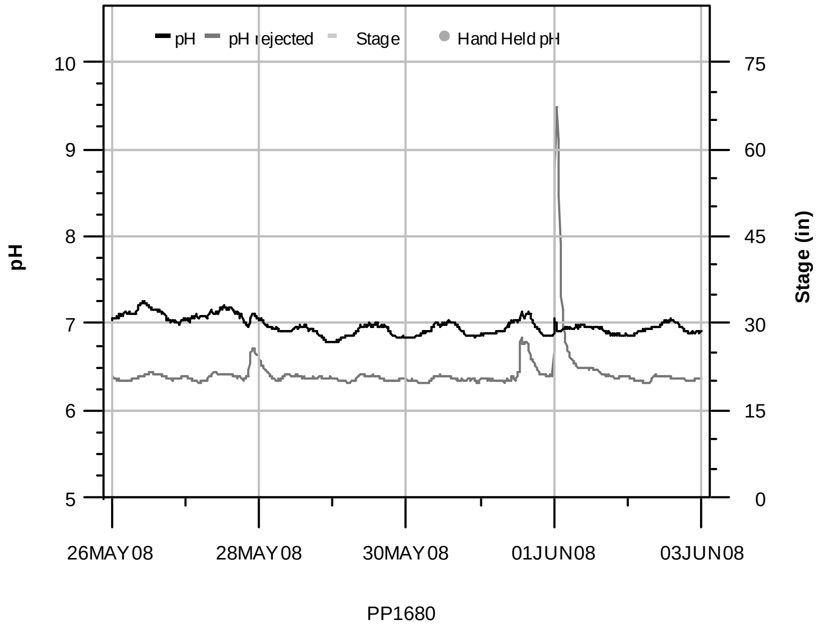

Figure F.94 Continuous pH at Site PP1680, 05/26/08 to 06/03/08

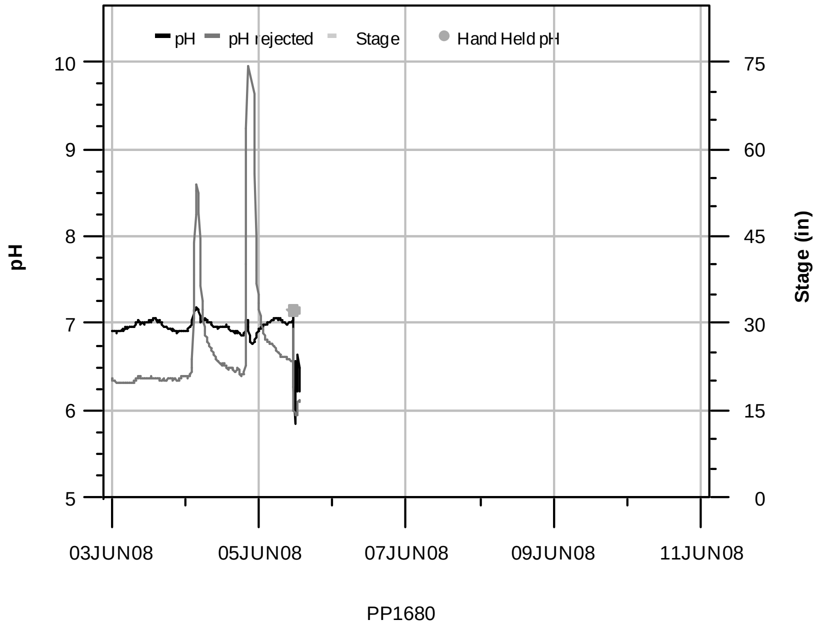

Figure F.95 Continuous pH at Site PP1680, 06/03/08 to 06/11/08

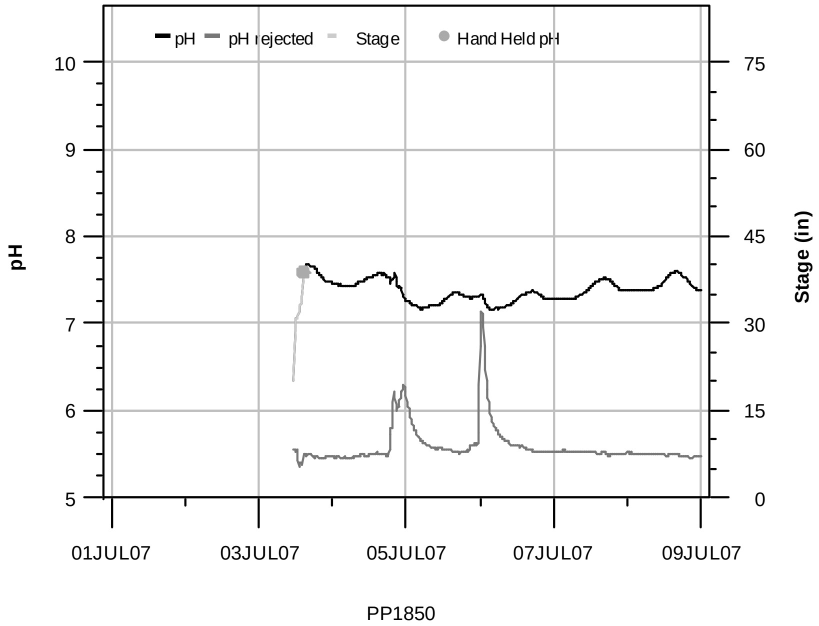

Figure F.96 Continuous pH at Site PP1850, 07/01/07 to 07/09/07

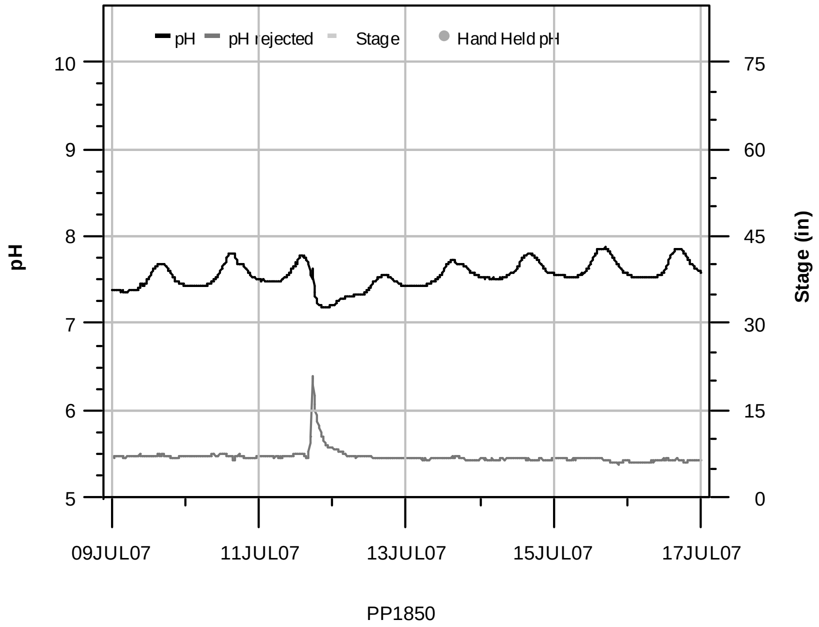

Figure F.97 Continuous pH at Site PP1850, 07/09/07 to 07/17/07

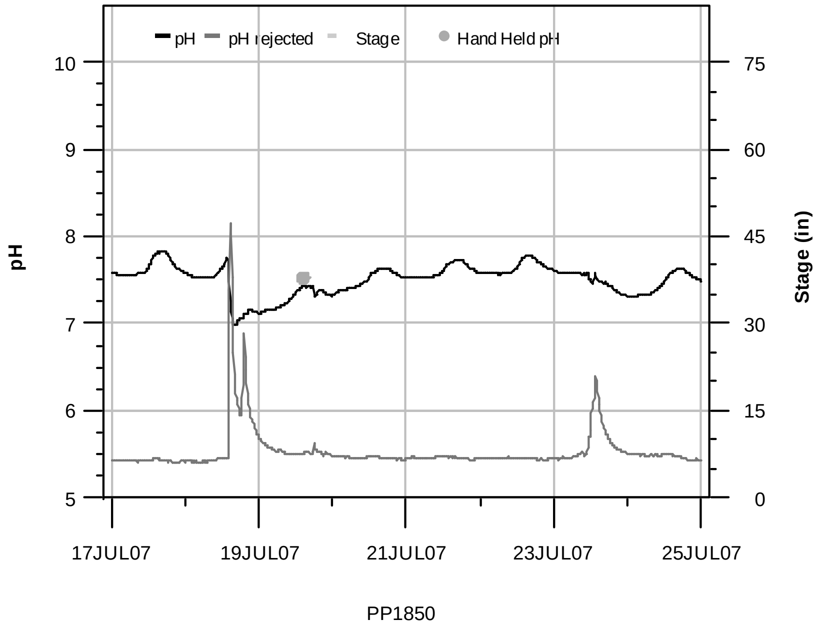

Figure F.98 Continuous pH at Site PP1850, 07/17/07 to 07/25/07

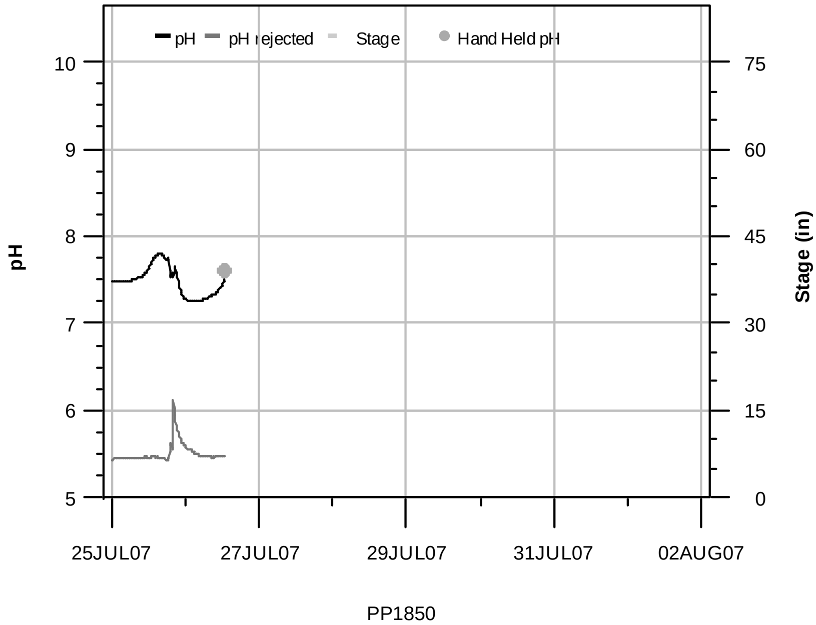

Figure F.99 Continuous pH at Site PP1850, 07/25/07 to 08/02/07

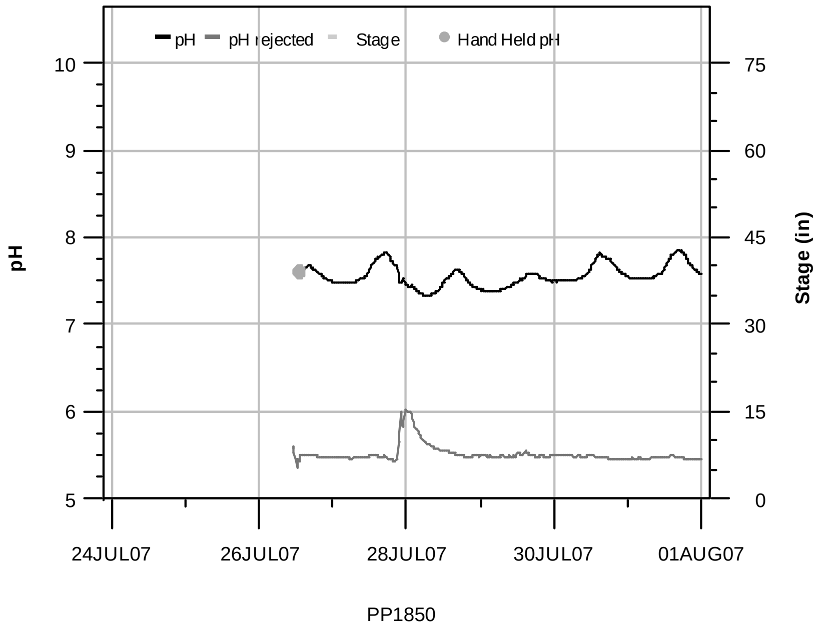

Figure F.100 Continuous pH at Site PP1850, 07/24/07 to 08/01/07

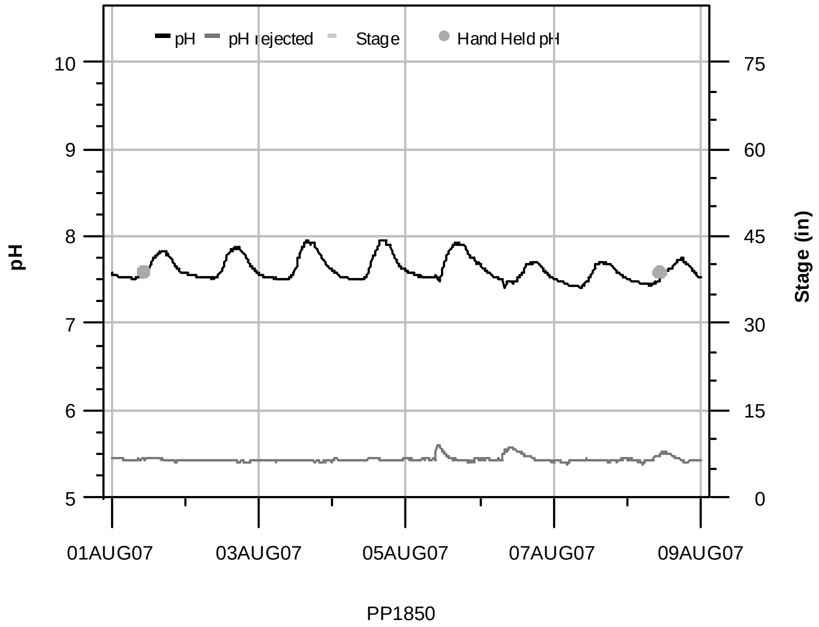

Figure F.101 Continuous pH at Site PP1850, 08/01/07 to 08/09/07

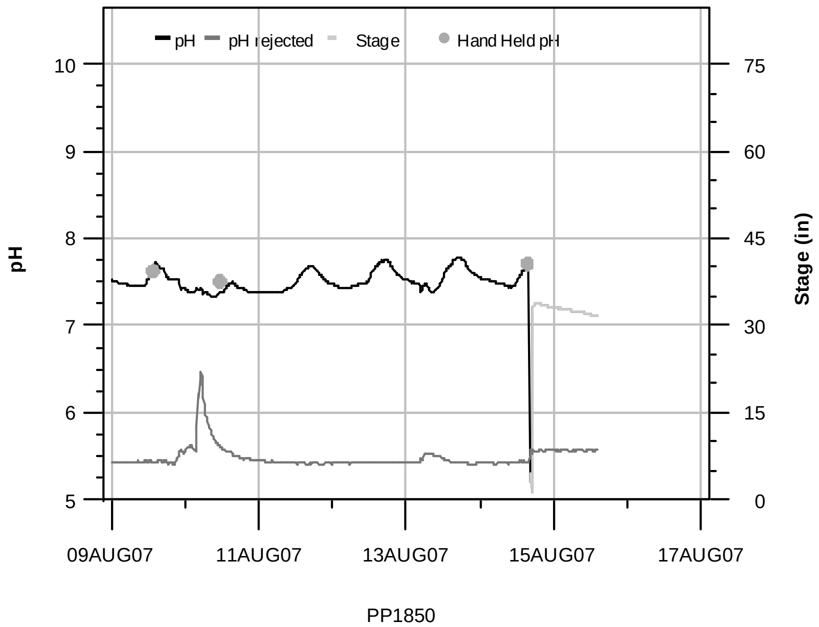

Figure F.102 Continuous pH at Site PP1850, 08/09/07 to 08/17/07

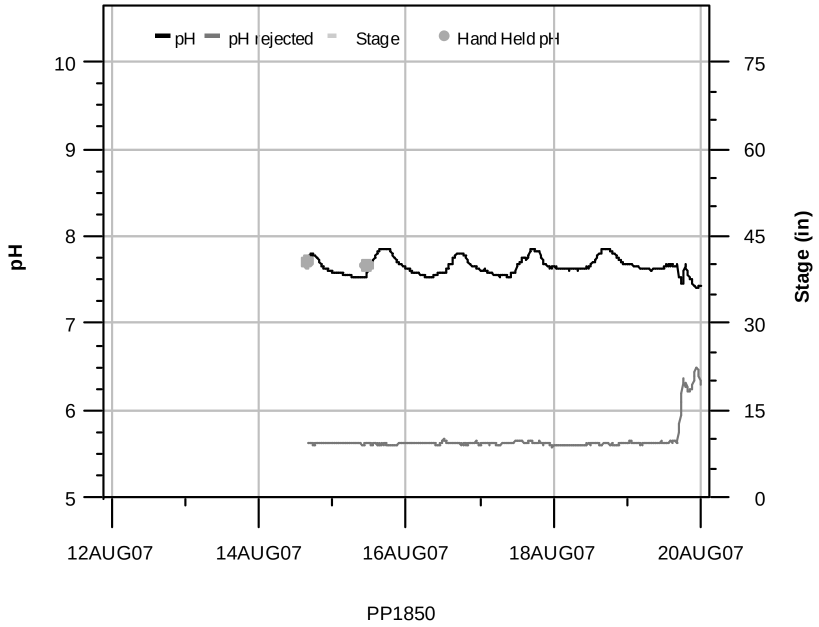

Figure F.103 Continuous pH at Site PP1850, 08/12/07 to 08/20/07

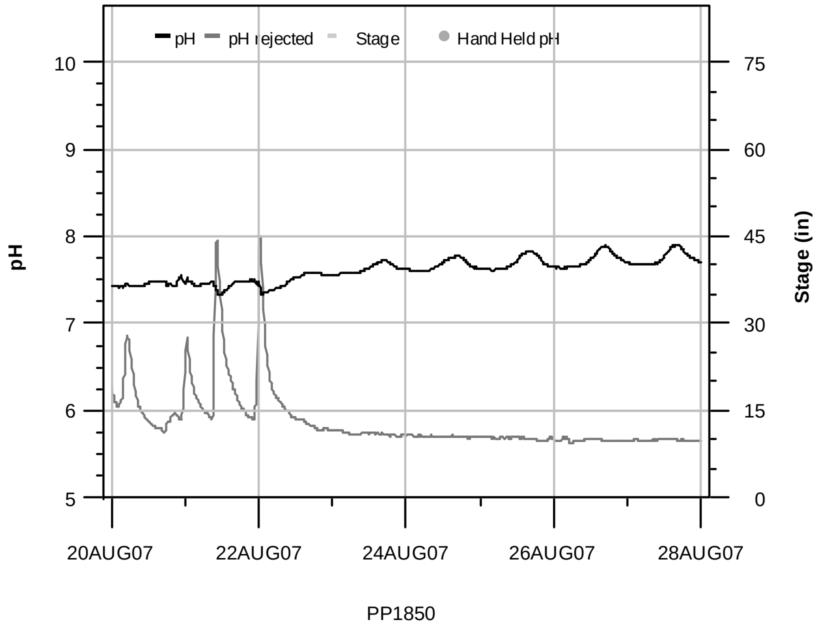

Figure F.104 Continuous pH at Site PP1850, 08/20/07 to 08/28/07

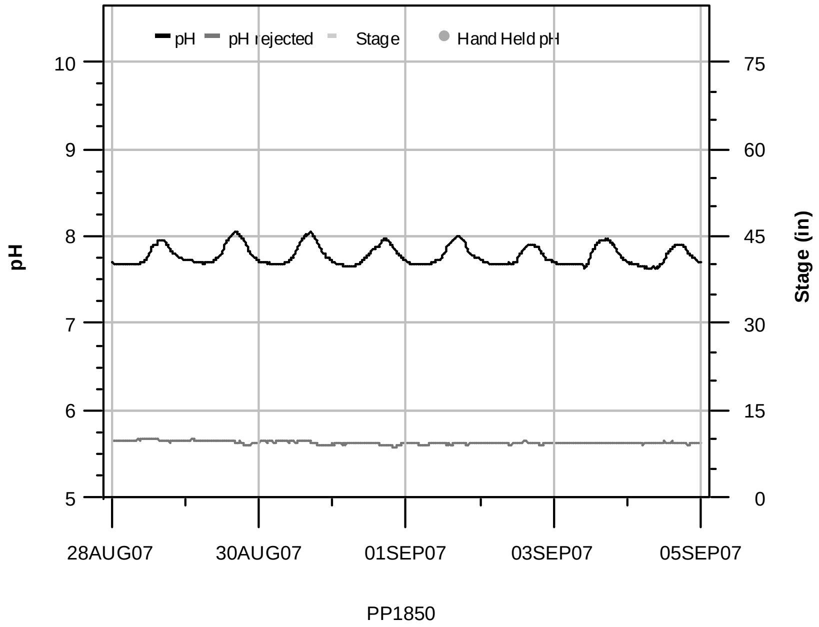

Figure F.105 Continuous pH at Site PP1850, 08/28/07 to 09/05/07

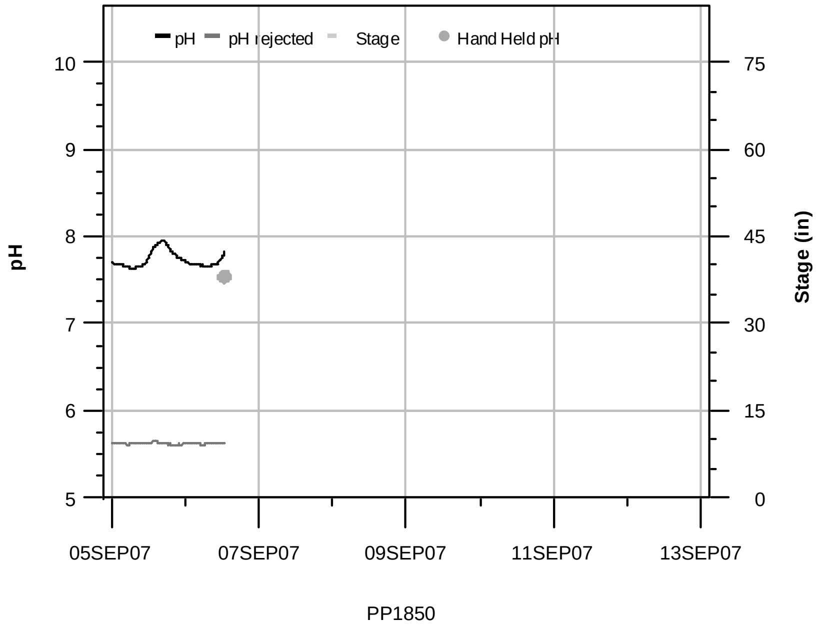

Figure F.106 Continuous pH at Site PP1850, 09/05/07 to 09/13/07

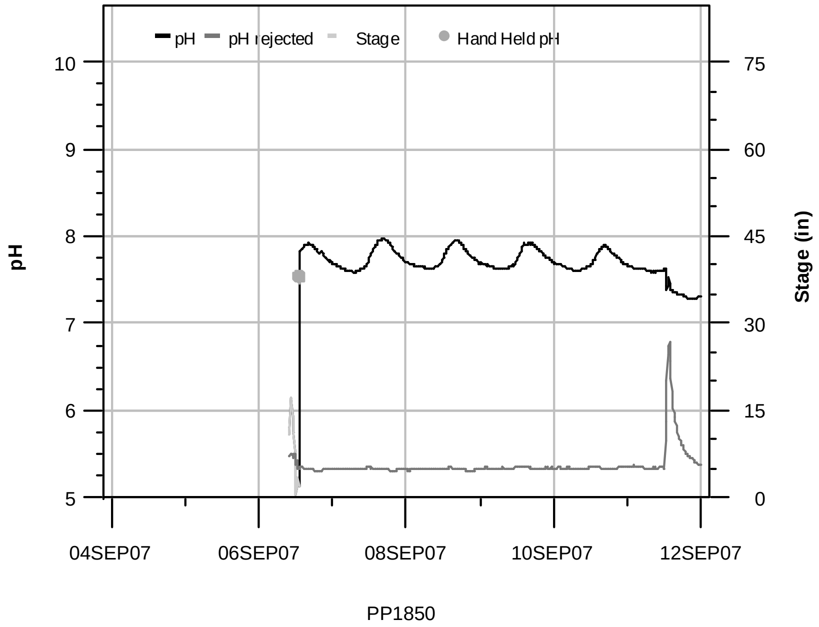

Figure F.107 Continuous pH at Site PP1850, 09/04/07 to 09/12/07

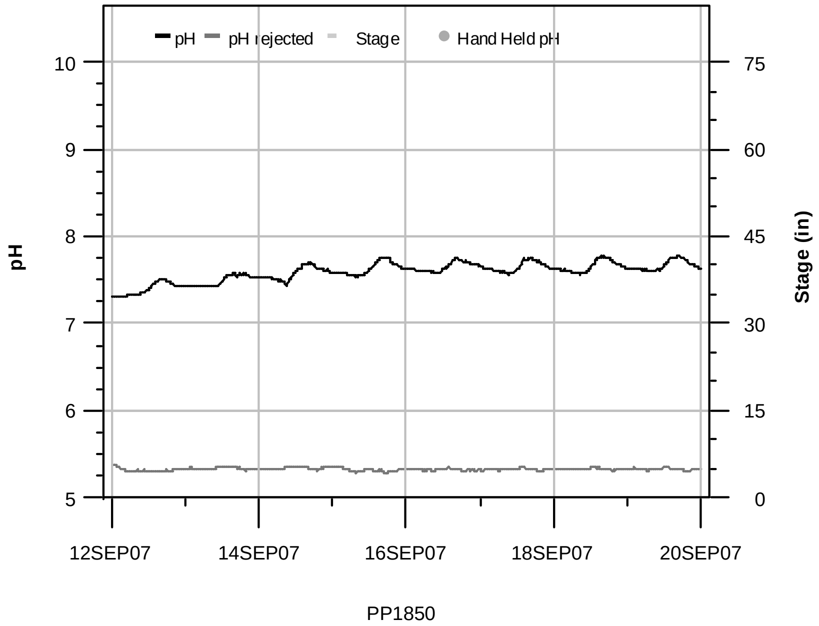

Figure F.108 Continuous pH at Site PP1850, 09/12/07 to 09/20/07

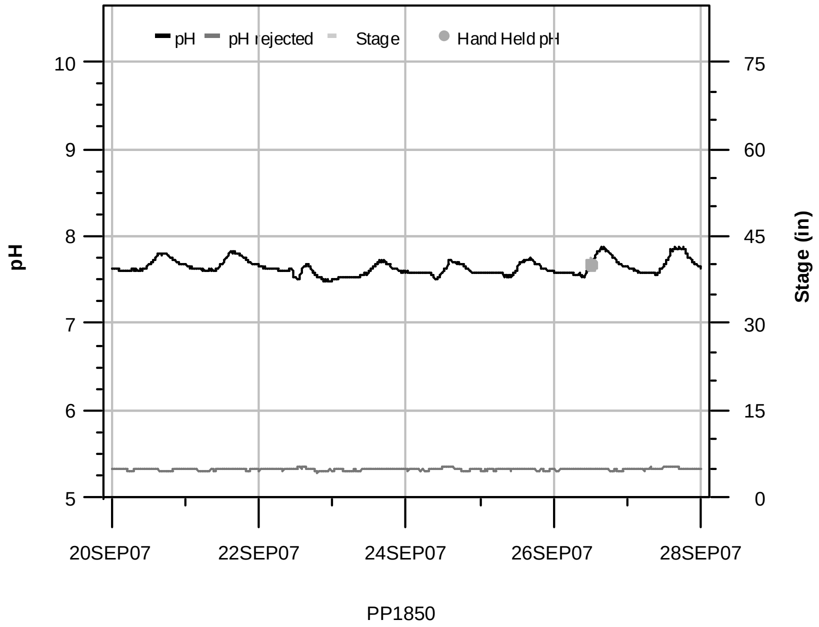

Figure F.109 Continuous pH at Site PP1850, 09/20/07 to 09/28/07

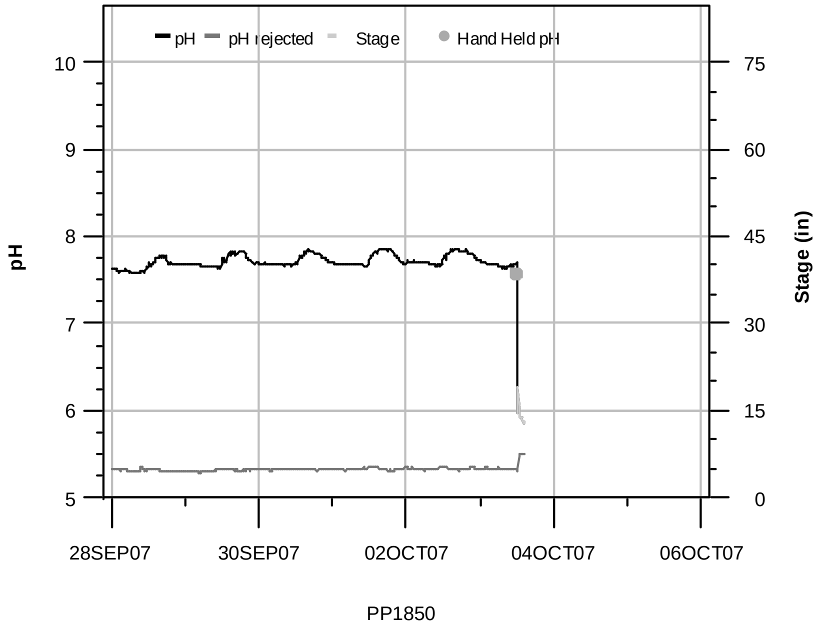

Figure F.110 Continuous pH at Site PP1850, 09/28/07 to 10/06/07

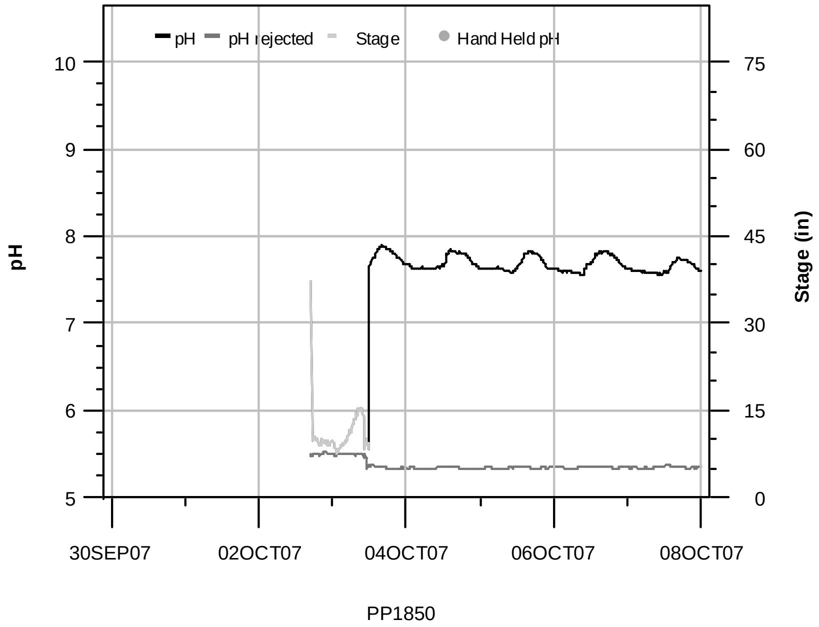

Figure F.111 Continuous pH at Site PP1850, 09/30/07 to 10/08/07

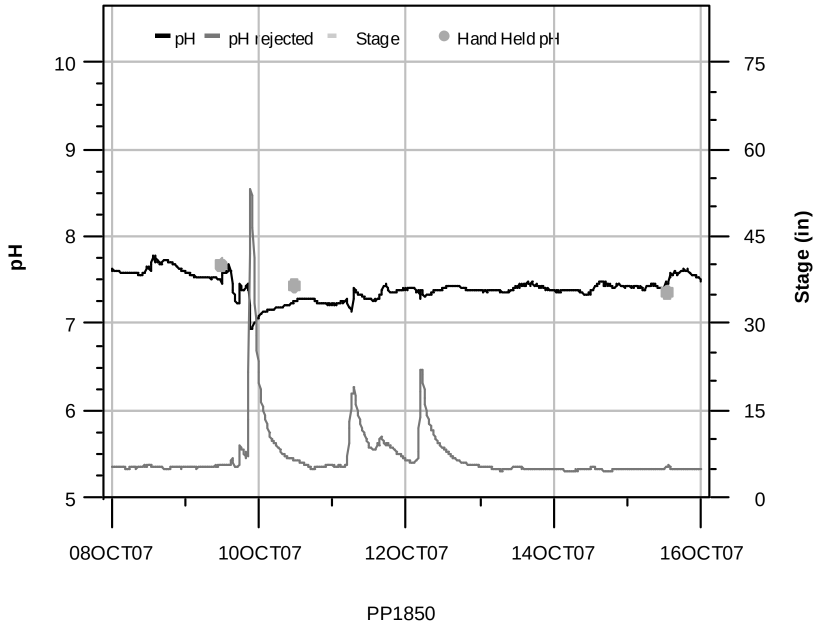

Figure F.112 Continuous pH at Site PP1850, 10/08/07 to 10/16/07

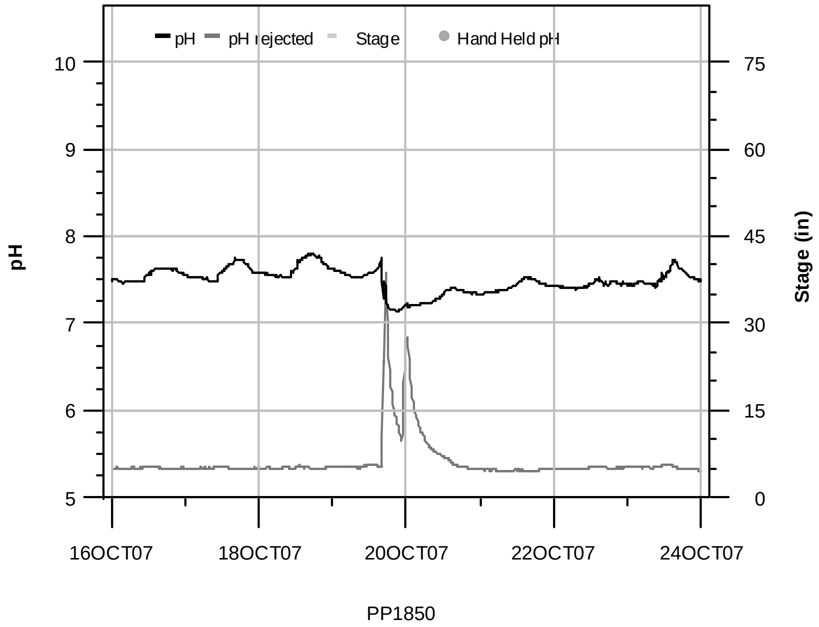

Figure F.113 Continuous pH at Site PP1850, 10/16/07 to 10/24/07

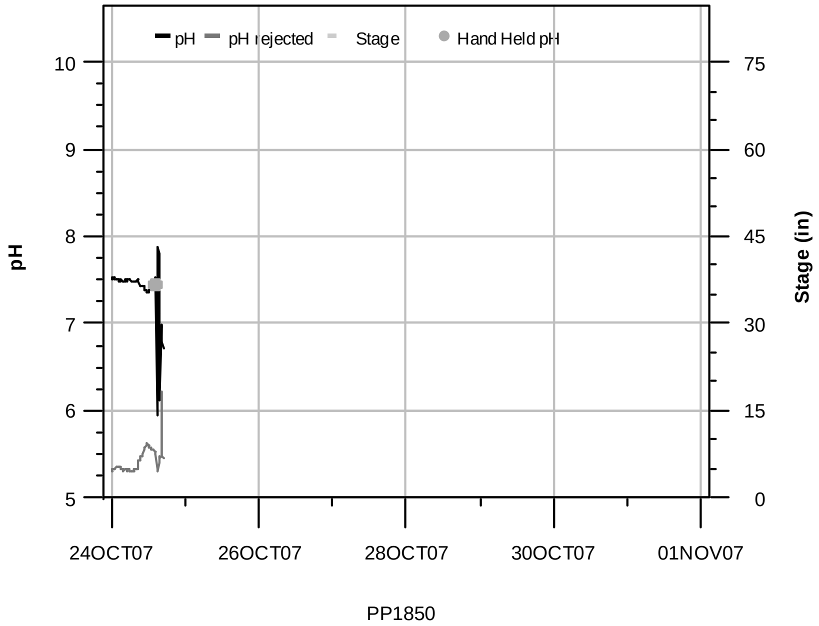

Figure F.114 Continuous pH at Site PP1850, 10/24/07 to 11/01/07

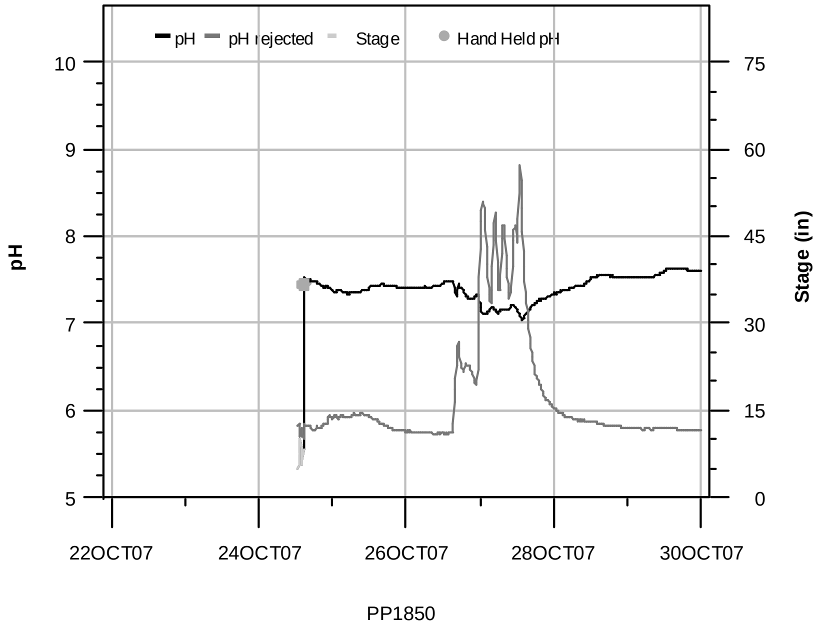

Figure F.115 Continuous pH at Site PP1850, 10/22/07 to 10/30/07

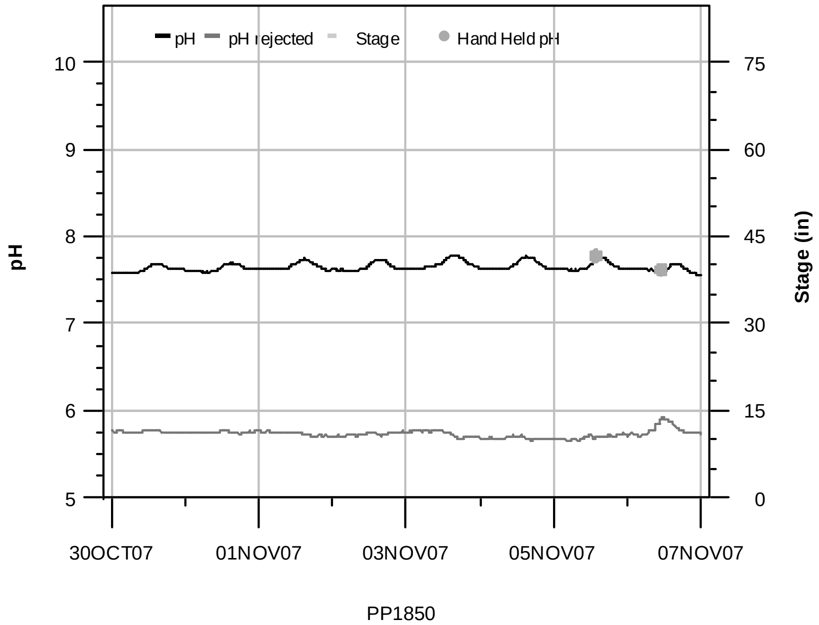

Figure F.116 Continuous pH at Site PP1850, 10/30/07 to 11/07/07

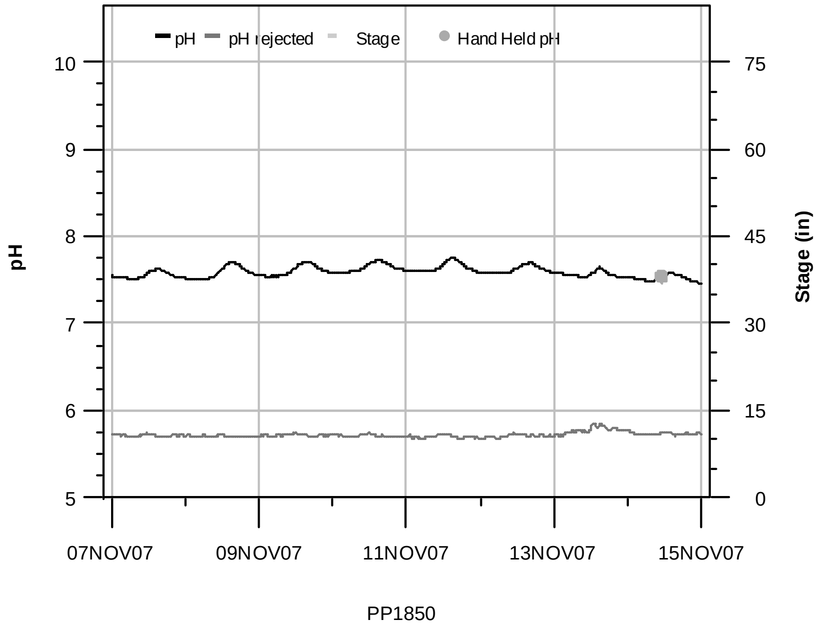

Figure F.117 Continuous pH at Site PP1850, 11/07/07 to 11/15/07

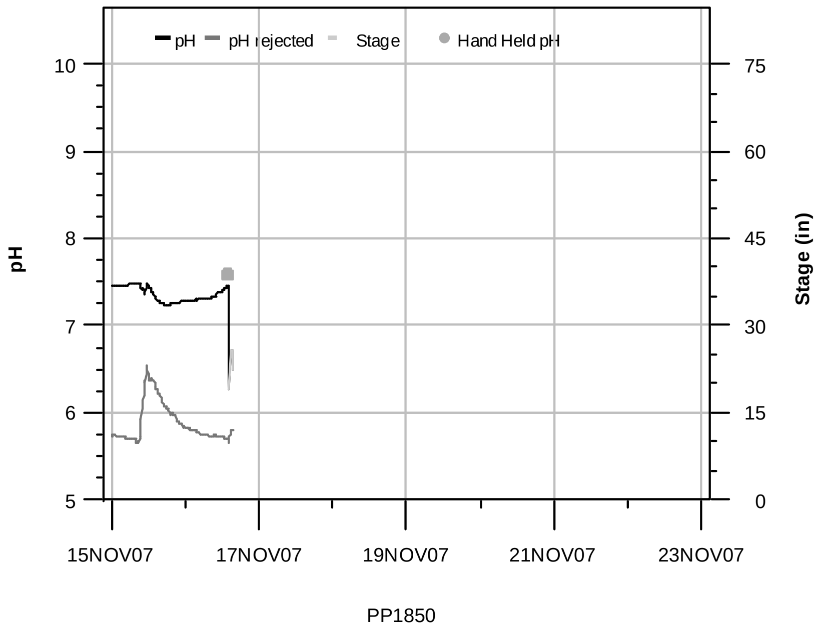

Figure F.118 Continuous pH at Site PP1850, 11/15/07 to 11/23/07

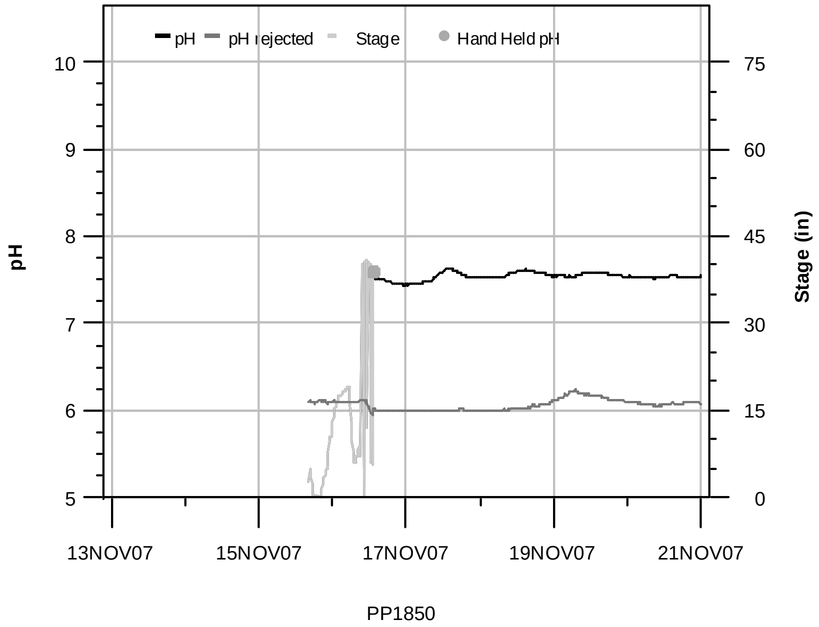

Figure F.119 Continuous pH at Site PP1850, 11/13/07 to 11/21/07

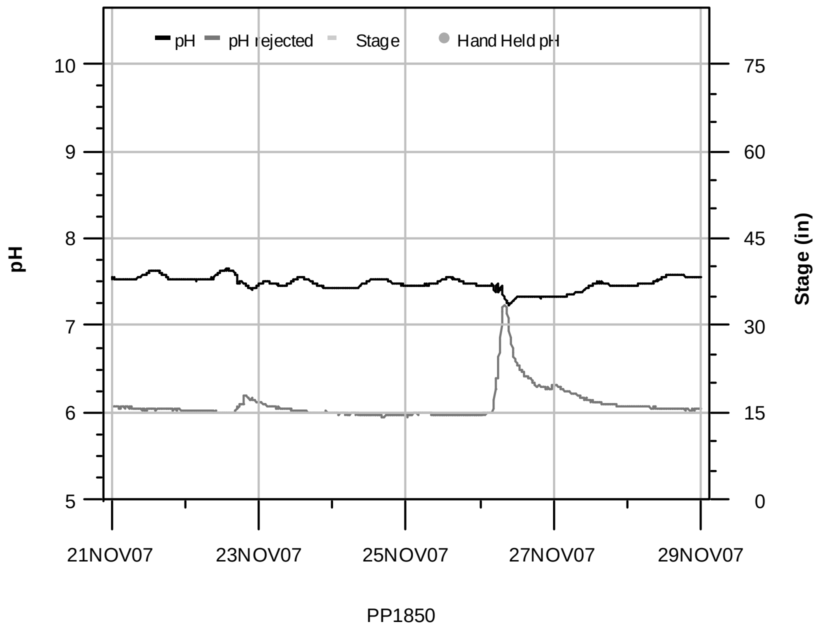

Figure F.120 Continuous pH at Site PP1850, 11/21/07 to 11/29/07

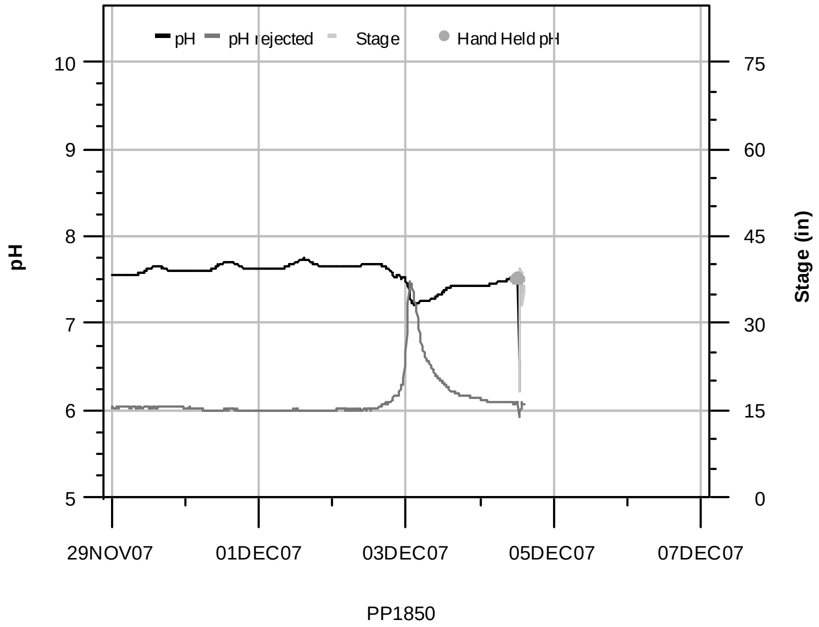

Figure F.121 Continuous pH at Site PP1850, 11/29/07 to 12/07/07

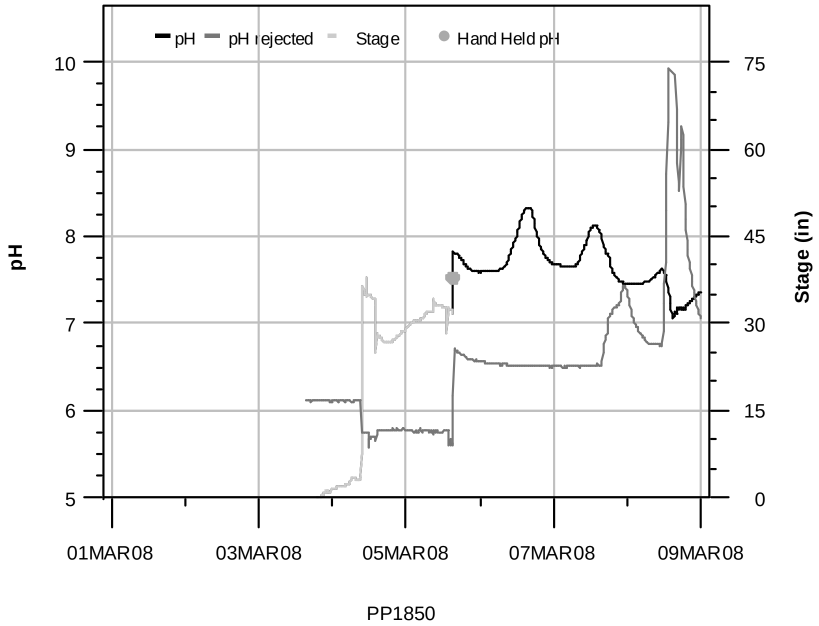

Figure F.122 Continuous pH at Site PP1850, 03/01/08 to 03/09/08

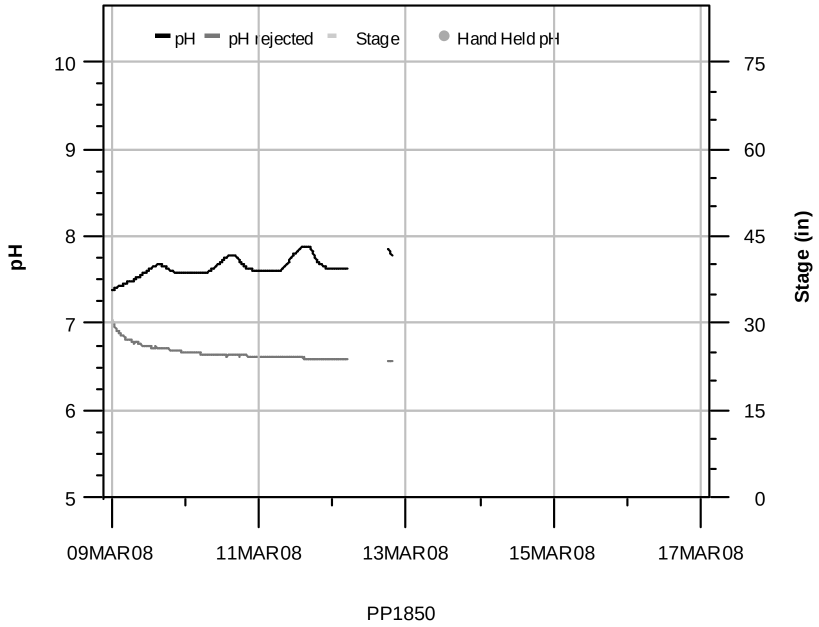

Figure F.123 Continuous pH at Site PP1850, 03/09/08 to 03/17/08

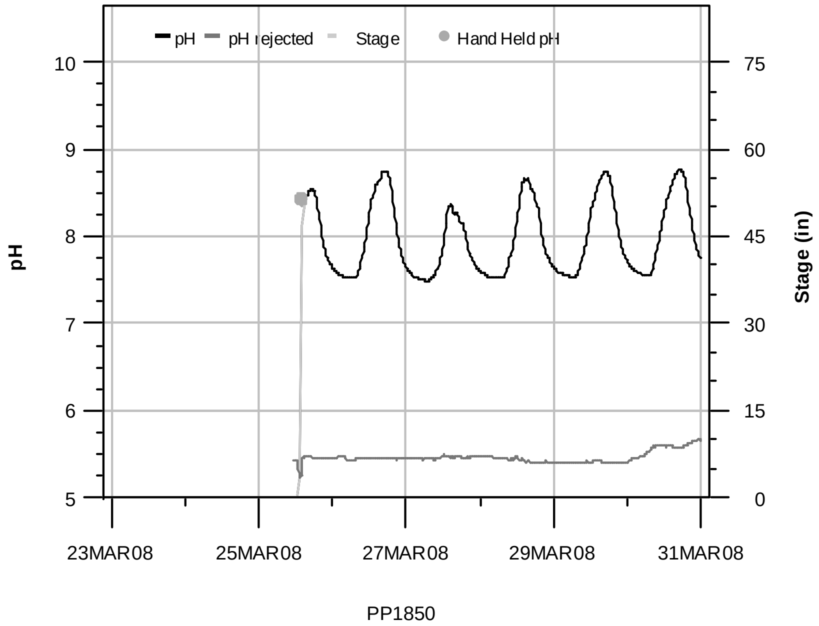

Figure F.124 Continuous pH at Site PP1850, 03/23/08 to 03/31/08

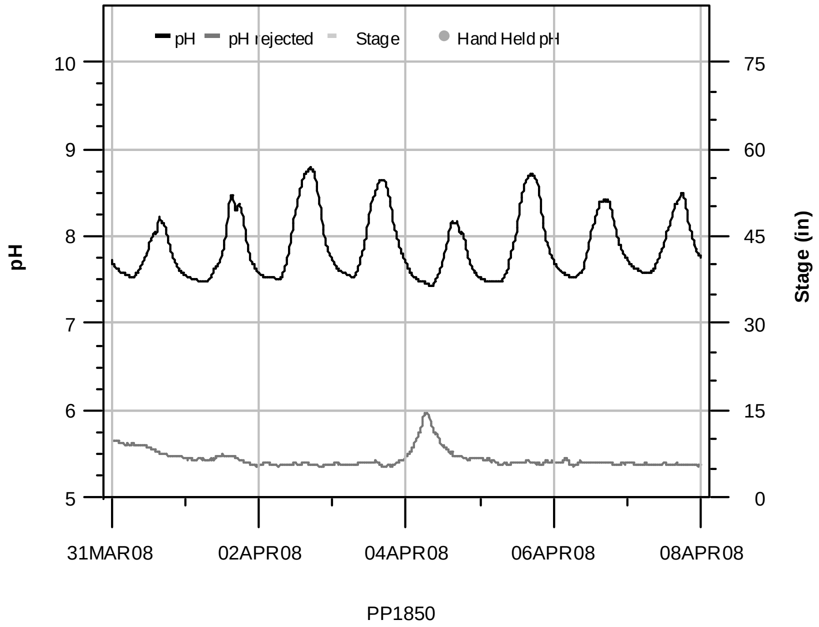

Figure F.125 Continuous pH at Site PP1850, 03/31/08 to 04/08/08

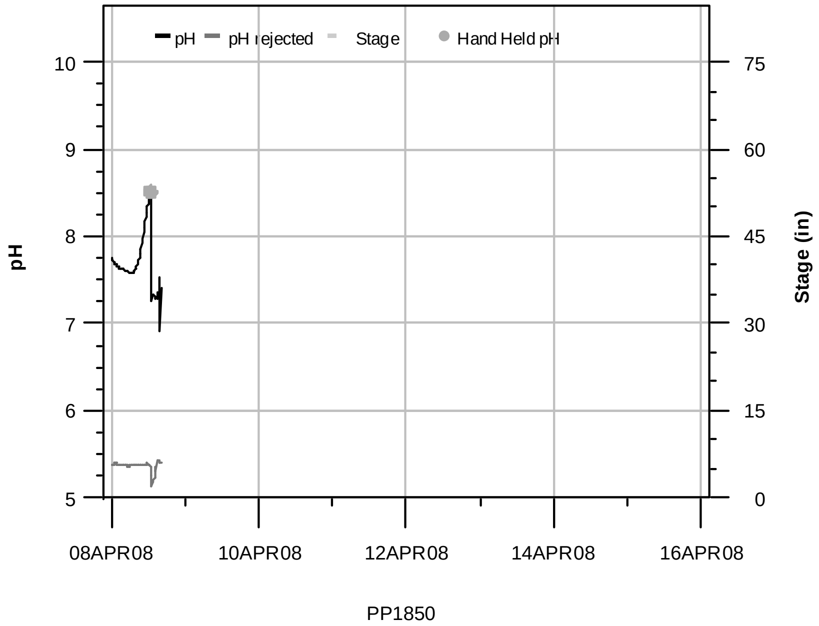

Figure F.126 Continuous pH at Site PP1850, 04/08/08 to 04/16/08

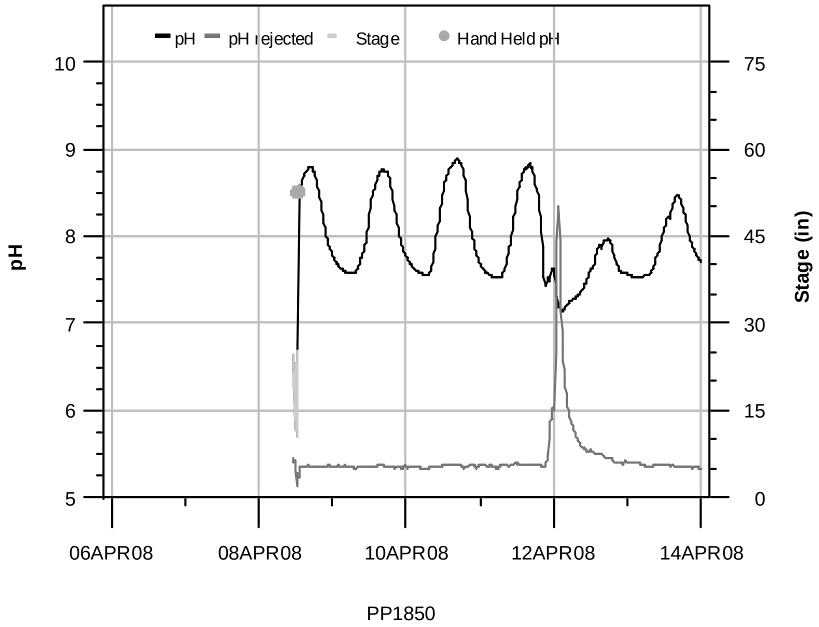

Figure F.127 Continuous pH at Site PP1850, 04/06/08 to 04/14/08

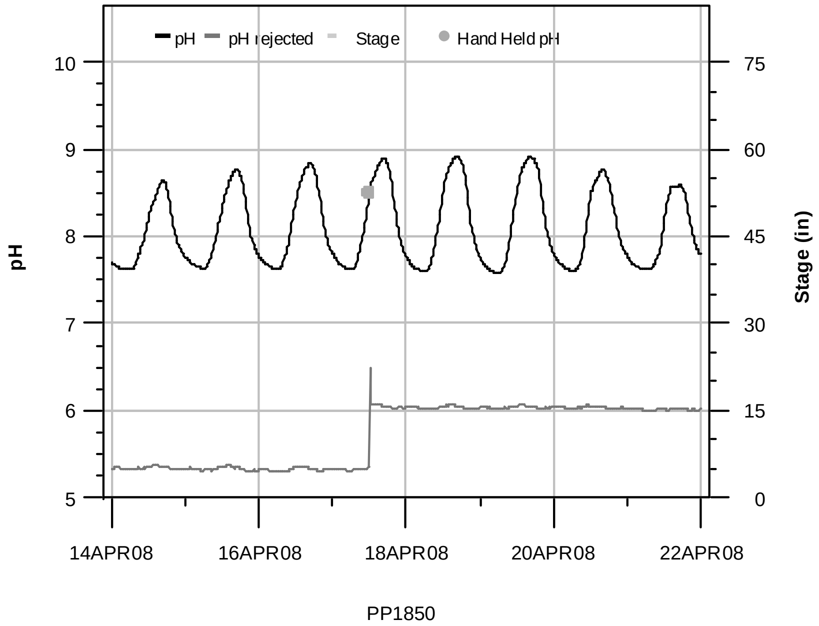

Figure F.128 Continuous pH at Site PP1850, 04/14/08 to 04/22/08

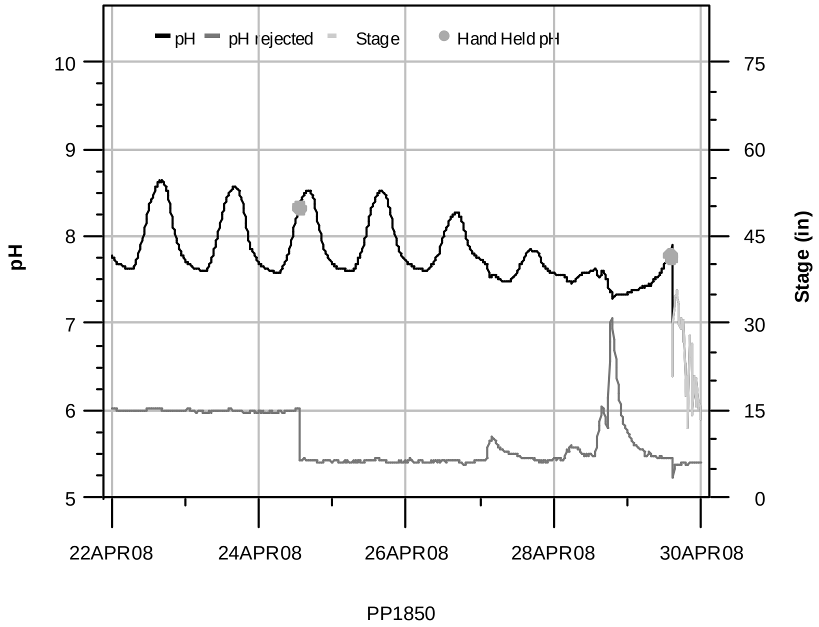

Figure F.129 Continuous pH at Site PP1850, 04/22/08 to 04/30/08

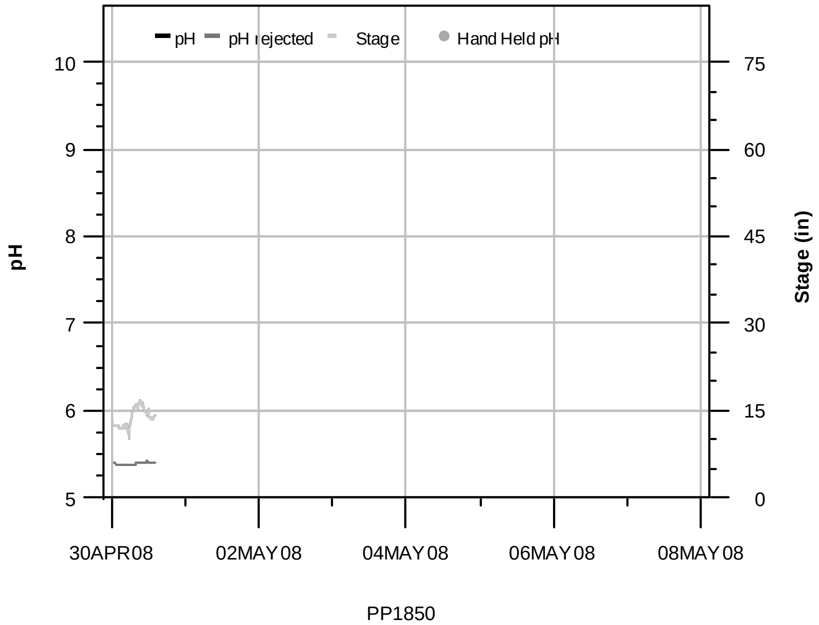

Figure F.130 Continuous pH at Site PP1850, 04/30/08 to 05/08/08

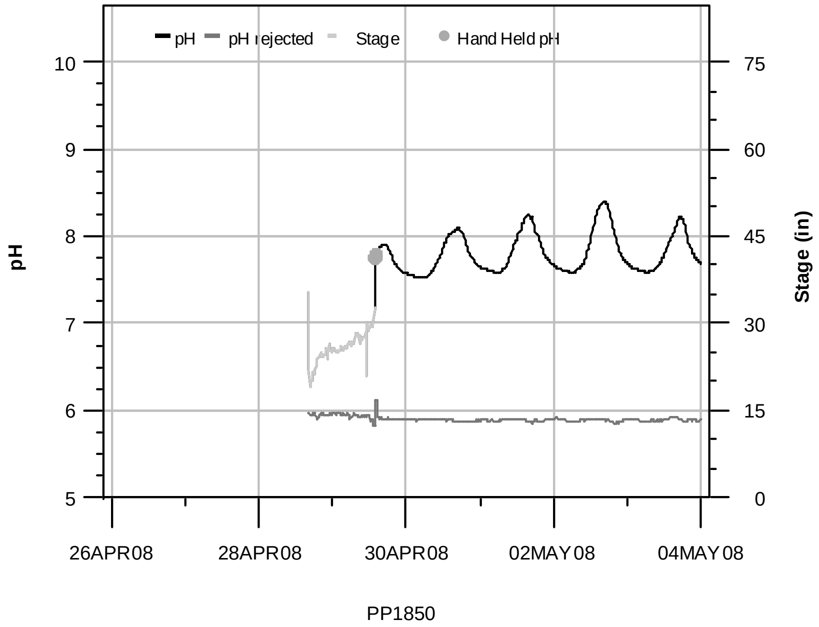

Figure F.131 Continuous pH at Site PP1850, 04/26/08 to 05/04/08

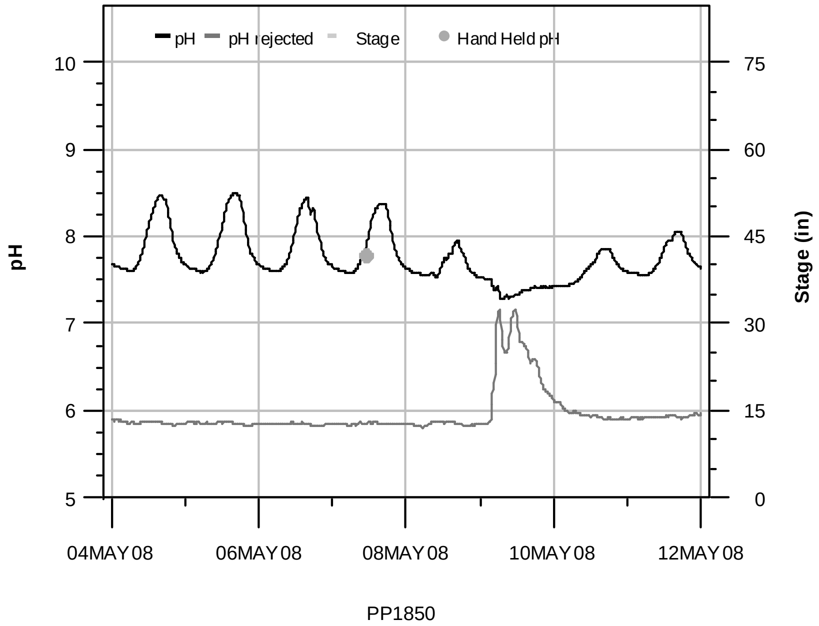

Figure F.132 Continuous pH at Site PP1850, 05/04/08 to 05/12/08

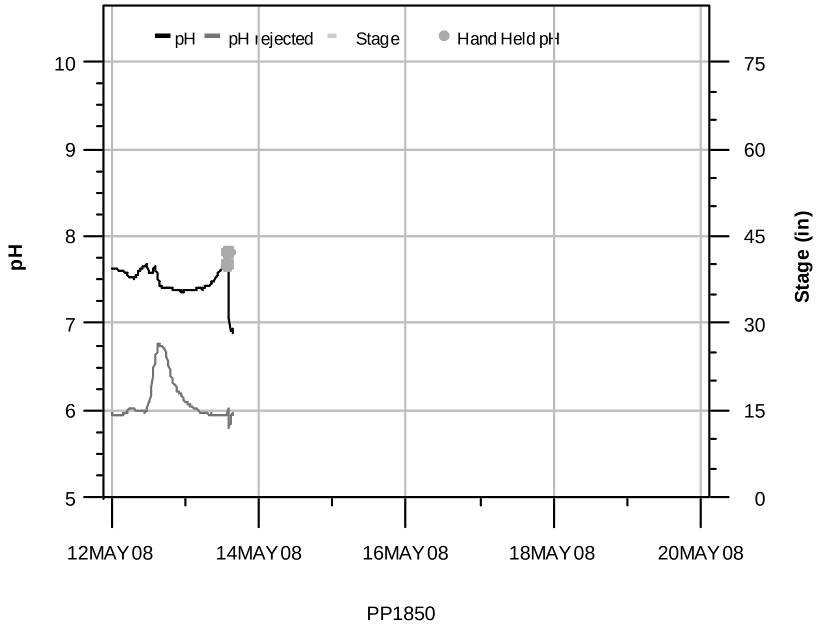

Figure F.133 Continuous pH at Site PP1850, 05/12/08 to 05/20/08

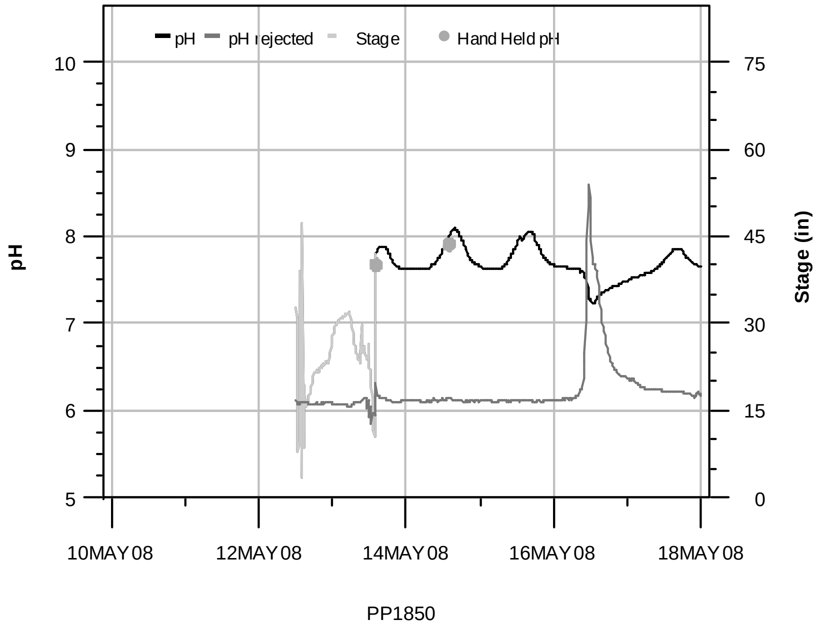

Figure F.134 Continuous pH at Site PP1850, 05/10/08 to 05/18/08

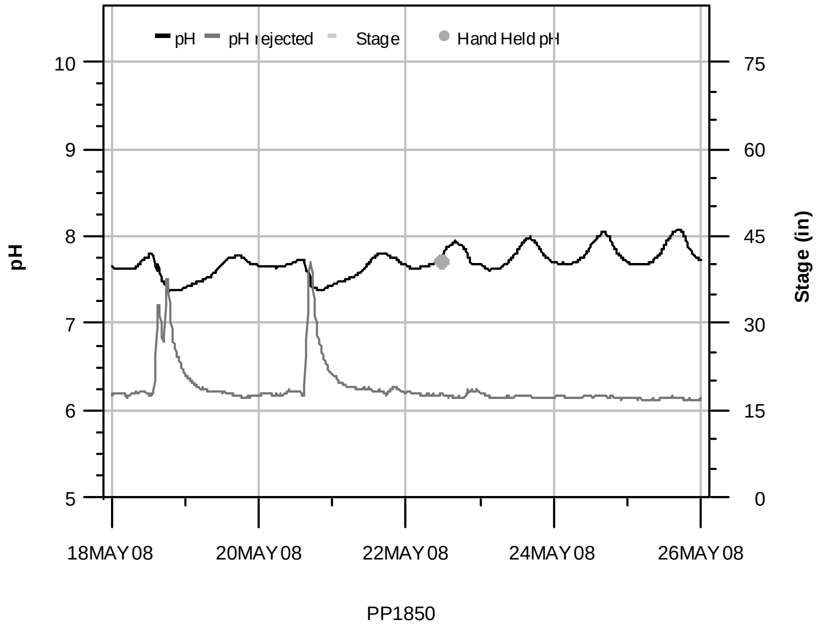

Figure F.135 Continuous pH at Site PP1850, 05/18/08 to 05/26/08

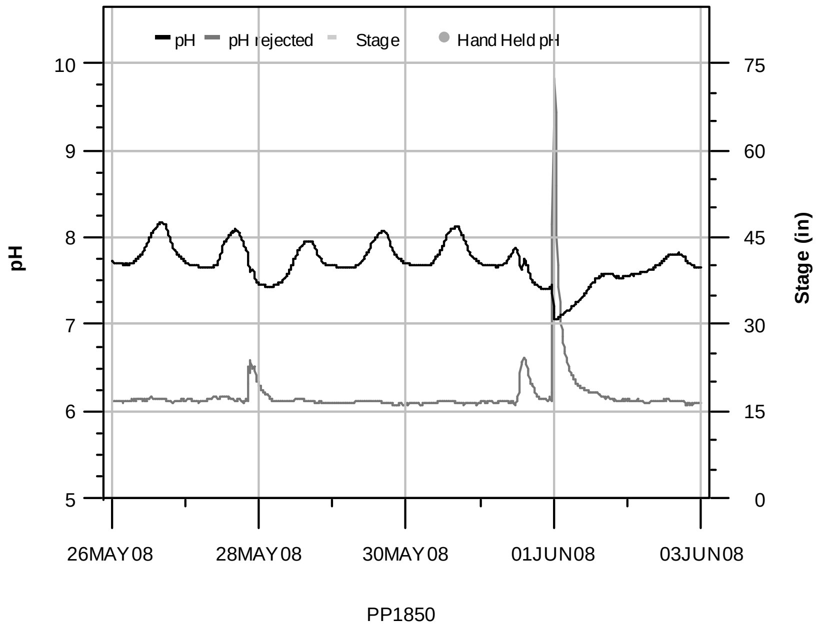

Figure F.136 Continuous pH at Site PP1850, 05/26/08 to 06/03/08

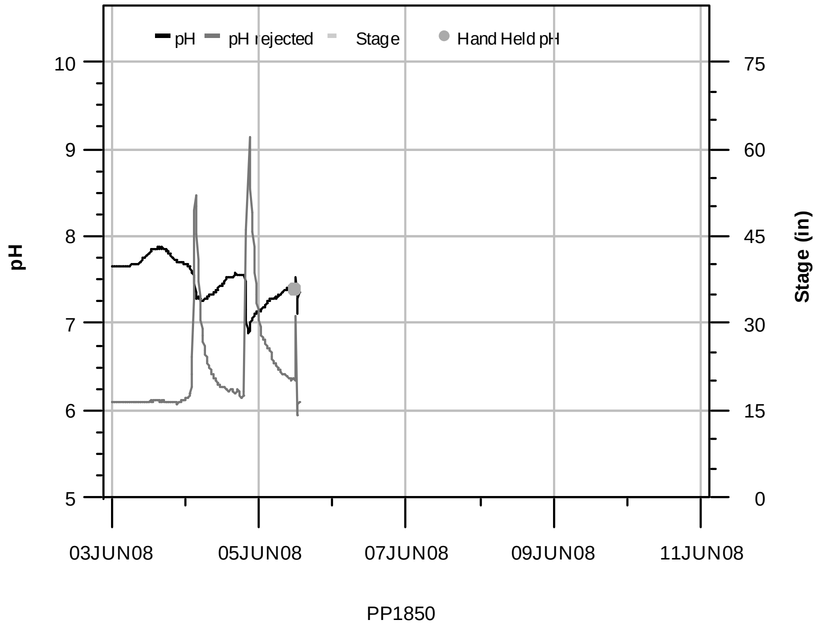

Figure F.137 Continuous pH at Site PP1850, 06/03/08 to 06/11/08

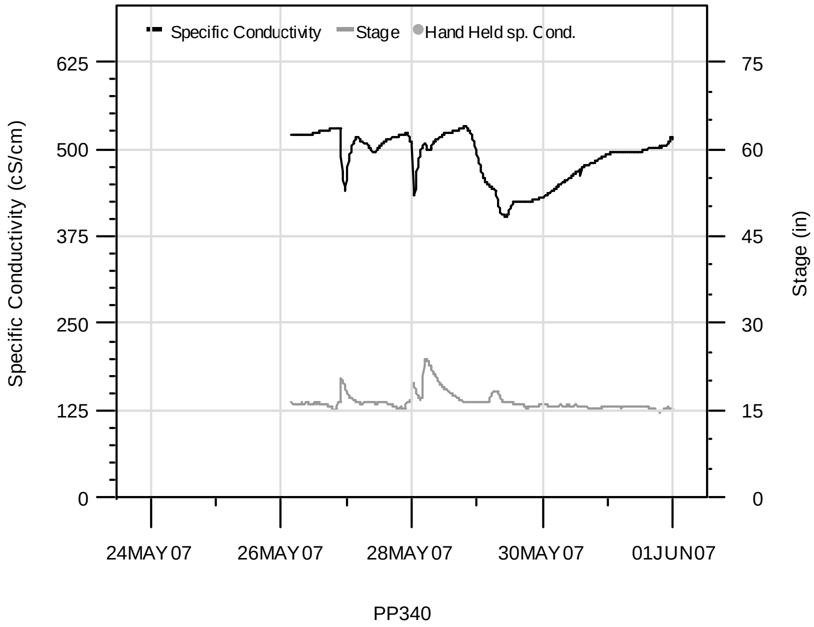

Figure G.1 Continuous Specific Conductivity at Site PP340, 05/24/07 to 06/01/07

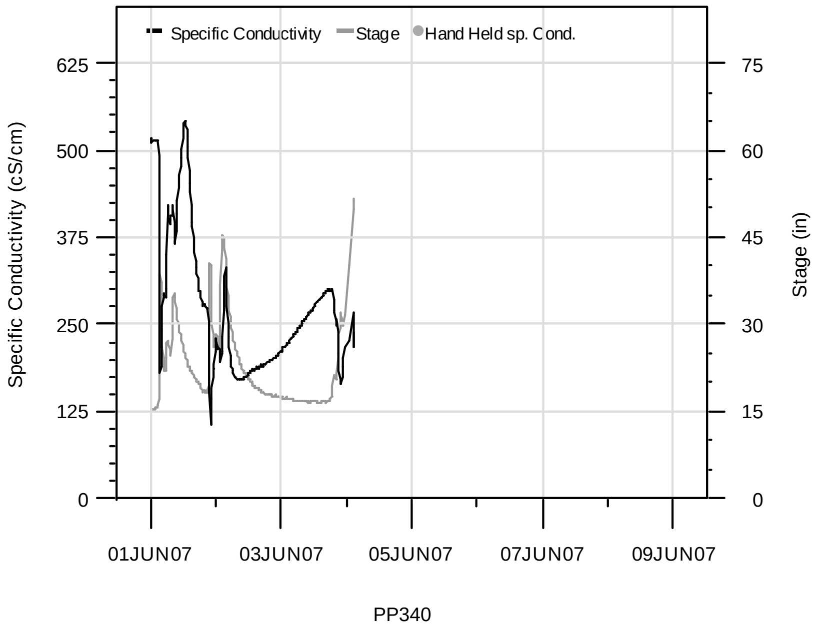

Figure G.2 Continuous Specific Conductivity at Site PP340, 06/01/07 to 06/09/07

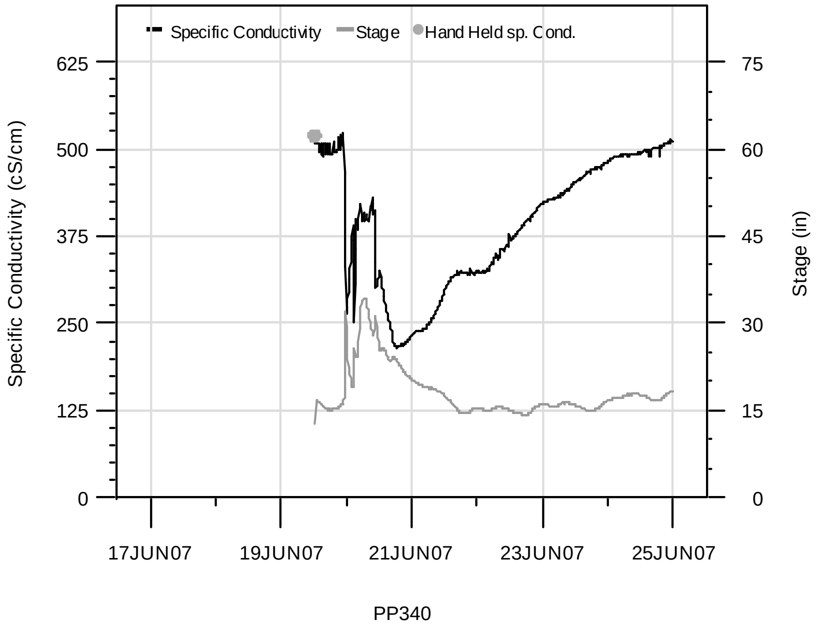

Figure G.3 Continuous Specific Conductivity at Site PP340, 06/17/07 to 06/25/07

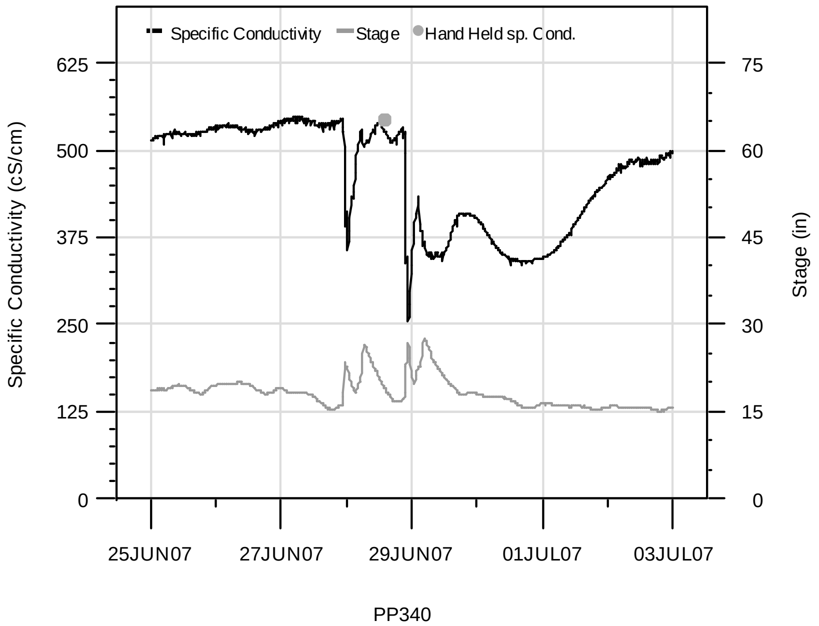

Figure G.4 Continuous Specific Conductivity at Site PP340, 06/25/07 to 07/03/07

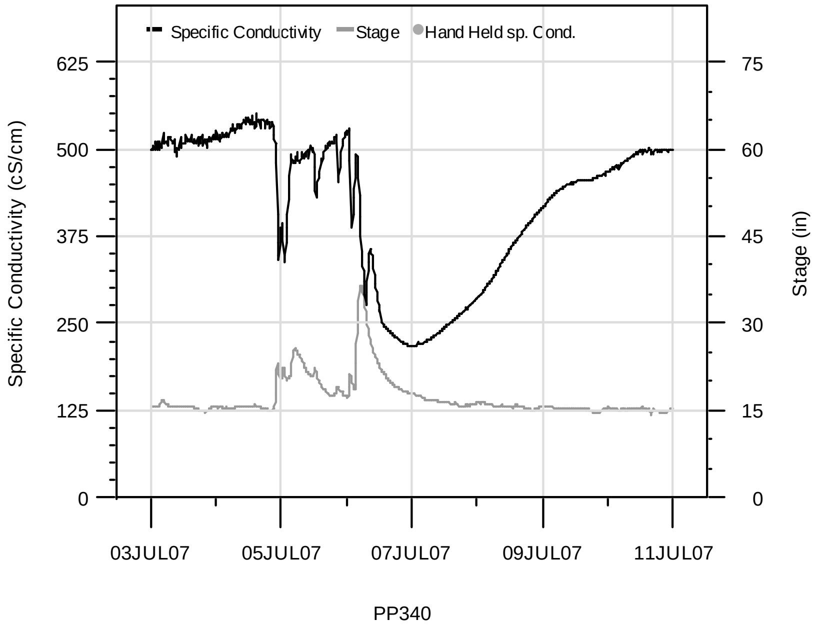

Figure G.5 Continuous Specific Conductivity at Site PP340, 07/03/07 to 07/11/07

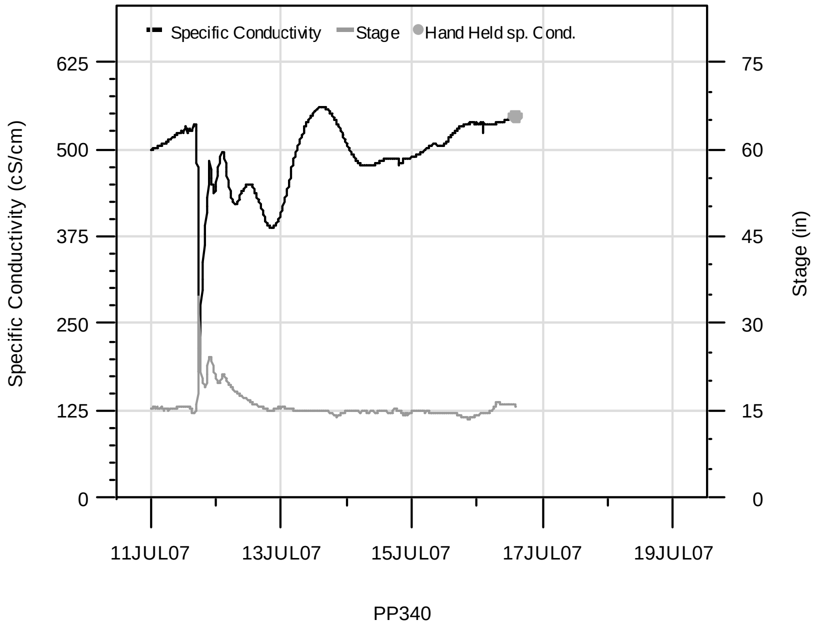

Figure G.6 Continuous Specific Conductivity at Site PP340, 07/11/07 to 07/19/07

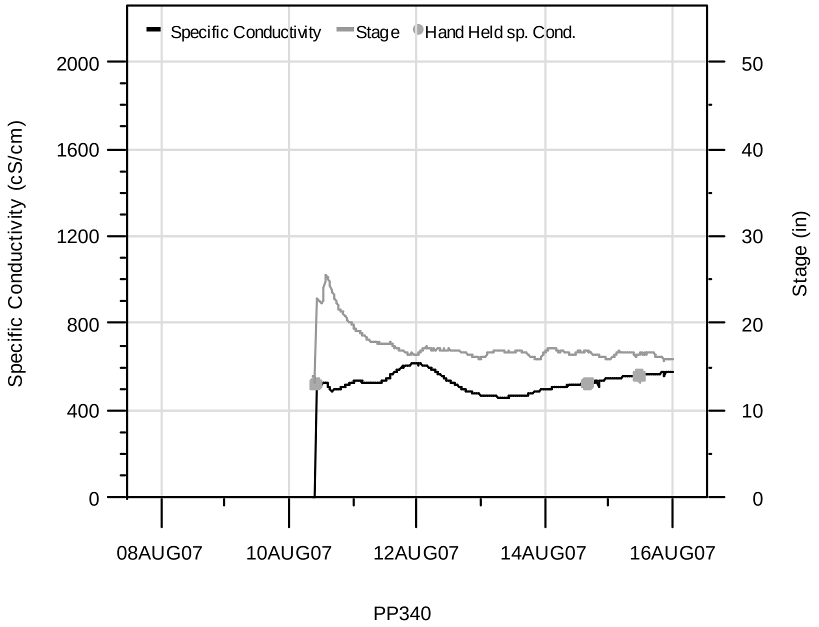

Figure G.7 Continuous Specific Conductivity at Site PP340, 08/08/07 to 08/16/07

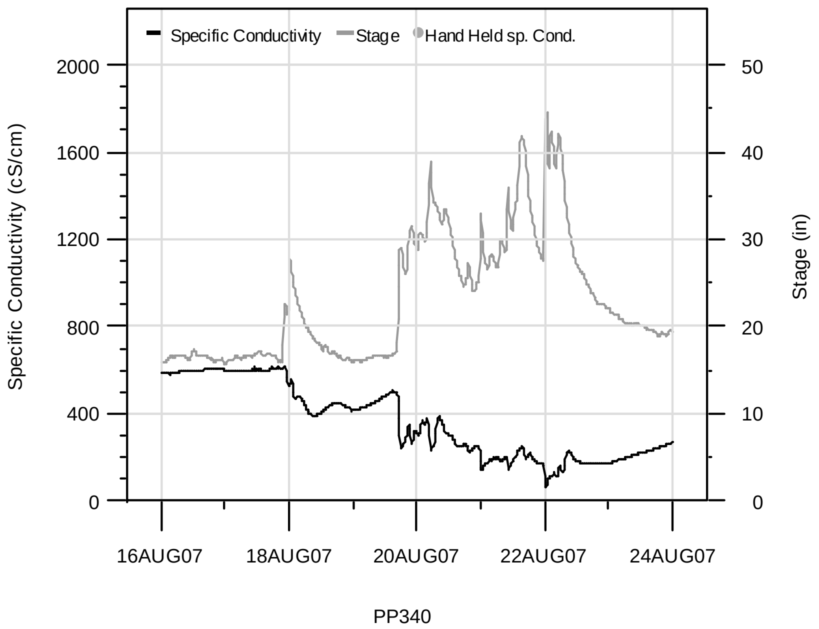

Figure G.8 Continuous Specific Conductivity at Site PP340, 08/16/07 to 08/24/07

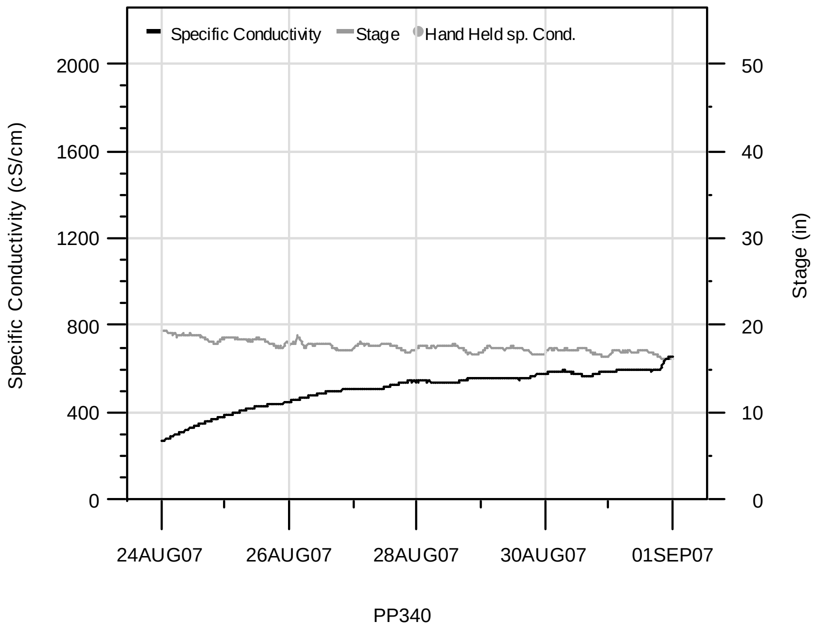

Figure G.9 Continuous Specific Conductivity at Site PP340, 08/24/07 to 09/1/07

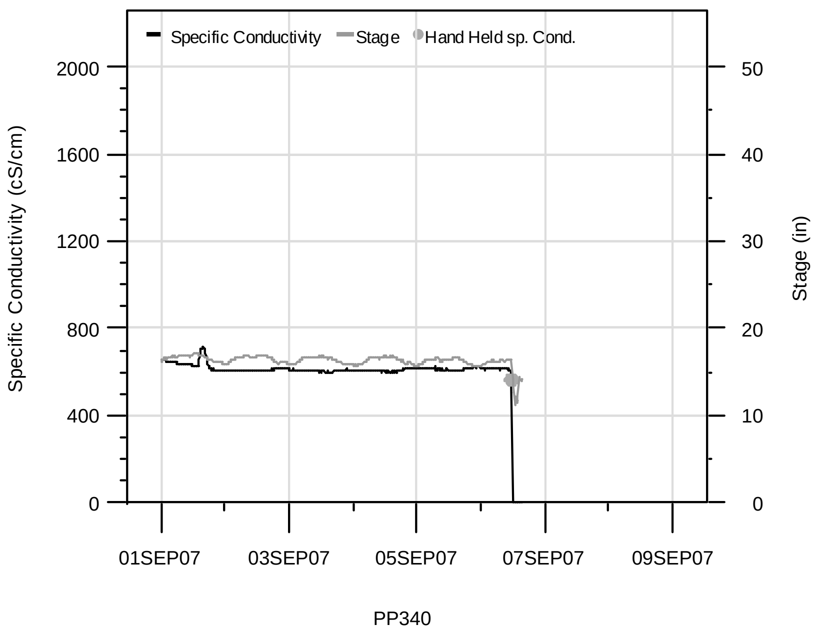

Figure G.10 Continuous Specific Conductivity at Site PP340, 09/01/07 to 09/09/07

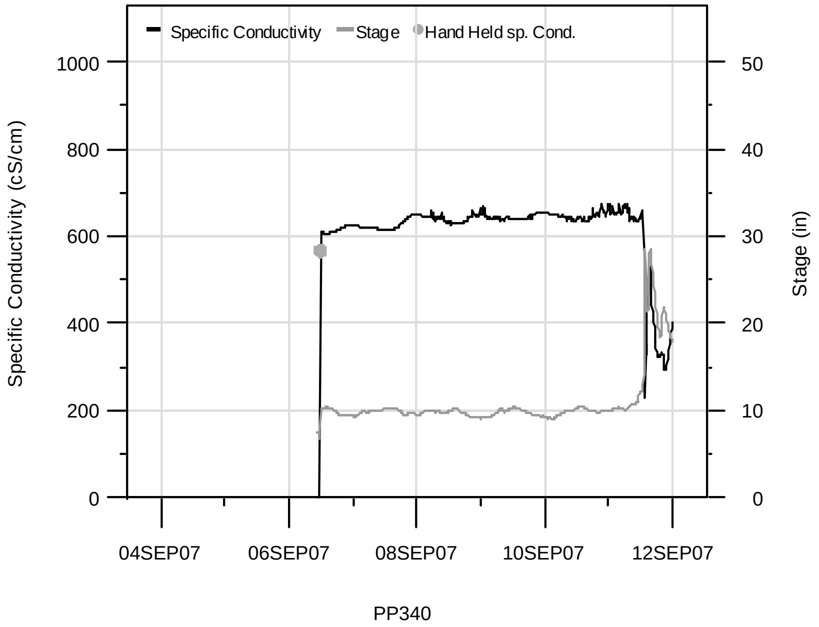

Figure G.11 Continuous Specific Conductivity at Site PP340, 09/04/07 to 09/12/07

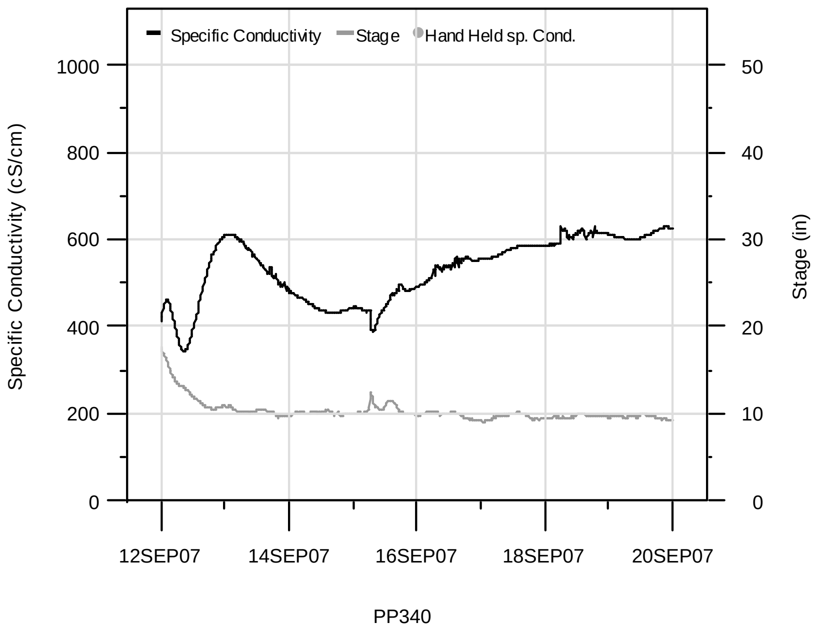

Figure G.12 Continuous Specific Conductivity at Site PP340, 09/12/07 to 09/20/07

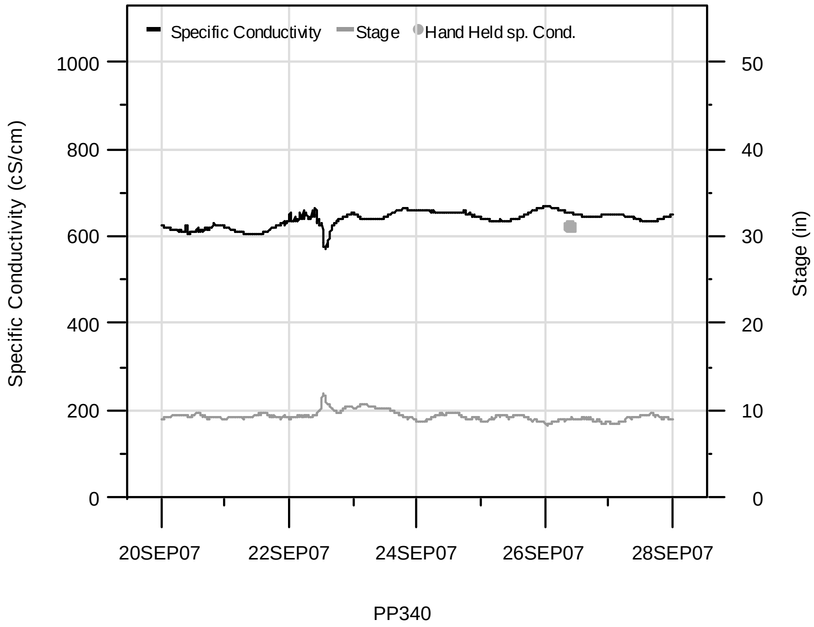

Figure G.13 Continuous Specific Conductivity at Site PP340, 09/20/07 to 09/28/07

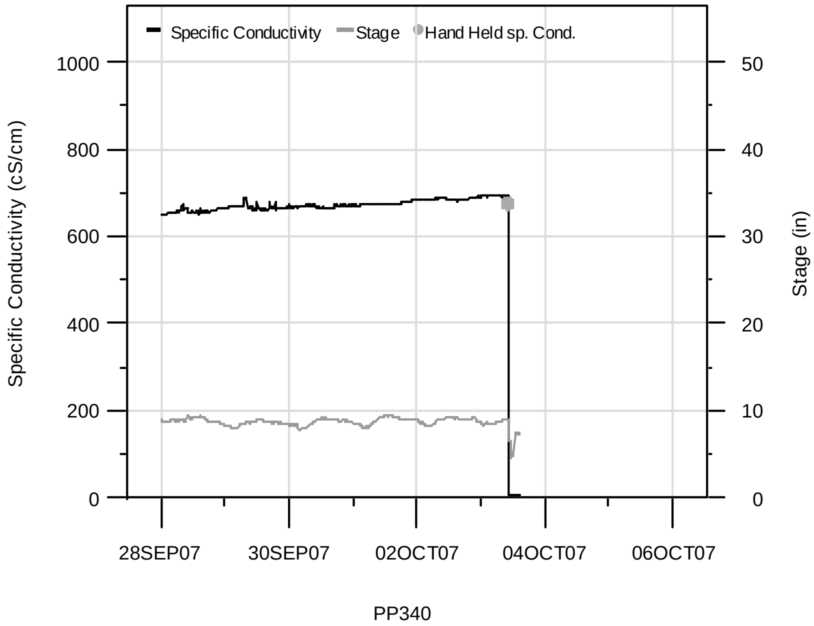

Figure G.14 Continuous Specific Conductivity at Site PP340, 09/28/07 to 10/06/07

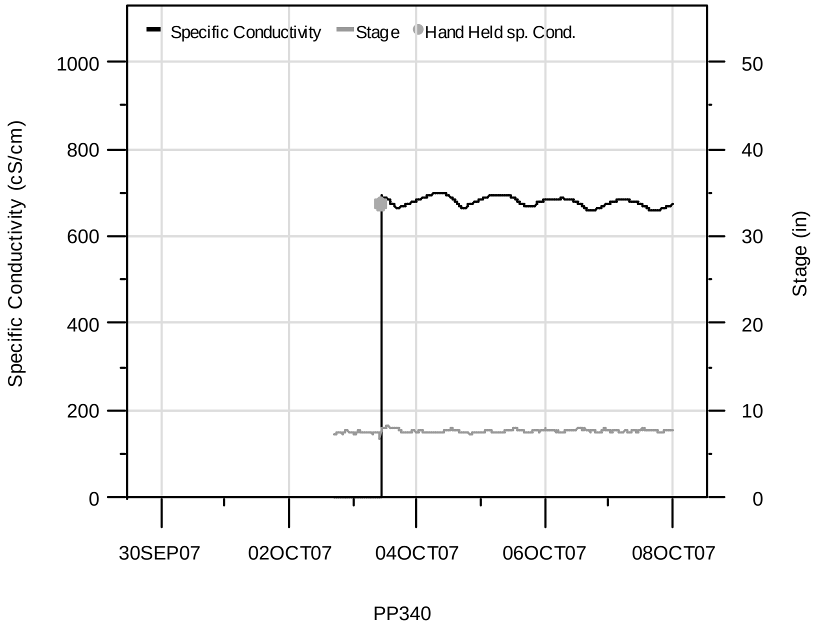

Figure G.15 Continuous Specific Conductivity at Site PP340, 09/30/07 to 10/08/07

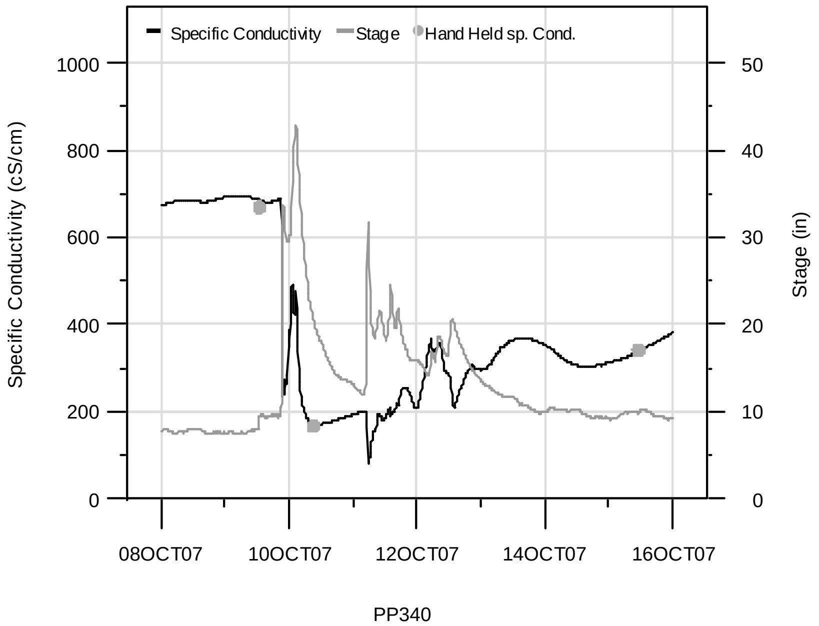

Figure G.16 Continuous Specific Conductivity at Site PP340, 10/08/07 to 10/16/07

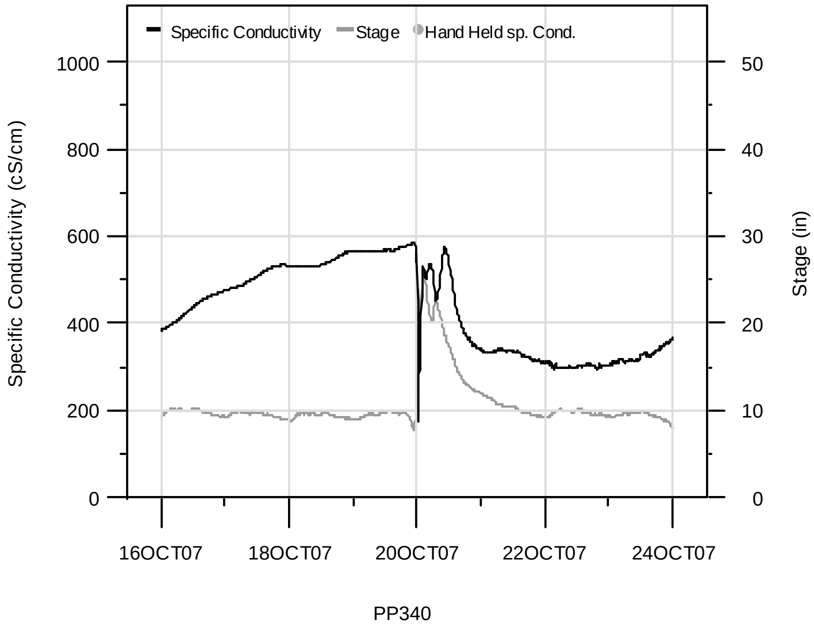

Figure G.17 Continuous Specific Conductivity at Site PP340, 10/16/07 to 10/24/07

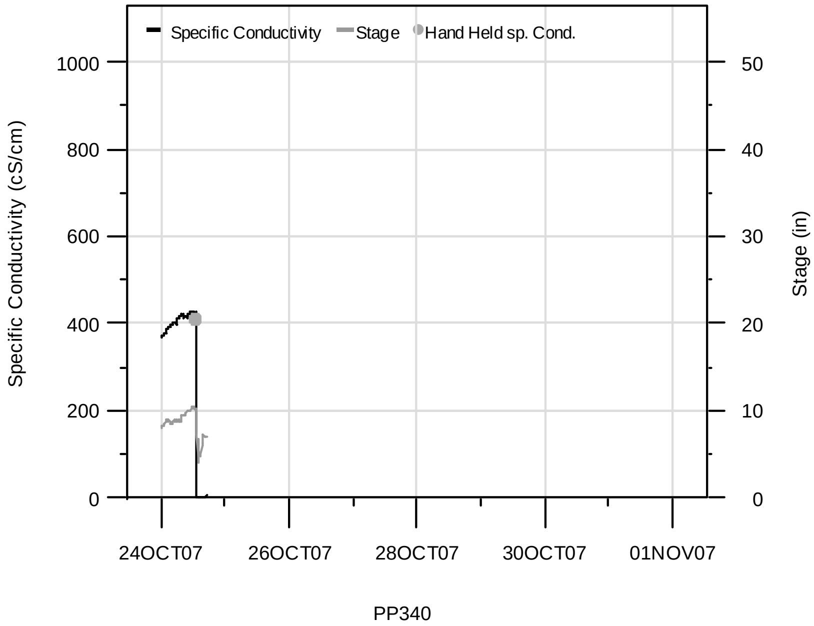

Figure G.18 Continuous Specific Conductivity at Site PP340, 10/24/07 to 11/01/07

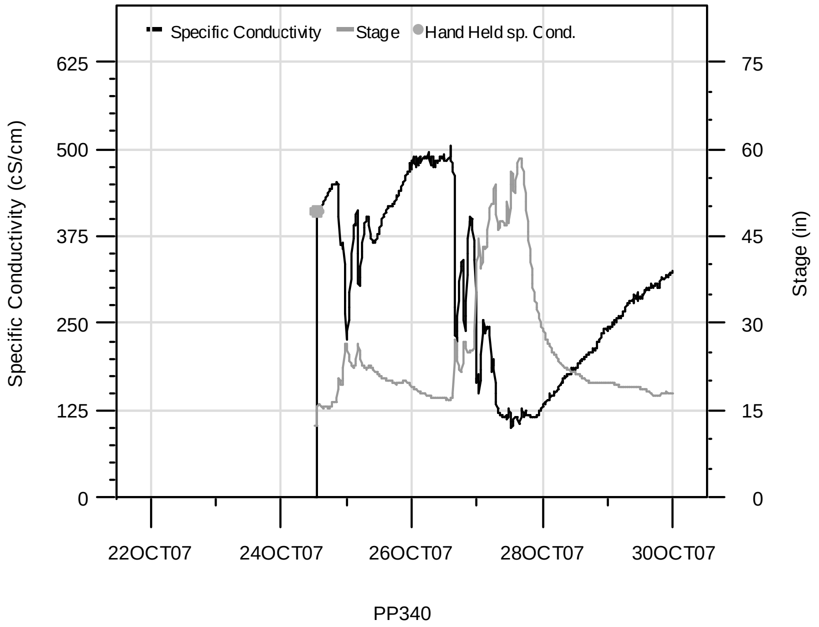

Figure G.19 Continuous Specific Conductivity at Site PP340, 10/22/07 to 10/30/07

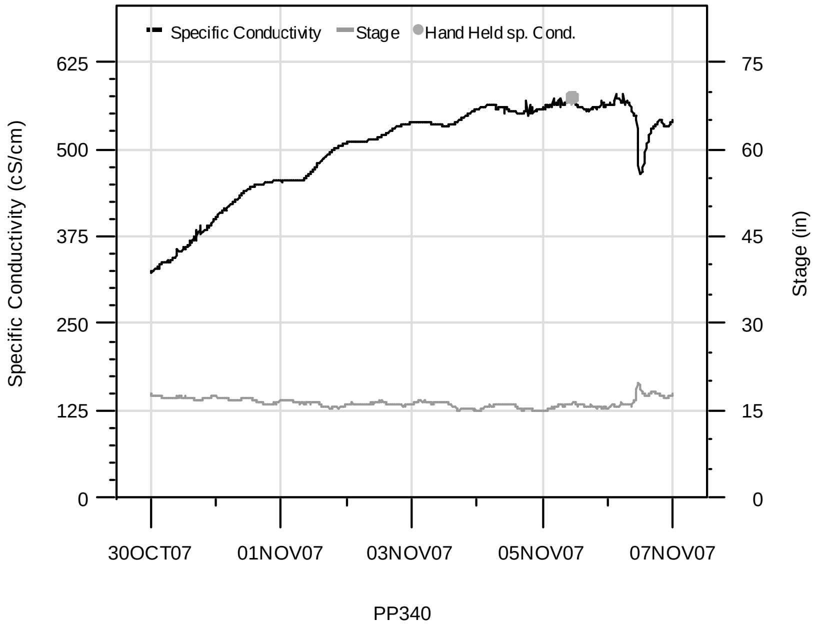

Figure G.20 Continuous Specific Conductivity at Site PP340, 10/30/07 to 11/07/07

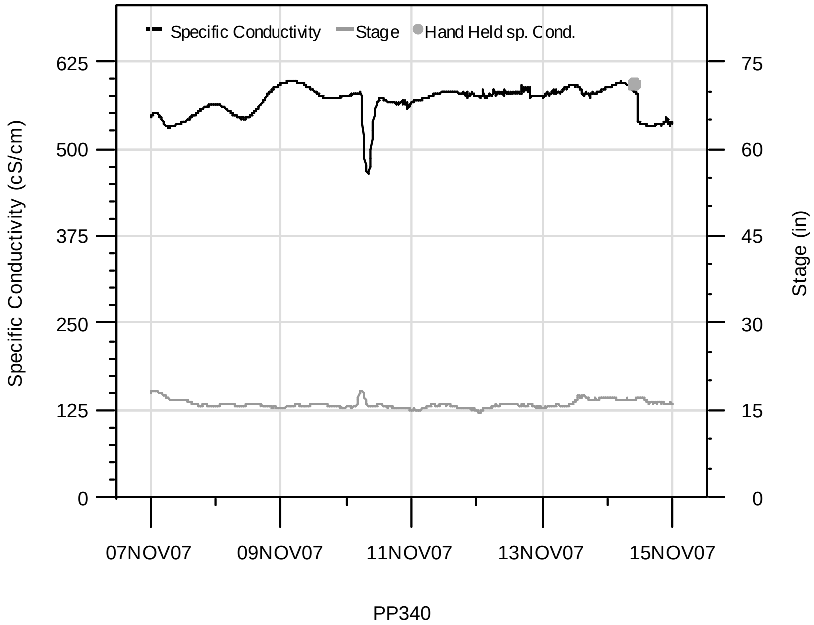

Figure G.21 Continuous Specific Conductivity at Site PP340, 11/07/07 to 11/15/07

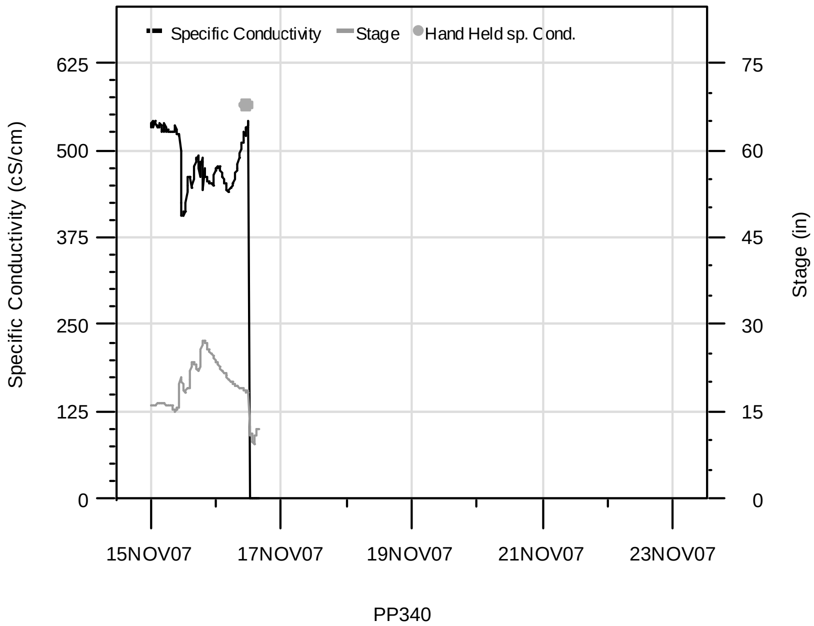

Figure G.22 Continuous Specific Conductivity at Site PP340, 11/15/07 to 11/23/07

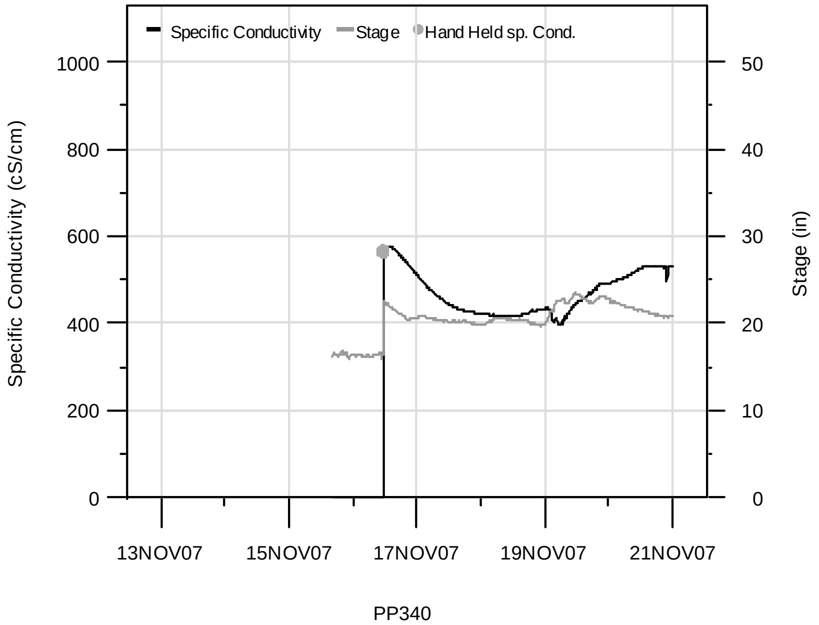

Figure G.23 Continuous Specific Conductivity at Site PP340, 11/13/07 to 11/21/07

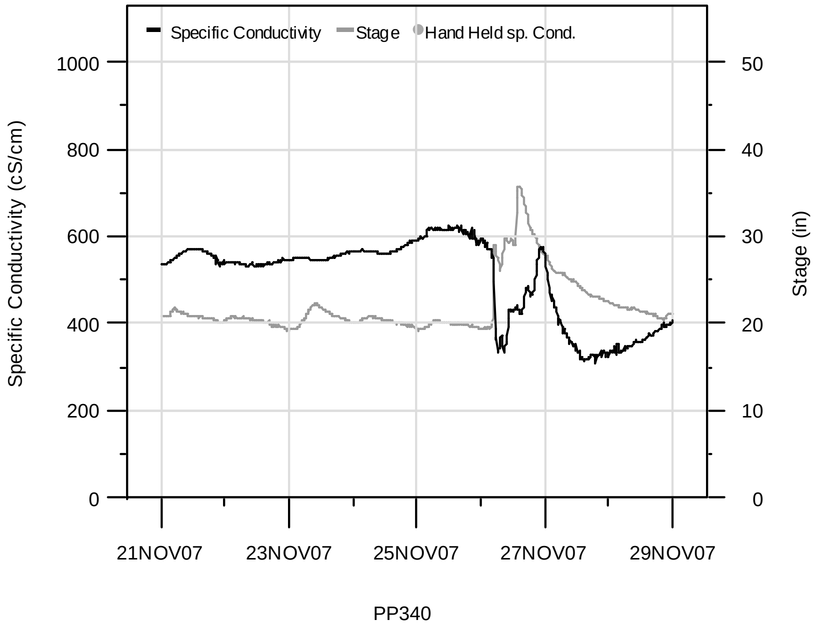

Figure G.24 Continuous Specific Conductivity at Site PP340, 11/21/07 to 11/29/07

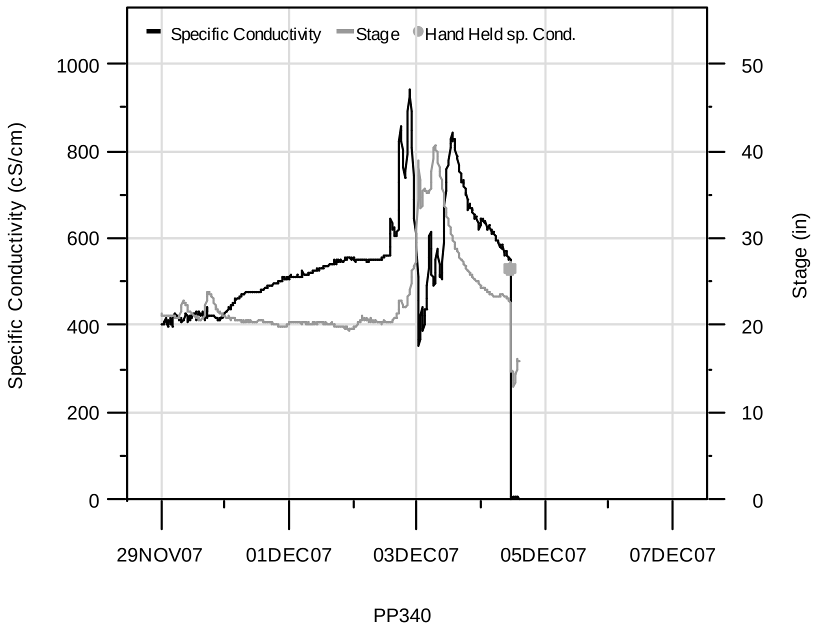

Figure G.25 Continuous Specific Conductivity at Site PP340, 11/29/07 to 12/07/07

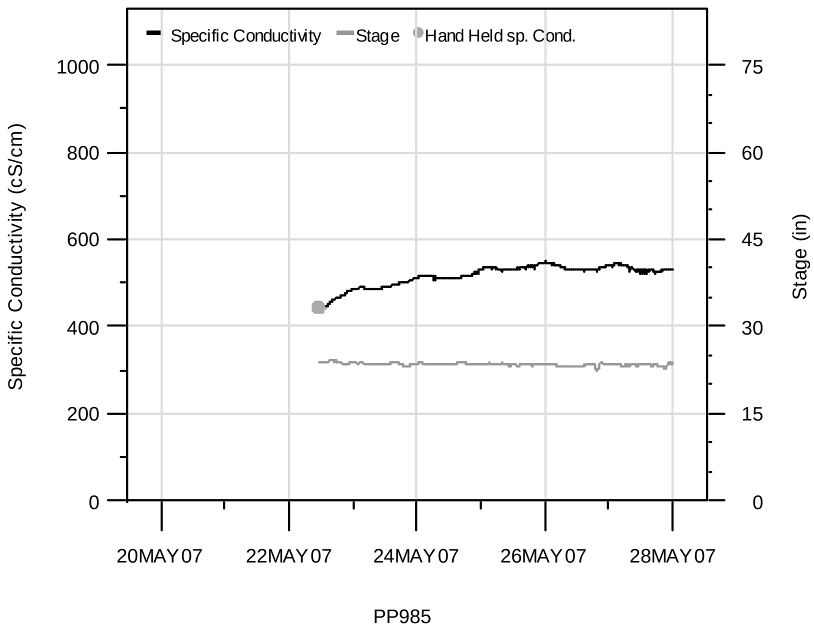

Figure G.26 Continuous Specific Conductivity at Site PP985, 05/20/07 to 05/28/07

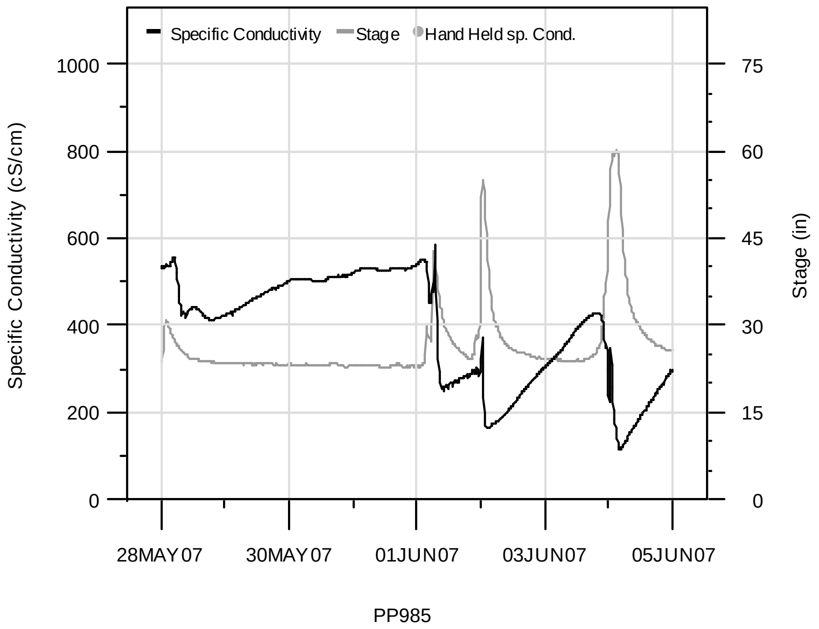

Figure G.27 Continuous Specific Conductivity at Site PP985, 05/28/07 to 06/05/07

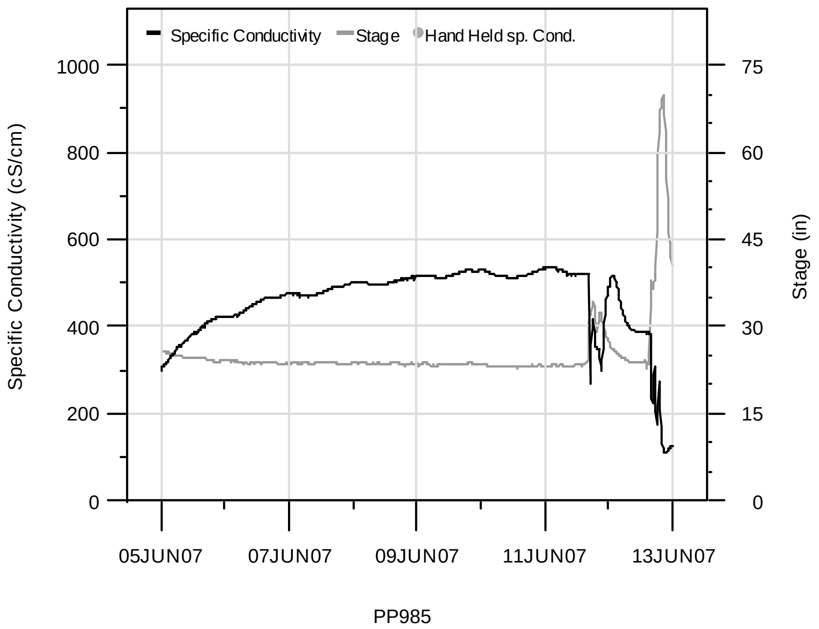

Figure G.28 Continuous Specific Conductivity at Site PP985, 06/05/07 to 06/13/07

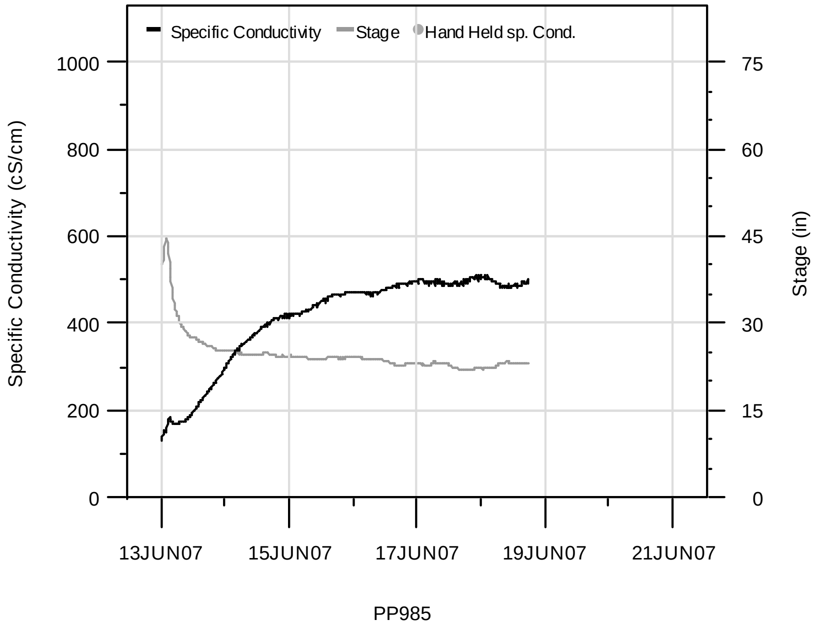

Figure G.29 Continuous Specific Conductivity at Site PP985, 06/13/07 to 06/21/07

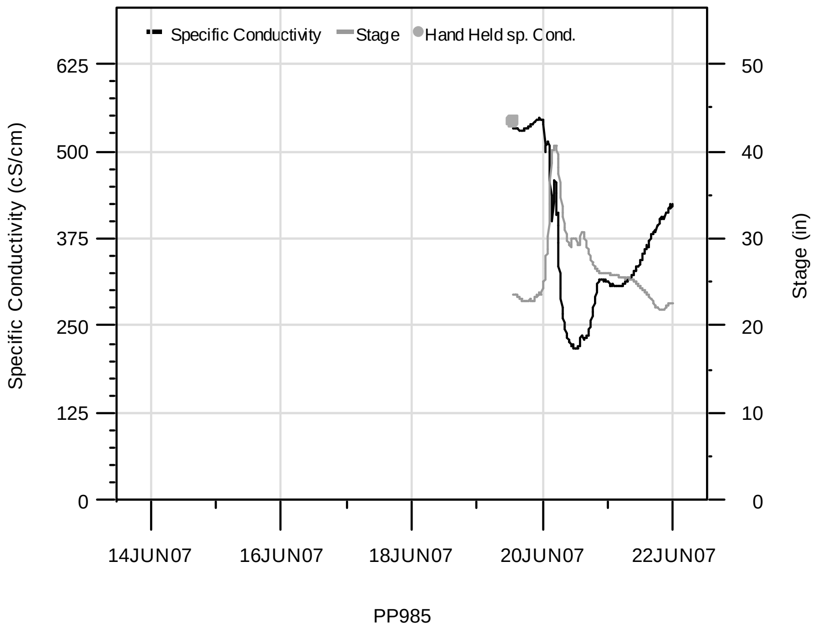

Figure G.30 Continuous Specific Conductivity at Site PP985, 06/14/07 to 06/22/07

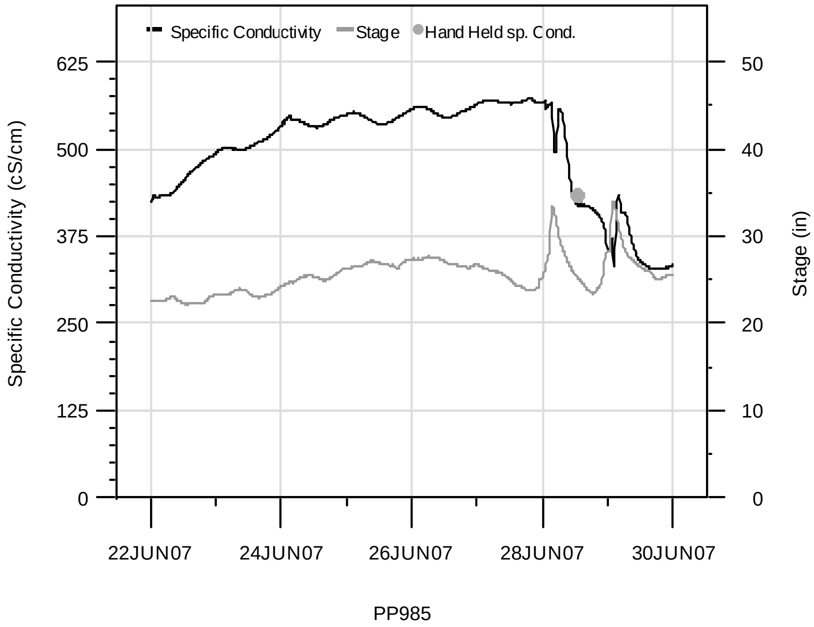

Figure G.31 Continuous Specific Conductivity at Site PP985, 06/22/07 to 06/30/07

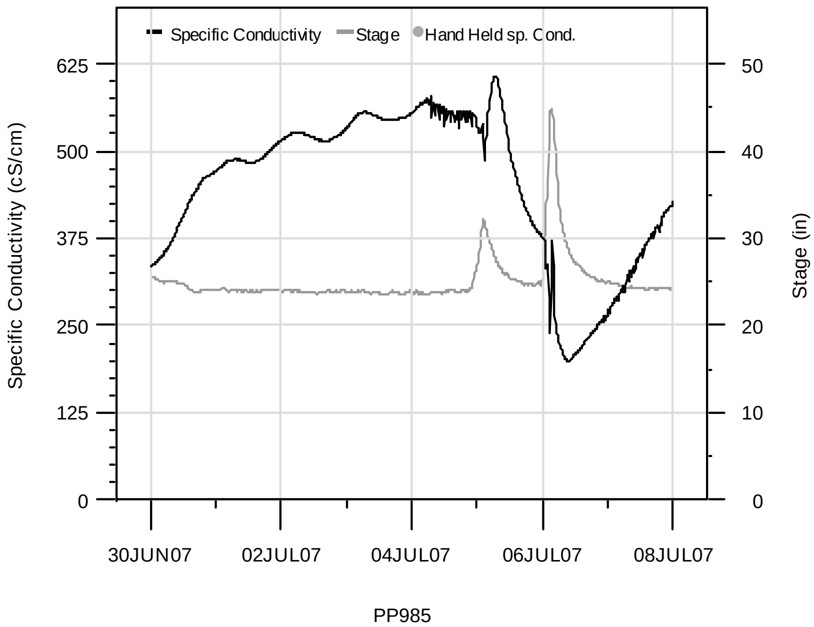

Figure G.32 Continuous Specific Conductivity at Site PP985, 06/30/07 to 07/08/07

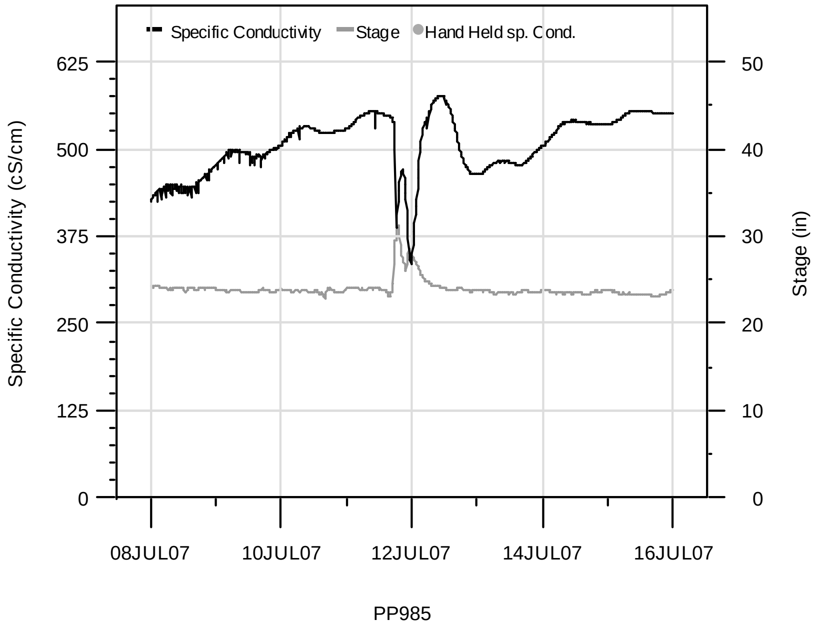

Figure G.33 Continuous Specific Conductivity at Site PP985, 07/08/07 to 07/16/07

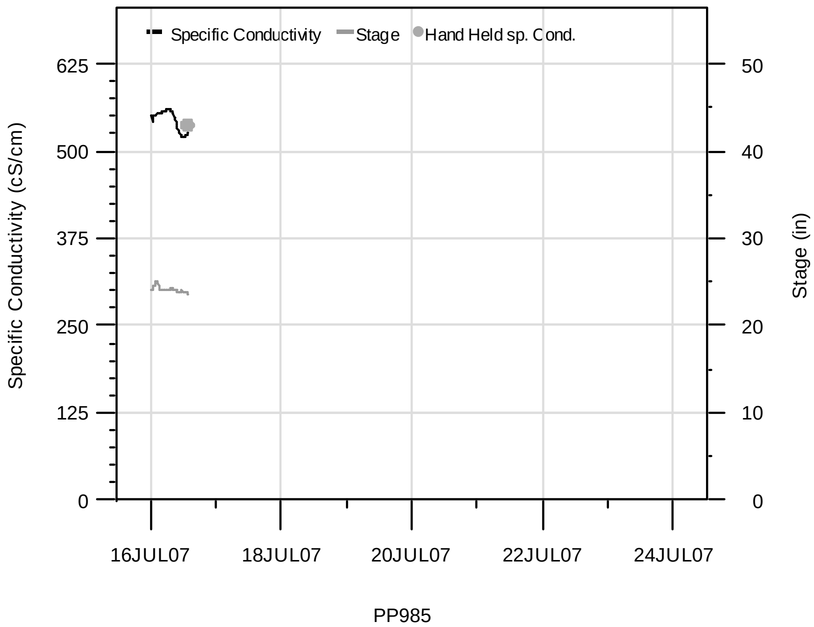

Figure G.34 Continuous Specific Conductivity at Site PP985, 07/16/07 to 07/24/07

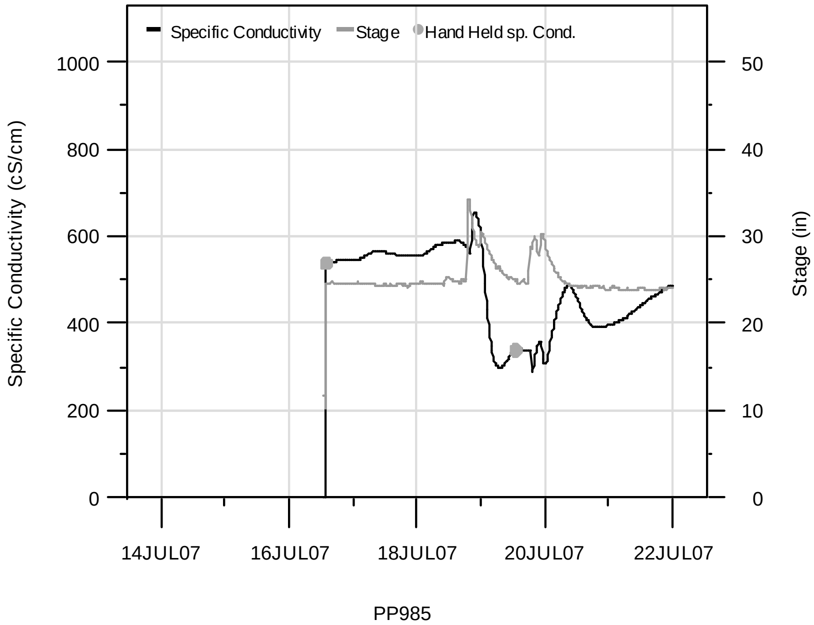

Figure G.35 Continuous Specific Conductivity at Site PP985, 07/14/07 to 07/22/07

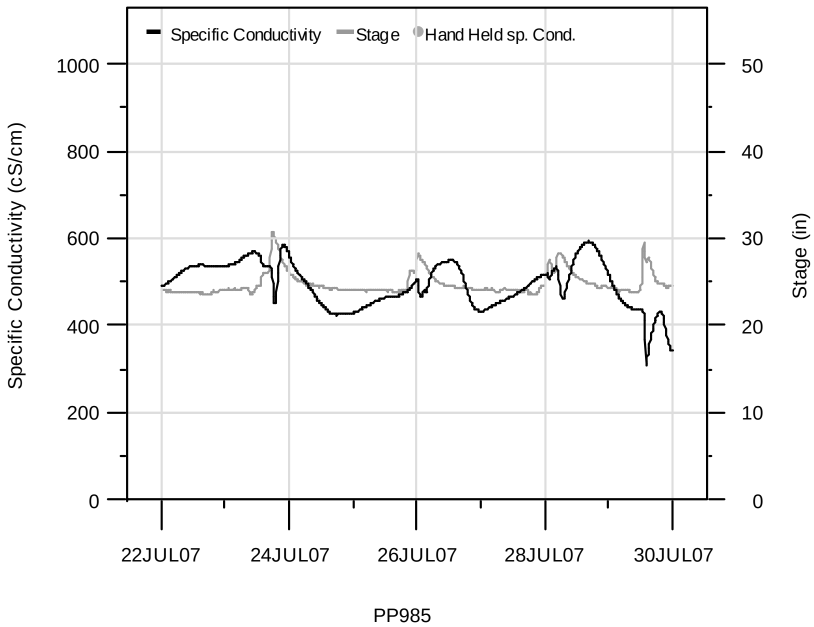

Figure G.36 Continuous Specific Conductivity at Site PP985, 07/22/07 to 07/30/07

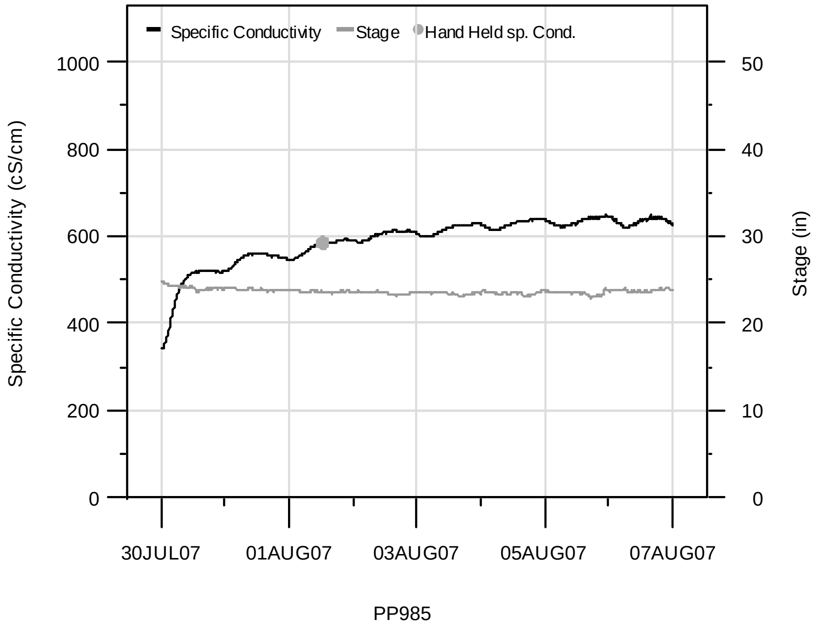

Figure G.37 Continuous Specific Conductivity at Site PP985, 07/30/07 to 08/07/07

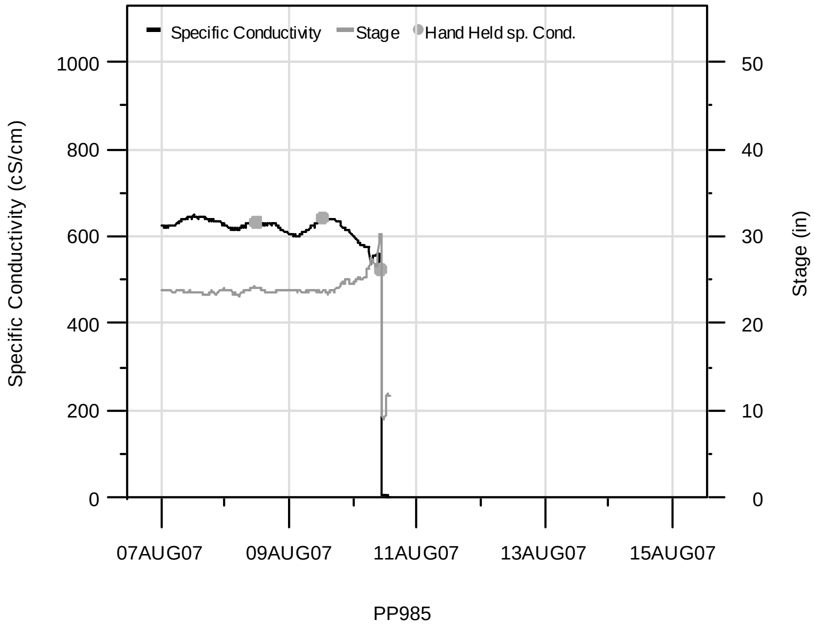

Figure G.38 Continuous Specific Conductivity at Site PP985, 08/07/07 to 08/15/07

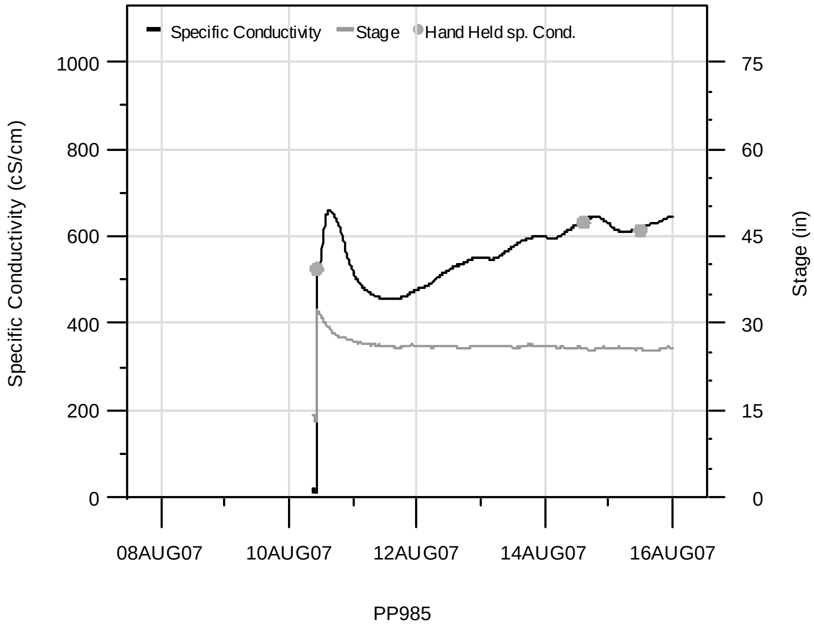

Figure G.39 Continuous Specific Conductivity at Site PP985, 08/08/07 to 08/16/07

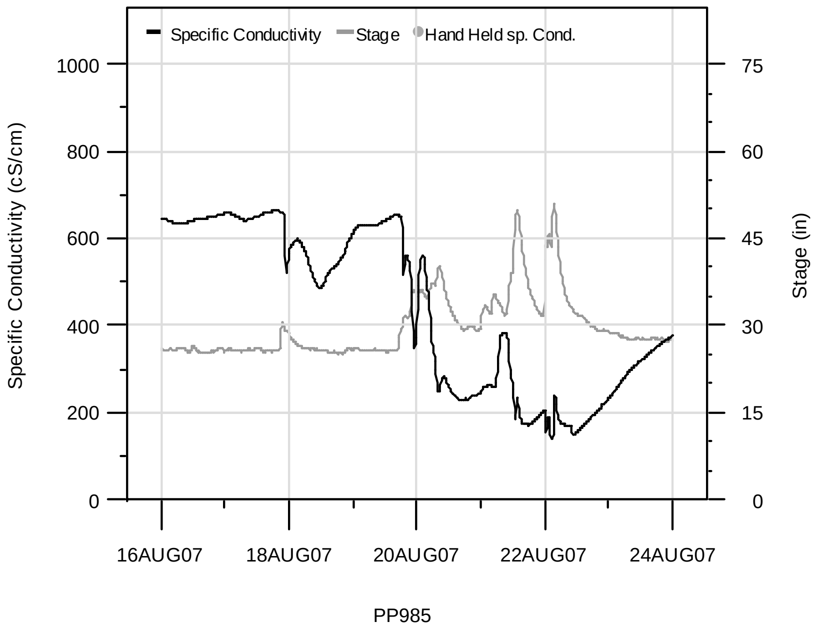

Figure G.40 Continuous Specific Conductivity at Site PP985, 08/16/07 to 08/24/07

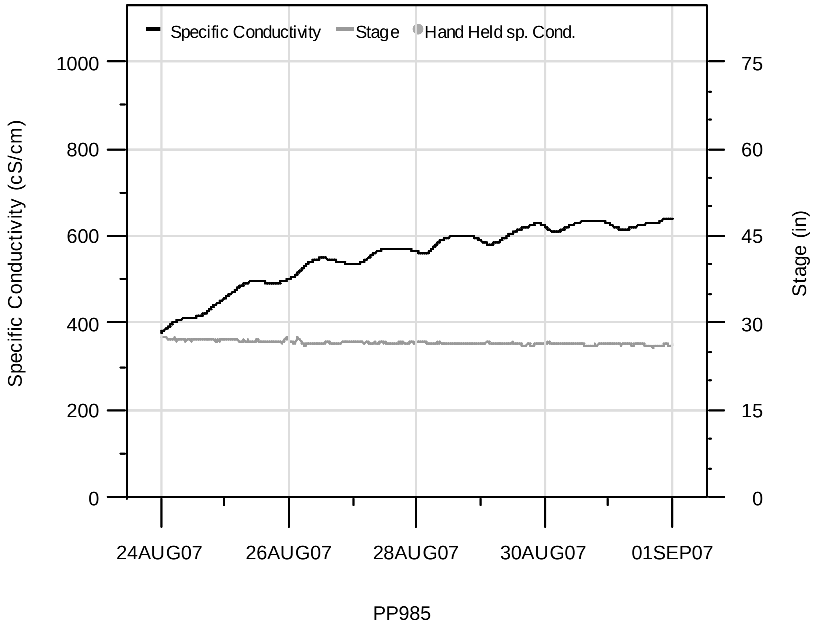

Figure G.41 Continuous Specific Conductivity at Site PP985, 08/24/07 to 09/1/07

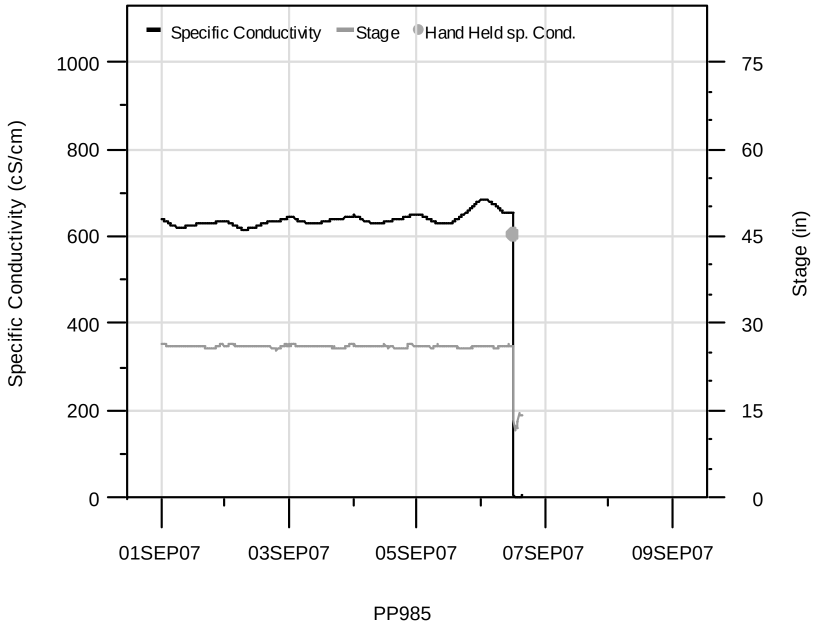

Figure G.42 Continuous Specific Conductivity at Site PP985, 09/01/07 to 09/09/07

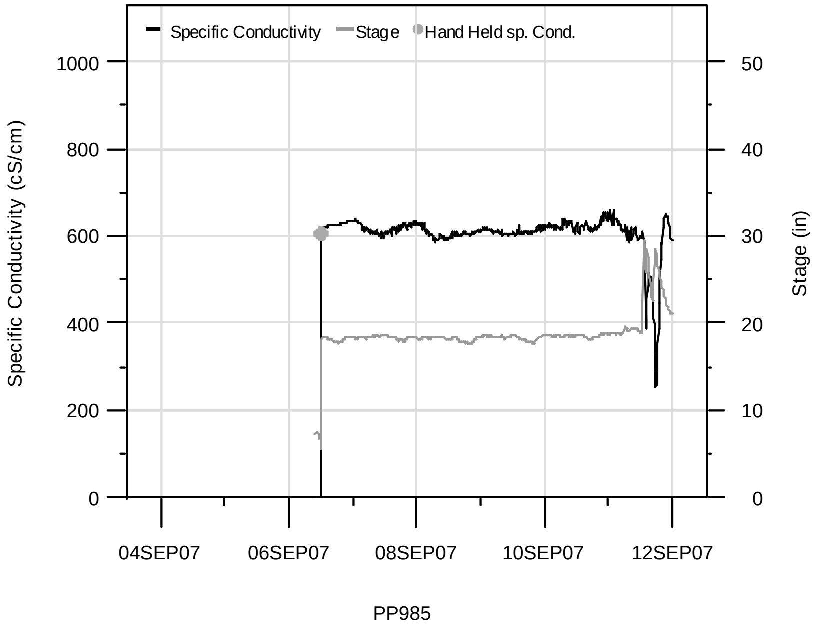

Figure G.43 Continuous Specific Conductivity at Site PP985, 09/04/07 to 09/12/07

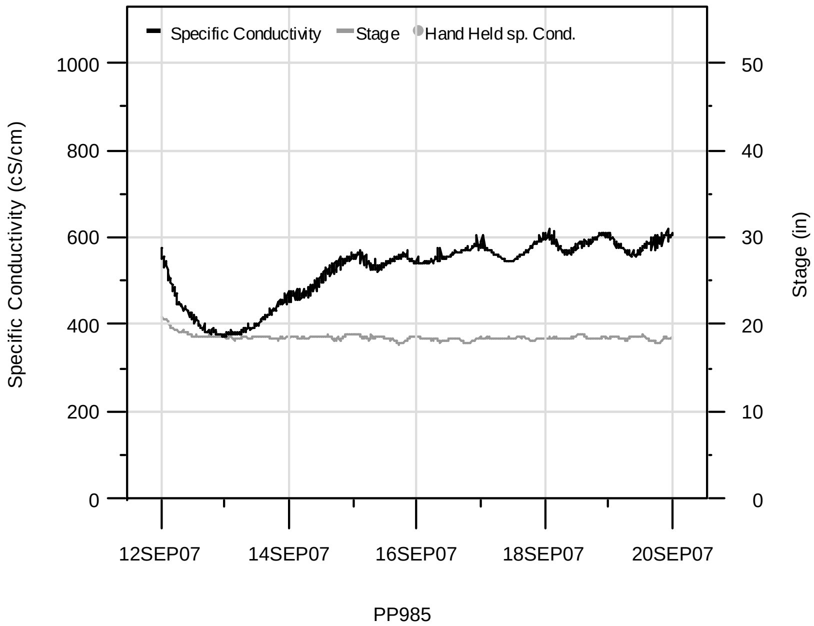

Figure G.44 Continuous Specific Conductivity at Site PP985, 09/12/07 to 09/20/07

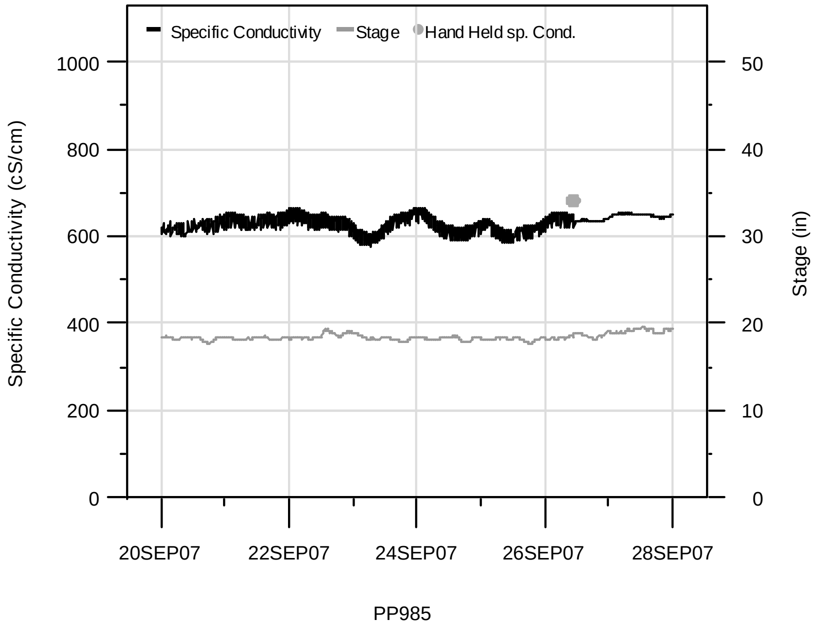

Figure G.45 Continuous Specific Conductivity at Site PP985, 09/20/07 to 09/28/07

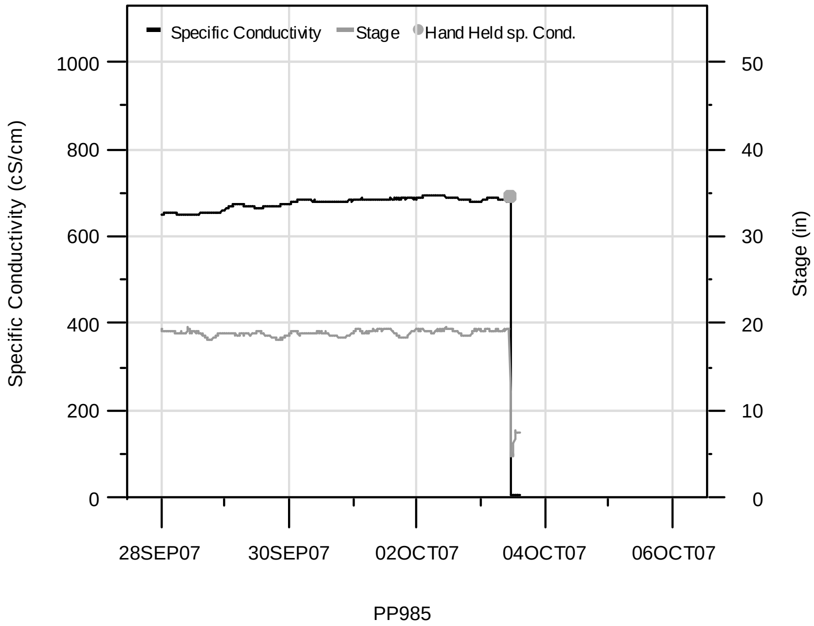

Figure G.46 Continuous Specific Conductivity at Site PP985, 09/28/07 to 10/06/07

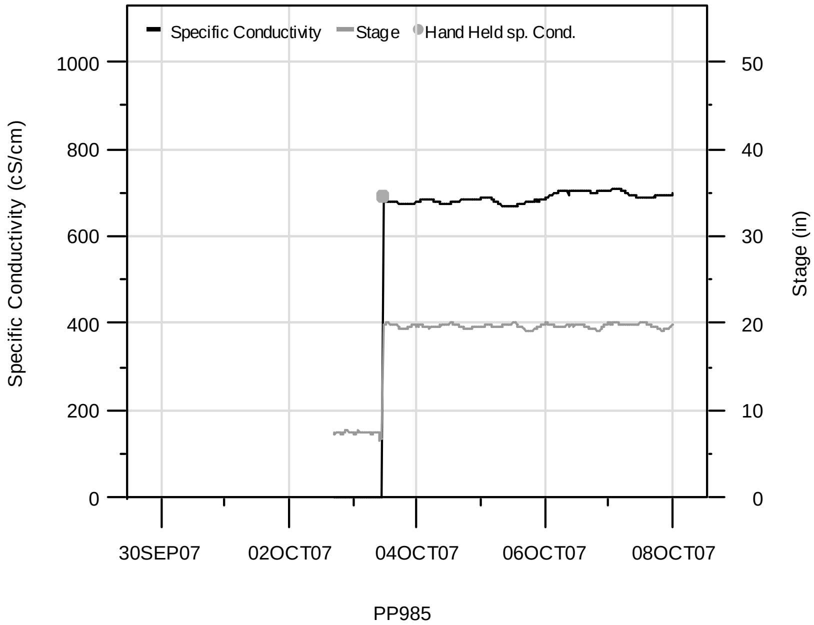

Figure G.47 Continuous Specific Conductivity at Site PP985, 09/30/07 to 10/08/07

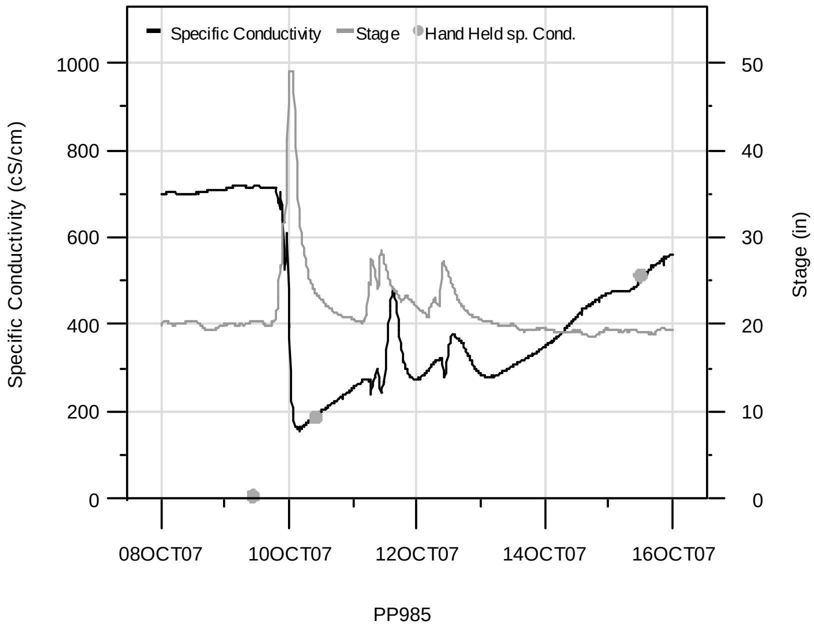

Figure G.48 Continuous Specific Conductivity at Site PP985, 10/08/07 to 10/16/07

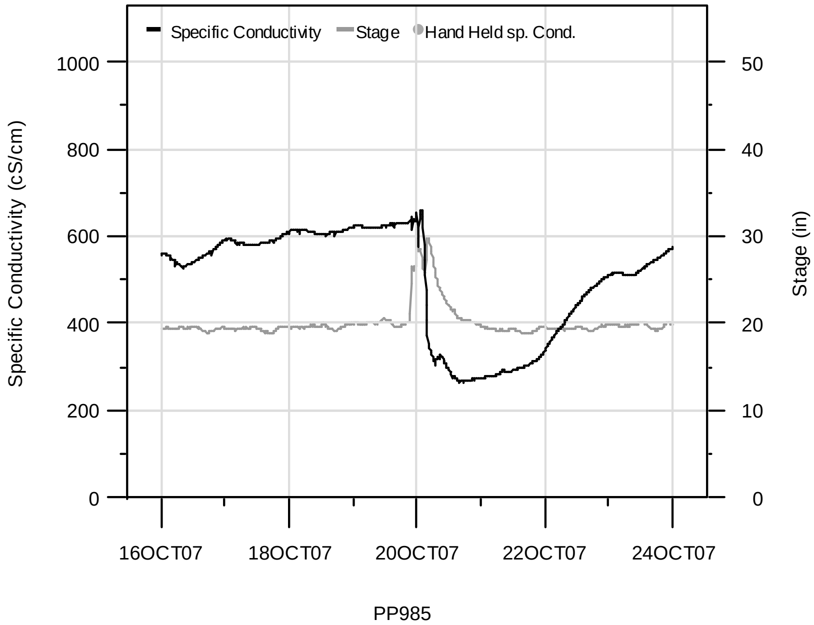

Figure G.49 Continuous Specific Conductivity at Site PP985, 10/16/07 to 10/24/07

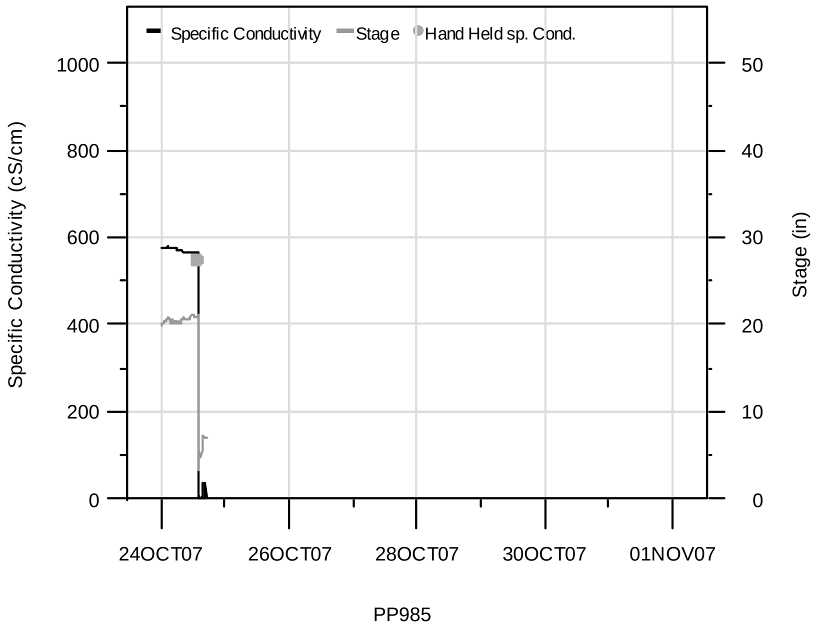

Figure G.50 Continuous Specific Conductivity at Site PP985, 10/24/07 to 11/01/07

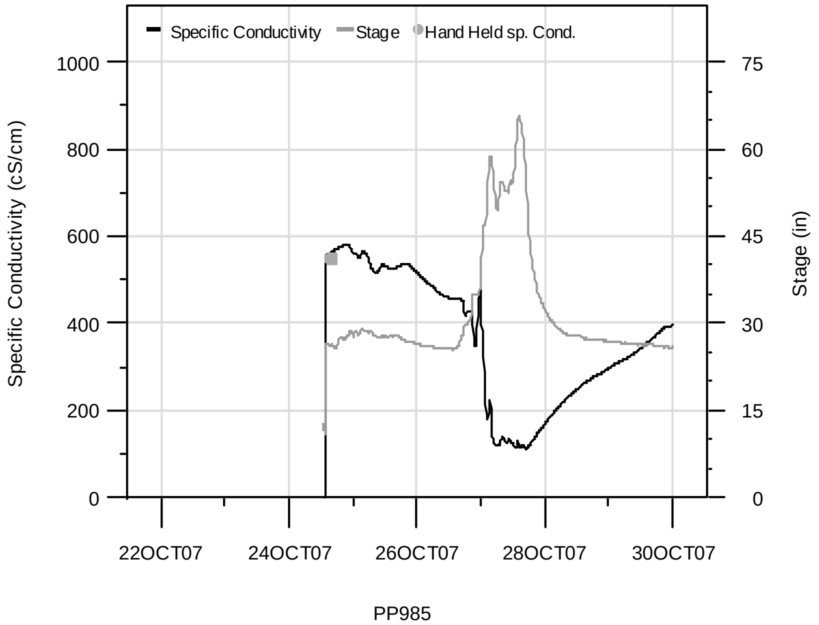

Figure G.51 Continuous Specific Conductivity at Site PP985, 10/22/07 to 10/30/07

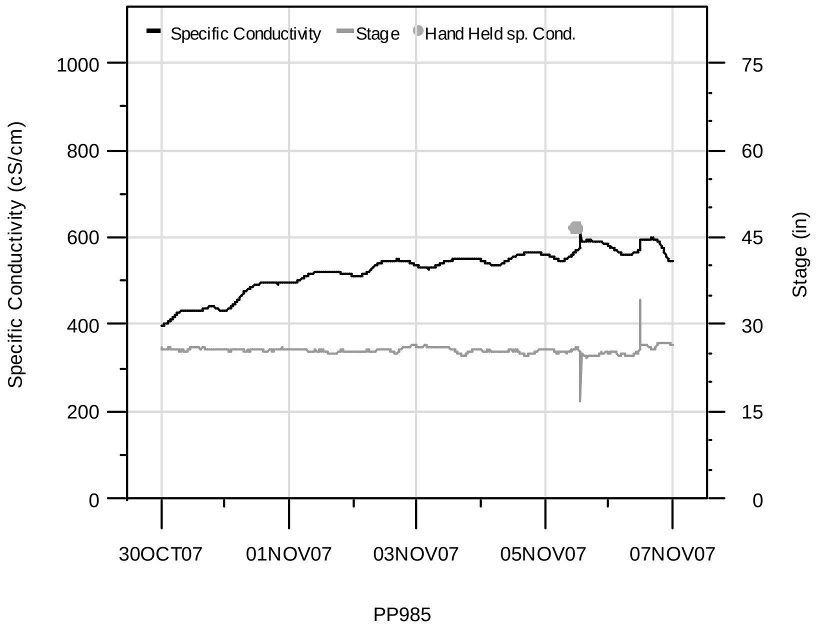

Figure G.52 Continuous Specific Conductivity at Site PP985, 10/30/07 to 11/07/07

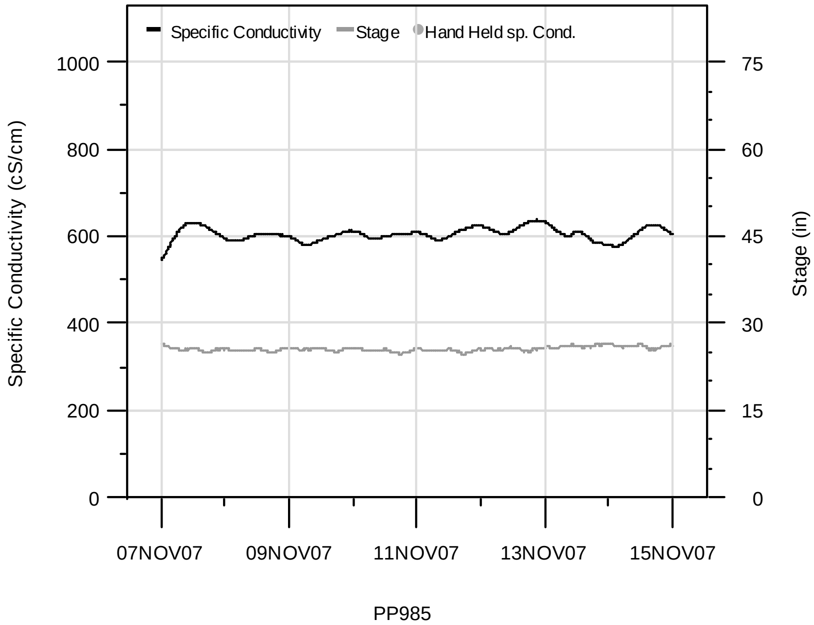

Figure G.53 Continuous Specific Conductivity at Site PP985, 11/07/07 to 11/15/07

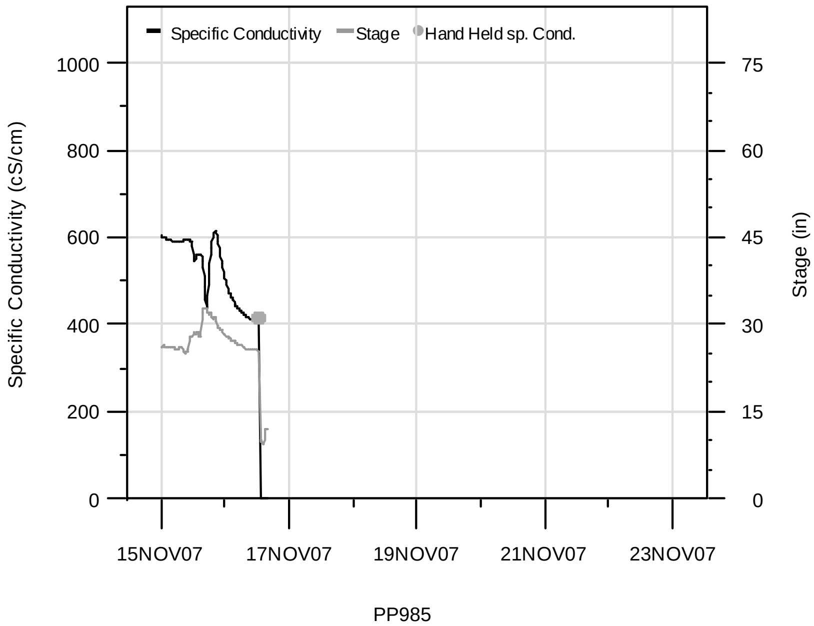

Figure G.54 Continuous Specific Conductivity at Site PP985, 11/15/07 to 11/23/07

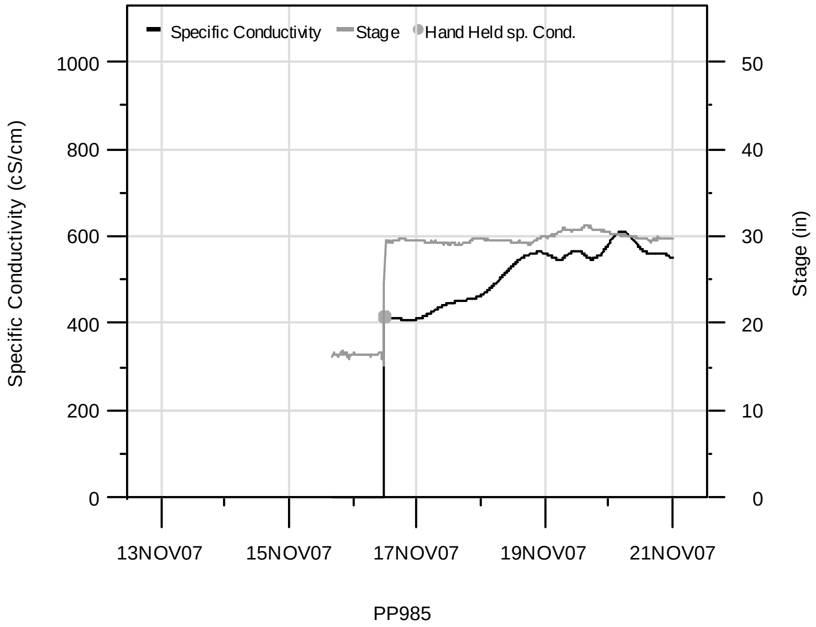

Figure G.55 Continuous Specific Conductivity at Site PP985, 11/13/07 to 11/21/07

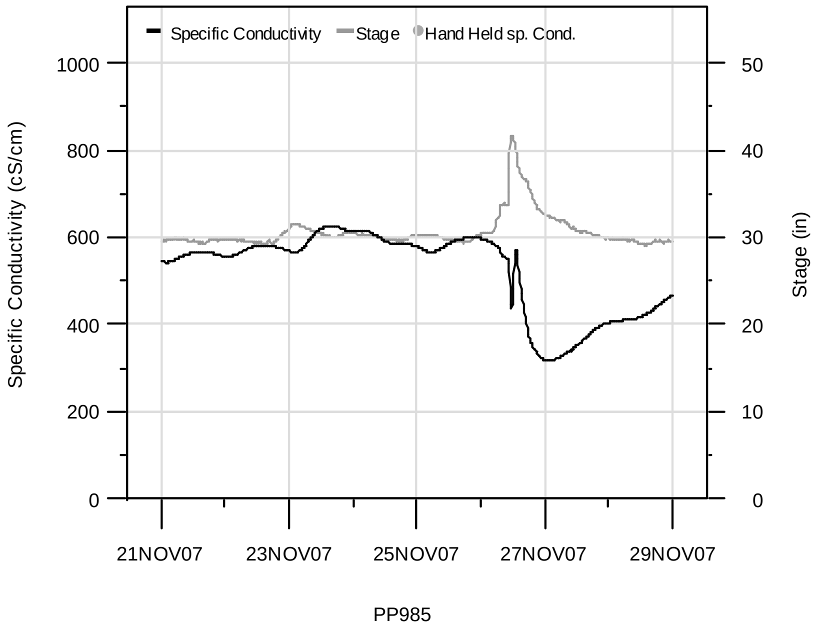

Figure G.56 Continuous Specific Conductivity at Site PP985, 11/21/07 to 11/29/07

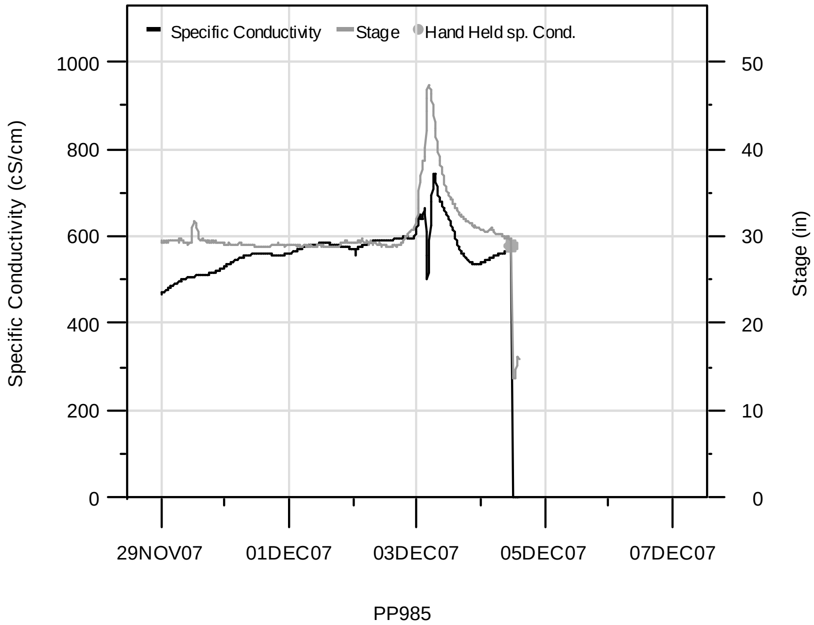

Figure G.57 Continuous Specific Conductivity at Site PP985, 11/29/07 to 12/07/07

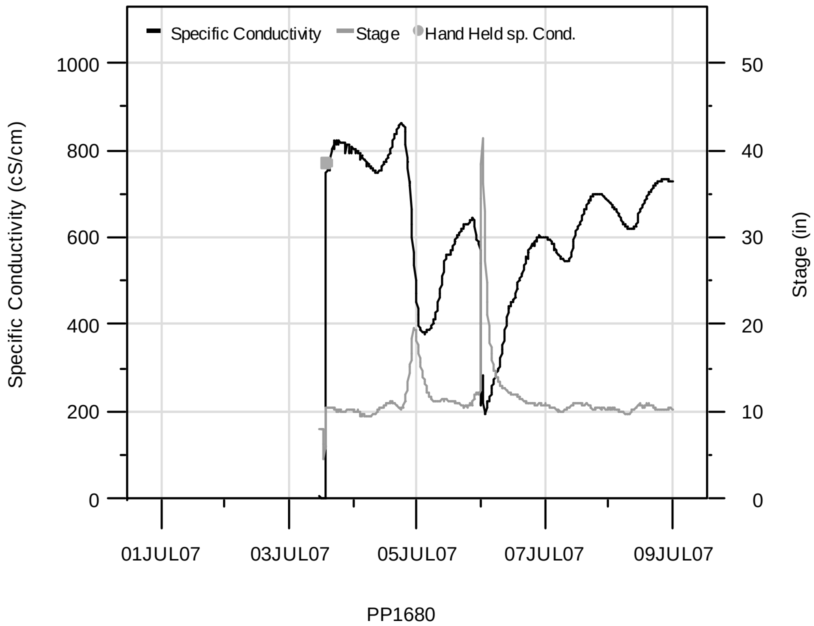

Figure G.58 Continuous Specific Conductivity at Site PP1680, 07/01/07 to 07/09/07

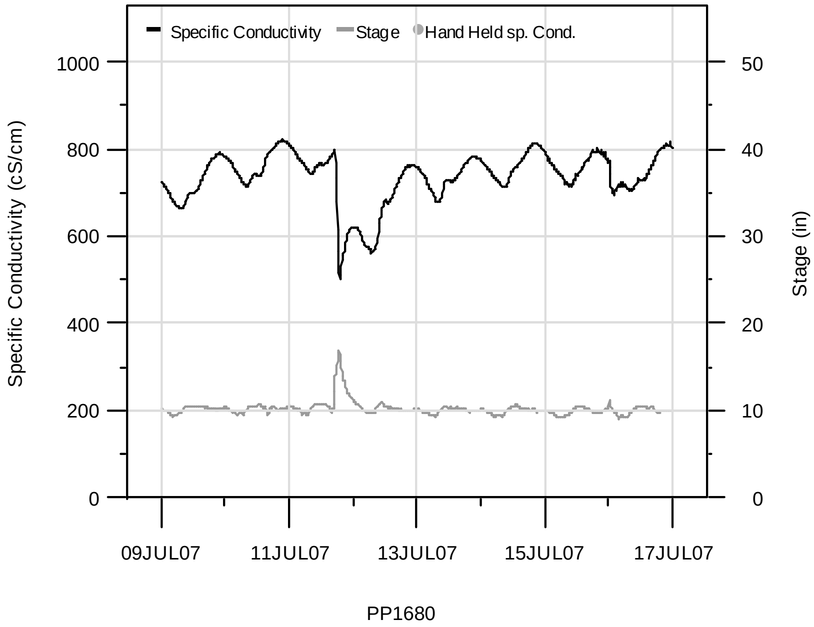

Figure G.59 Continuous Specific Conductivity at Site PP1680, 07/09/07 to 07/17/07

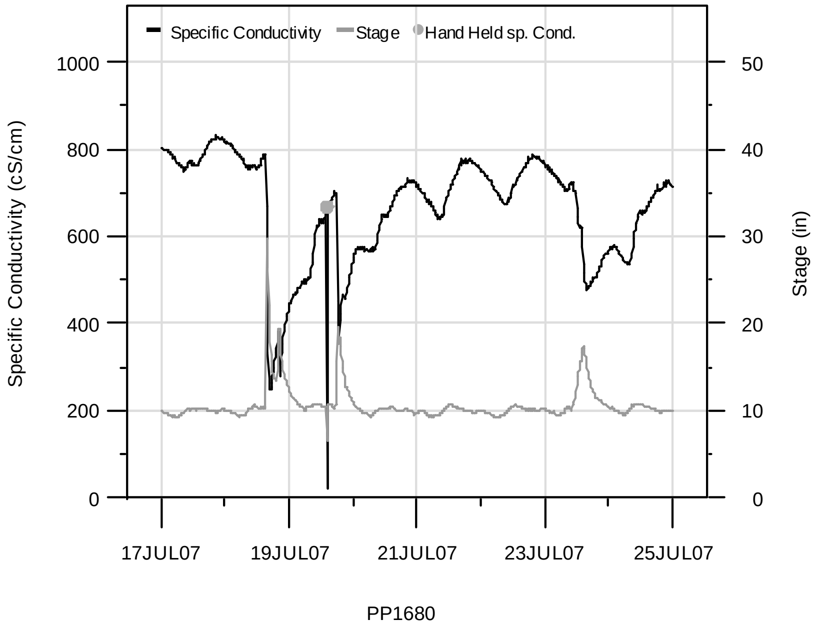

Figure G.60 Continuous Specific Conductivity at Site PP1680, 07/17/07 to 07/25/07

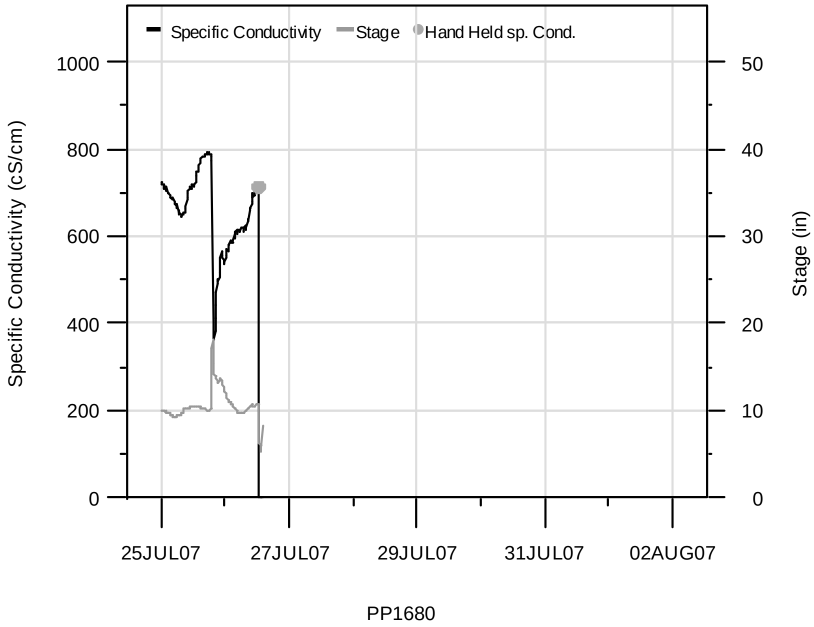

Figure G.61 Continuous Specific Conductivity at Site PP1680, 07/25/07 to 08/02/07

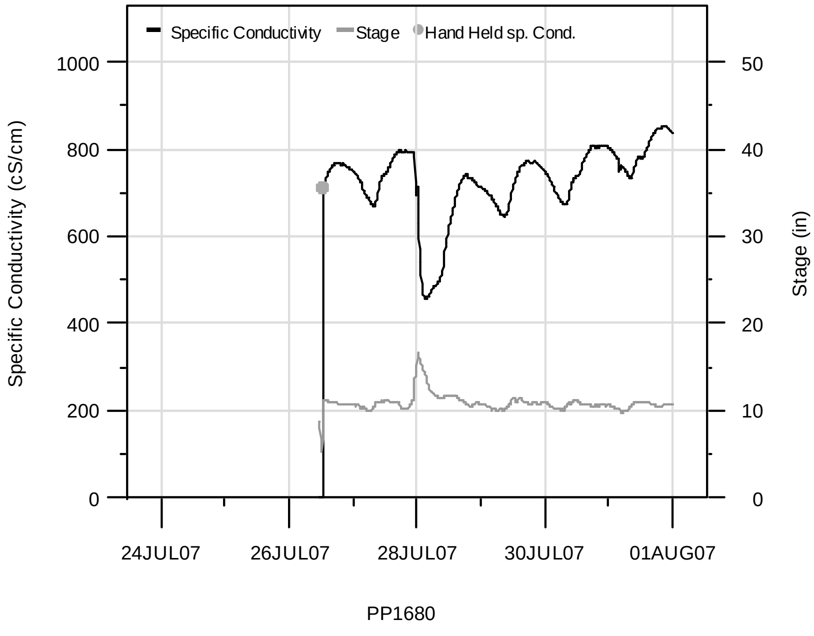

Figure G.62 Continuous Specific Conductivity at Site PP1680, 07/24/07 to 08/01/07

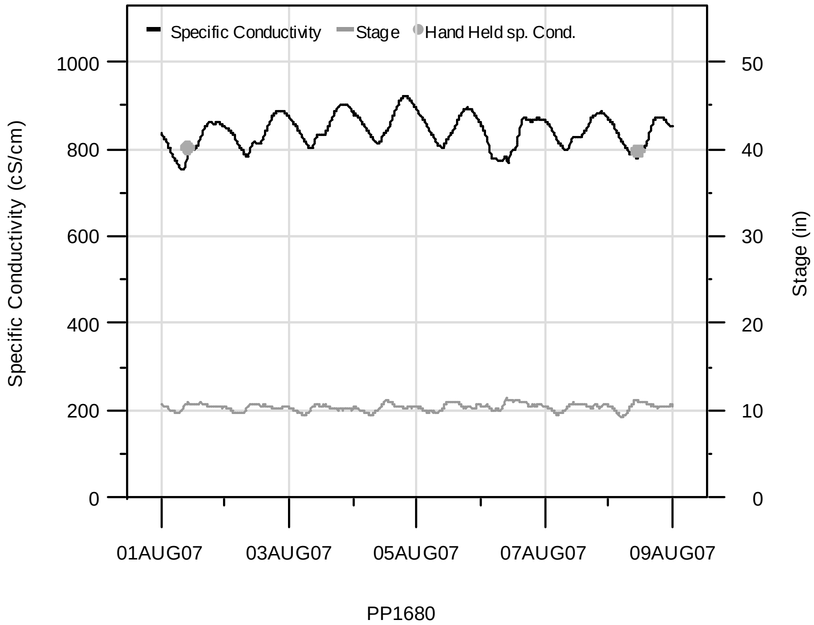

Figure G.63 Continuous Specific Conductivity at Site PP1680, 08/01/07 to 08/09/07

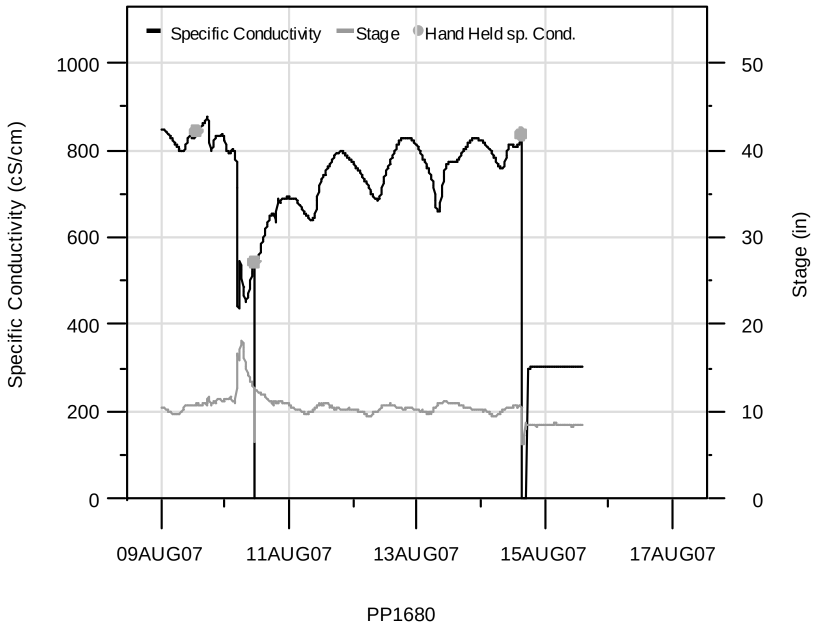

Figure G.64 Continuous Specific Conductivity at Site PP1680, 08/09/07 to 08/17/07

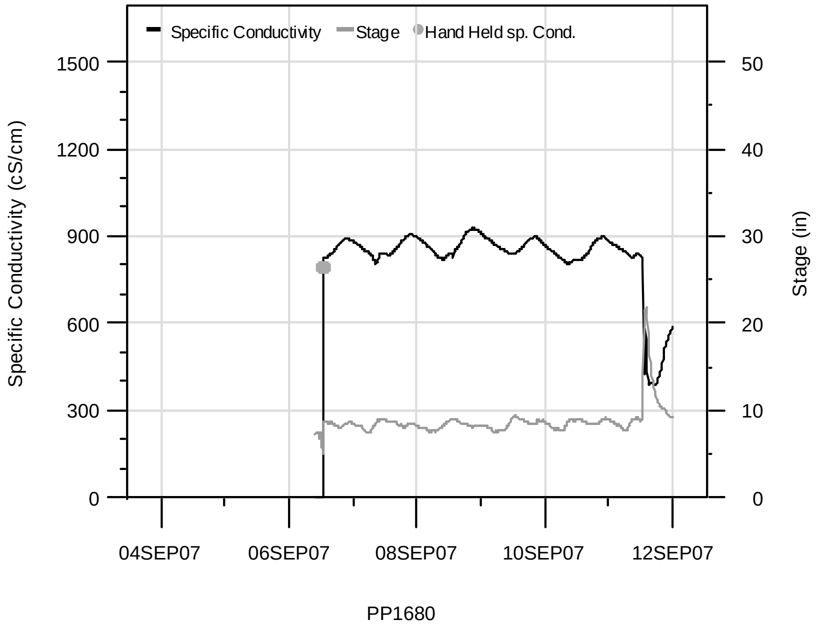

Figure G.65 Continuous Specific Conductivity at Site PP1680, 09/04/07 to 09/12/07

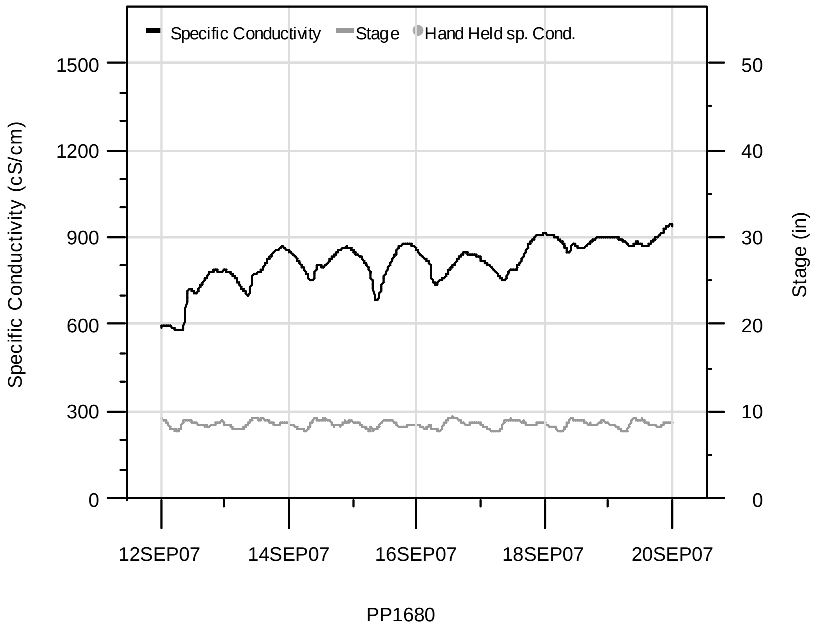

Figure G.66 Continuous Specific Conductivity at Site PP1680, 09/12/07 to 09/20/07

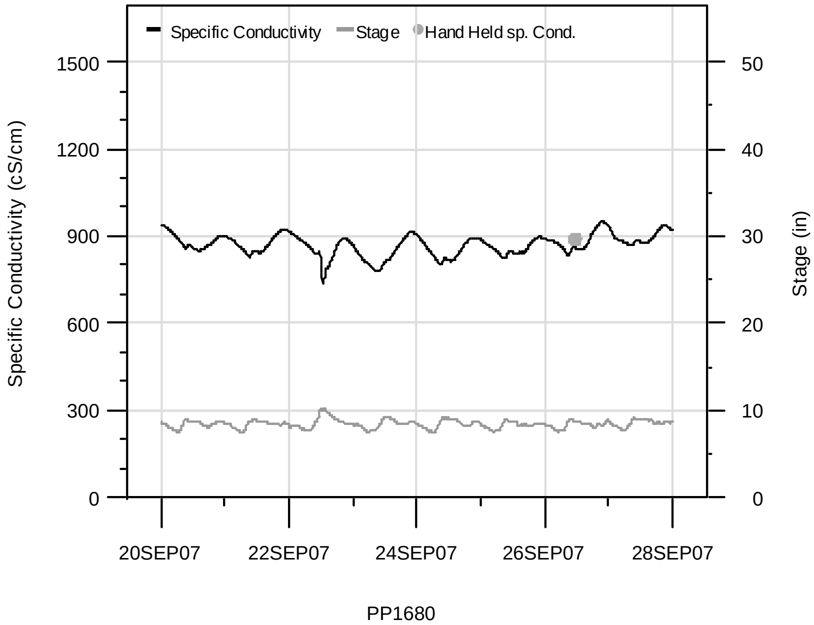

Figure G.67 Continuous Specific Conductivity at Site PP1680, 09/20/07 to 09/28/07

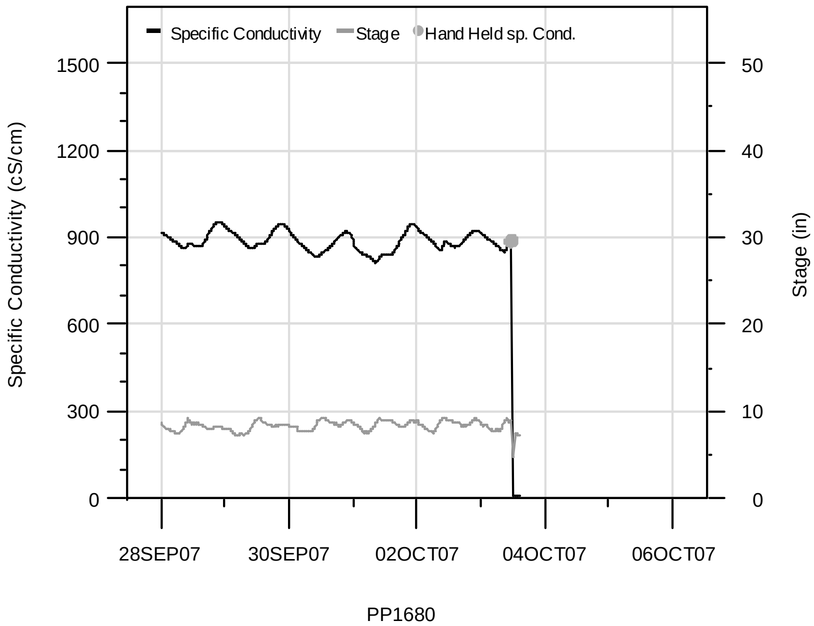

Figure G.68 Continuous Specific Conductivity at Site PP1680, 09/28/07 to 10/06/07

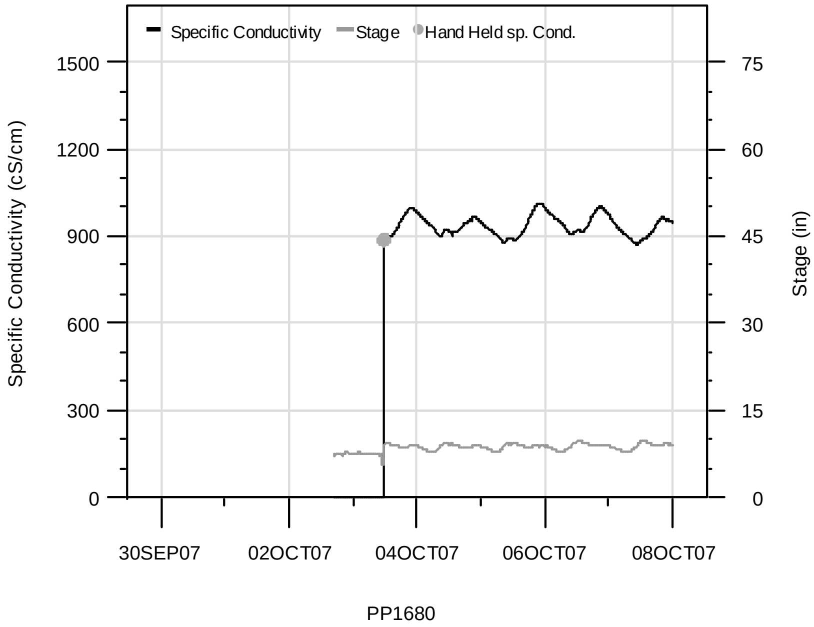

Figure G.69 Continuous Specific Conductivity at Site PP1680, 09/30/07 to 10/08/07

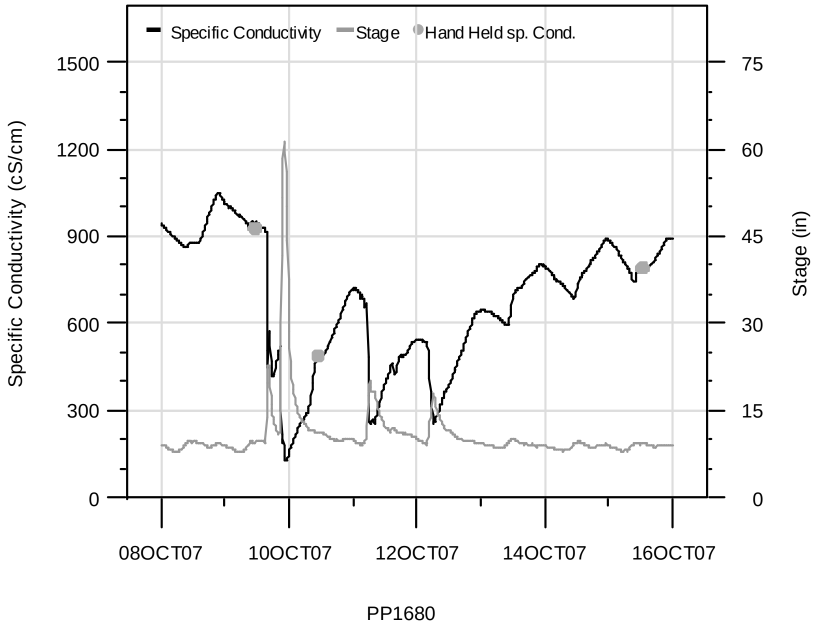

Figure G.70 Continuous Specific Conductivity at Site PP1680, 10/08/07 to 10/16/07

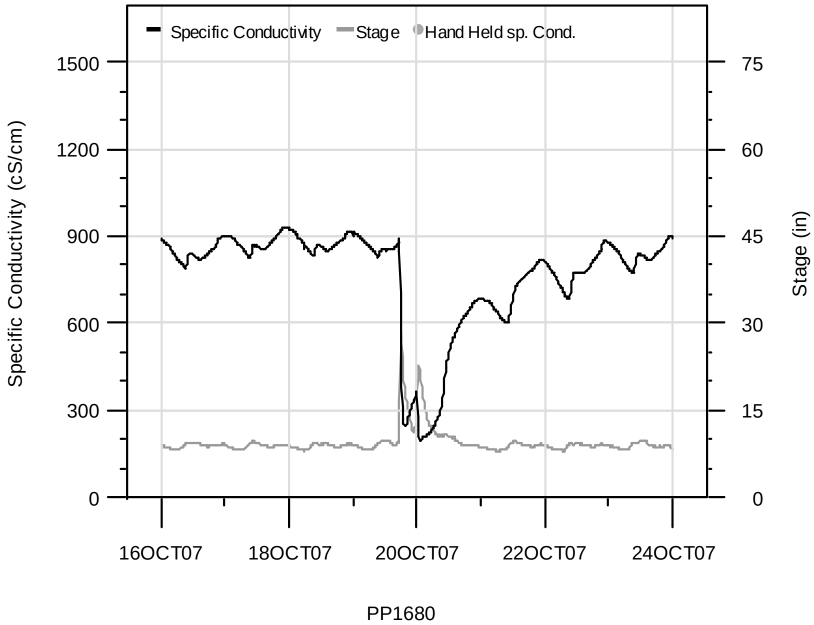

Figure G.71 Continuous Specific Conductivity at Site PP1680, 10/16/07 to 10/24/07

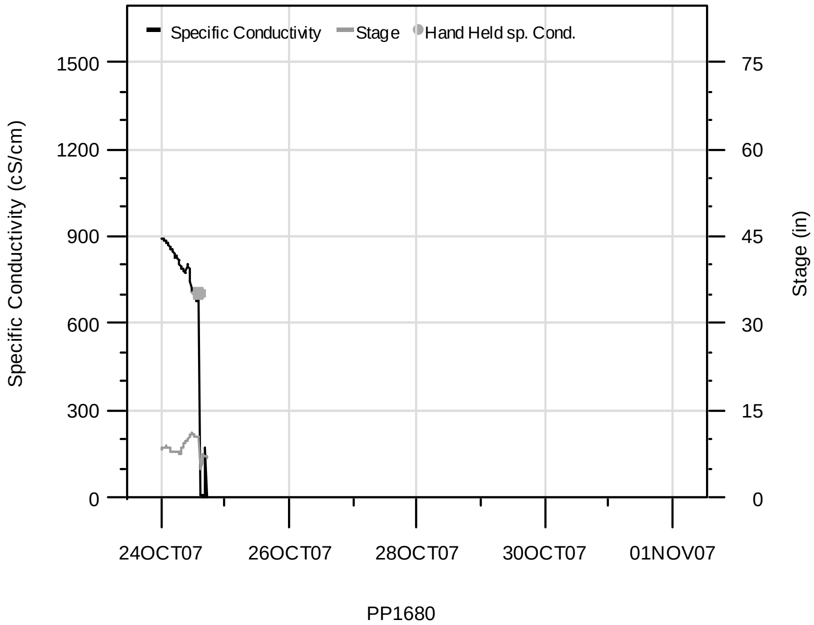

Figure G.72 Continuous Specific Conductivity at Site PP1680, 10/24/07 to 11/01/07

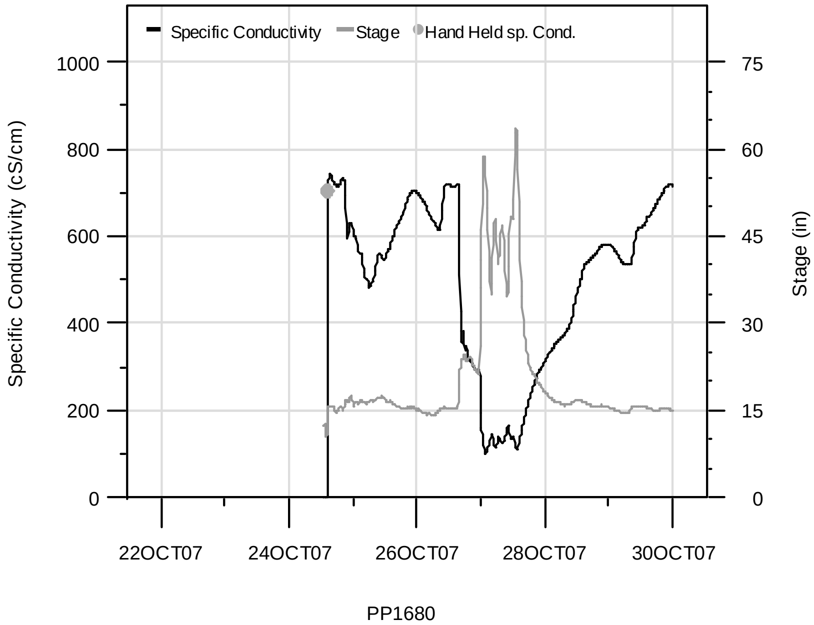

Figure G.73 Continuous Specific Conductivity at Site PP1680, 10/22/07 to 10/30/07

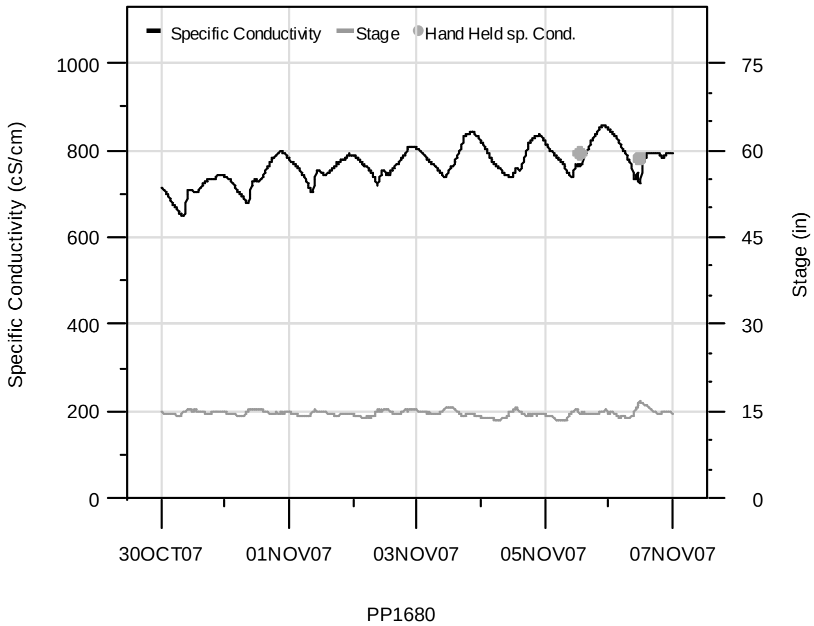

Figure G.74 Continuous Specific Conductivity at Site PP1680, 10/30/07 to 11/07/07

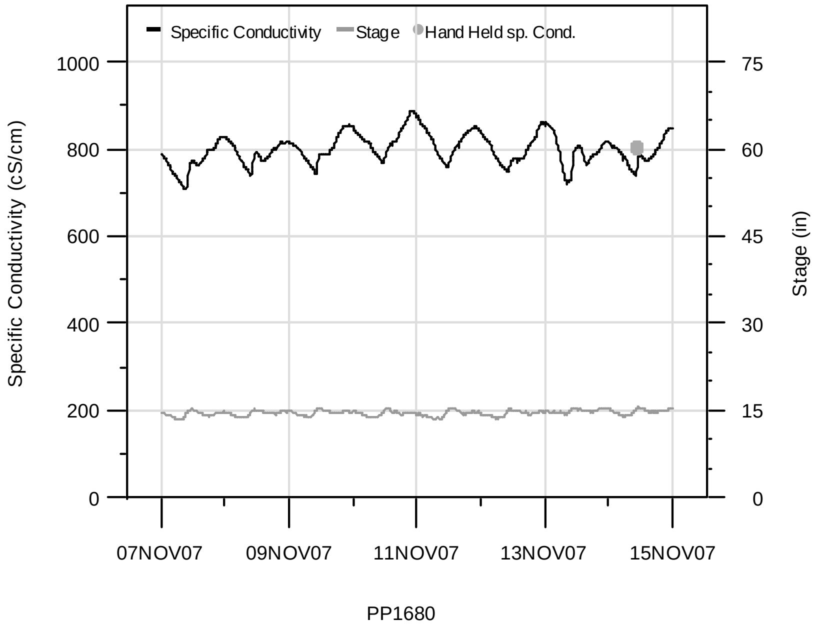

Figure G.75 Continuous Specific Conductivity at Site PP1680, 11/07/07 to 11/15/07

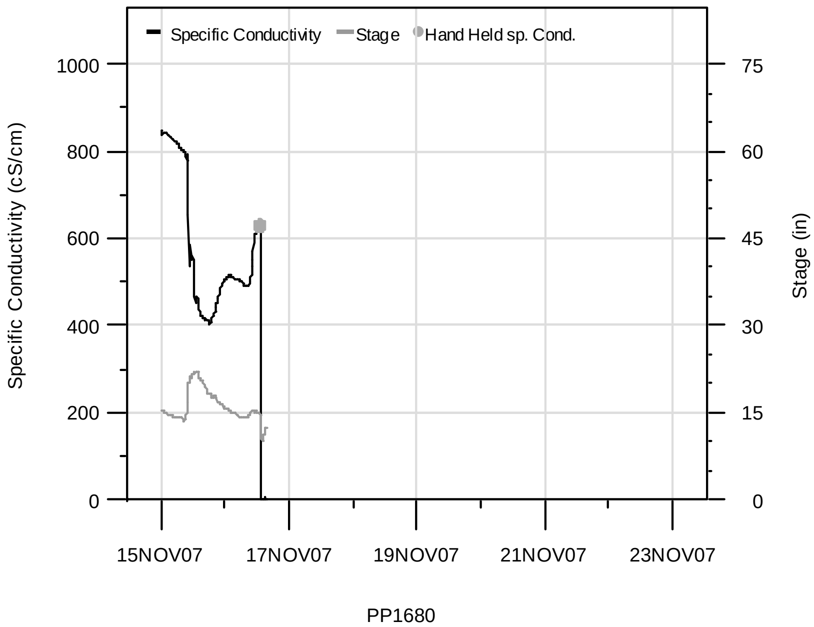

Figure G.76 Continuous Specific Conductivity at Site PP1680, 11/15/07 to 11/23/07

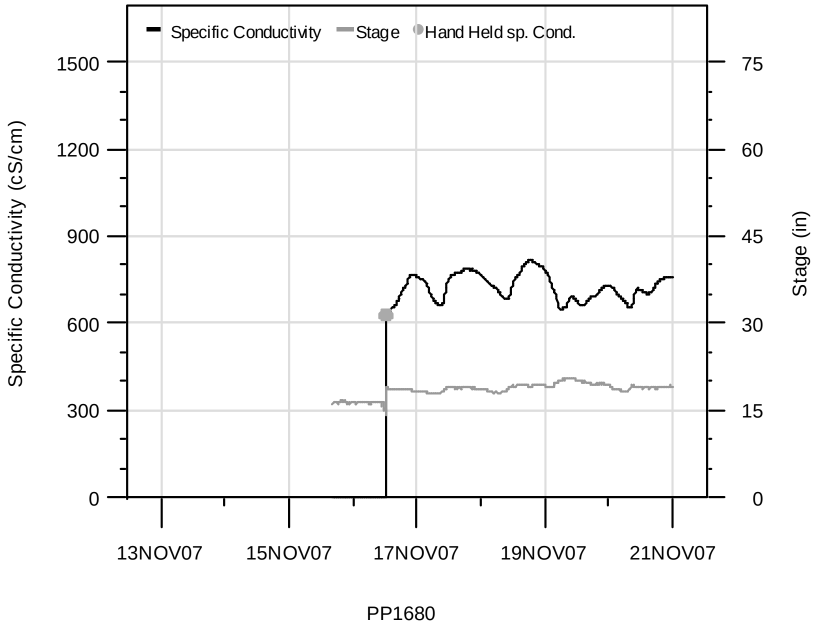

Figure G.77 Continuous Specific Conductivity at Site PP1680, 11/13/07 to 11/21/07

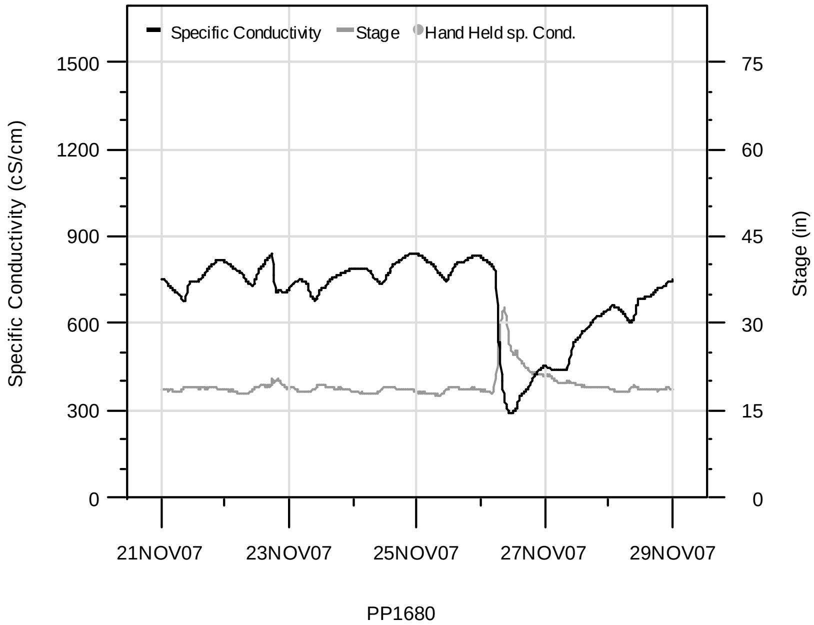

Figure G.78 Continuous Specific Conductivity at Site PP1680, 11/21/07 to 11/29/07

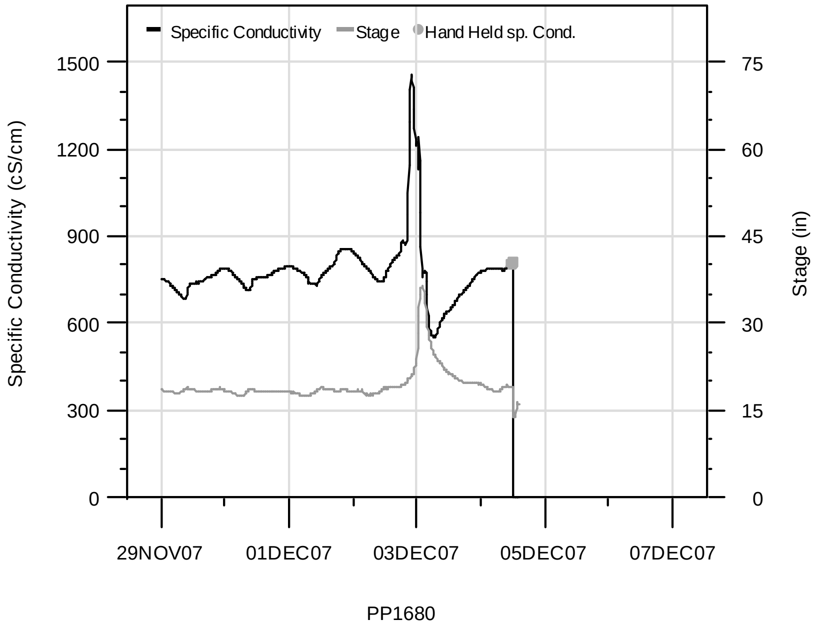

Figure G.79 Continuous Specific Conductivity at Site PP1680, 11/29/07 to 12/07/07

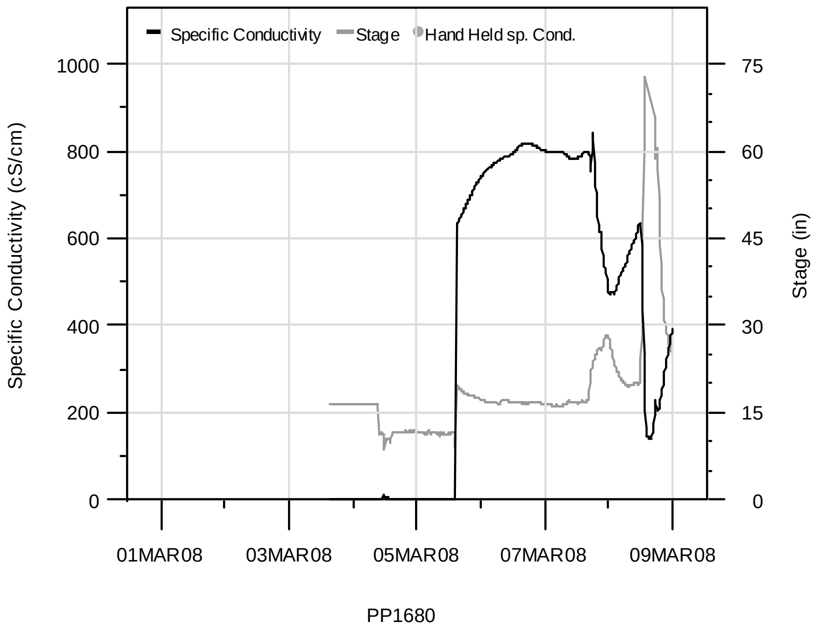

Figure G.80 Continuous Specific Conductivity at Site PP1680, 03/01/08 to 03/09/08

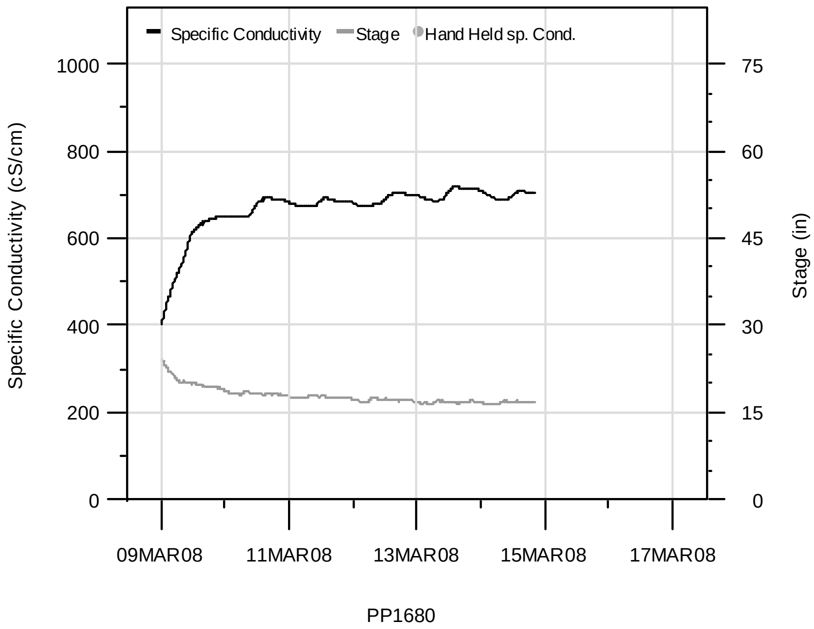

Figure G.81 Continuous Specific Conductivity at Site PP1680, 03/09/08 to 03/17/08

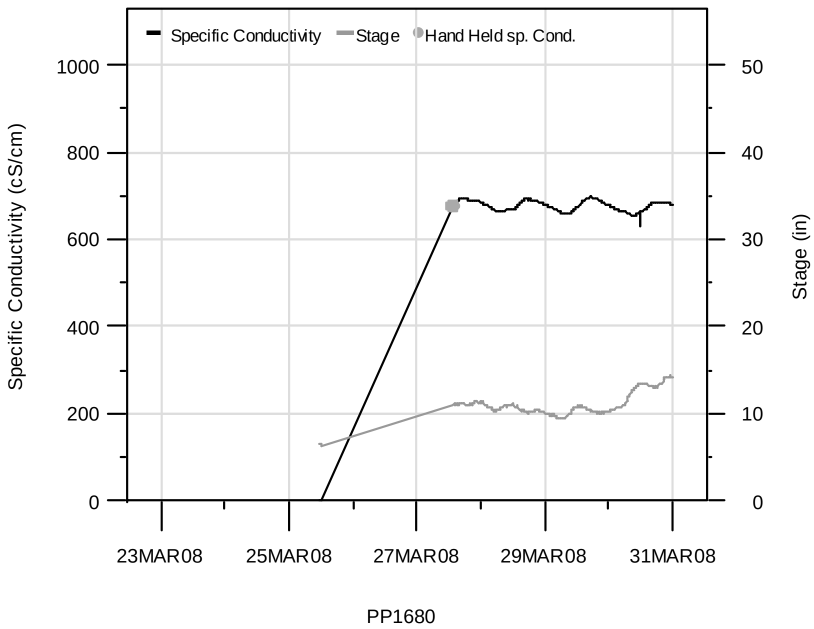

Figure G.82 Continuous Specific Conductivity at Site PP1680, 03/23/08 to 03/31/08

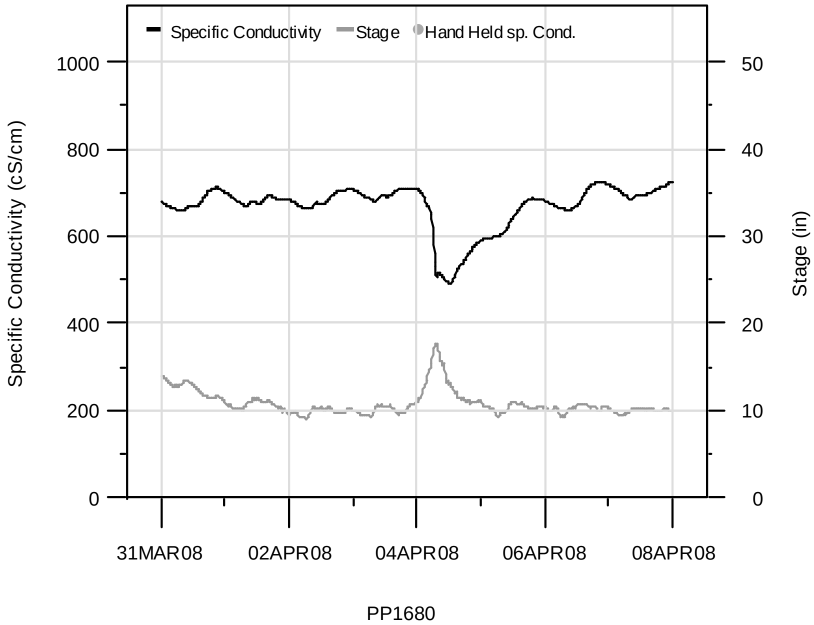

Figure G.83 Continuous Specific Conductivity at Site PP1680, 03/31/08 to 04/08/08

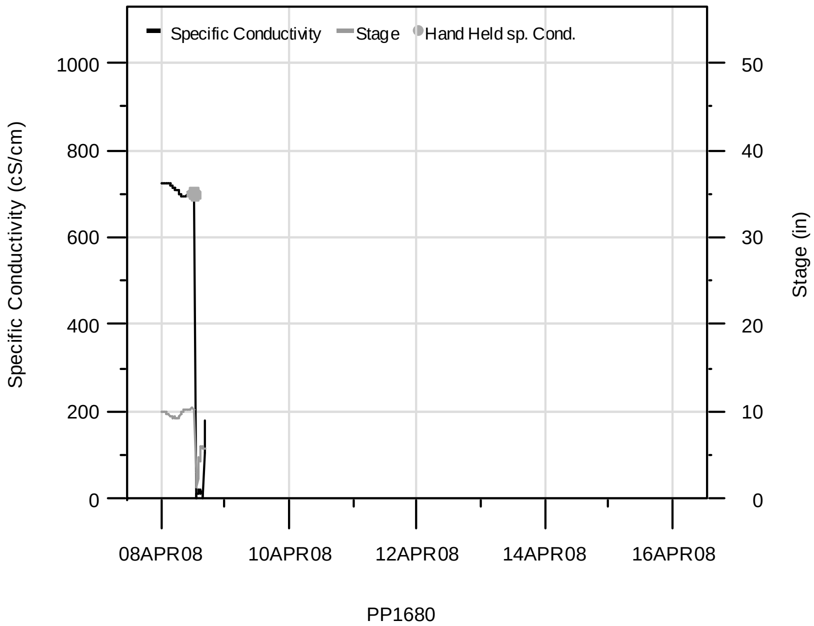

Figure G.84 Continuous Specific Conductivity at Site PP1680, 04/08/08 to 04/16/08

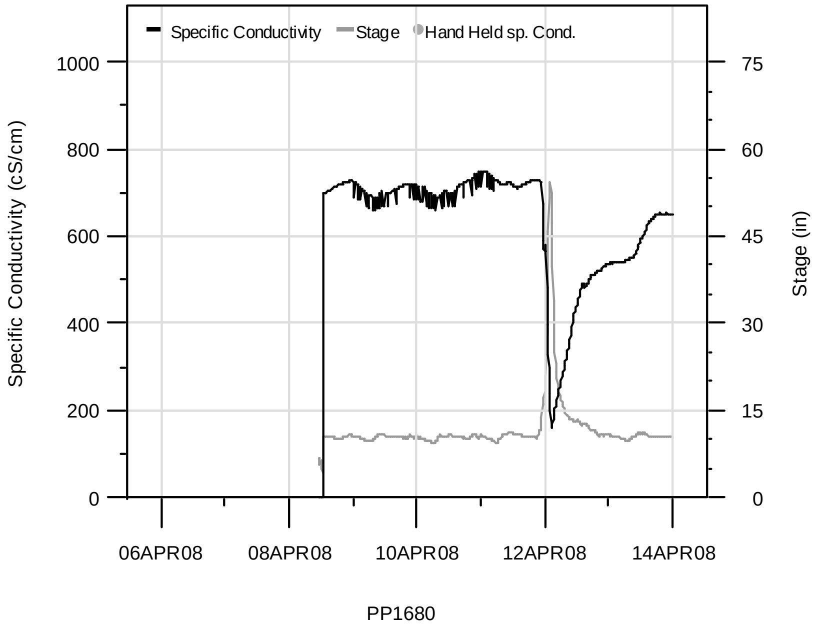

Figure G.85 Continuous Specific Conductivity at Site PP1680, 04/06/08 to 04/14/08

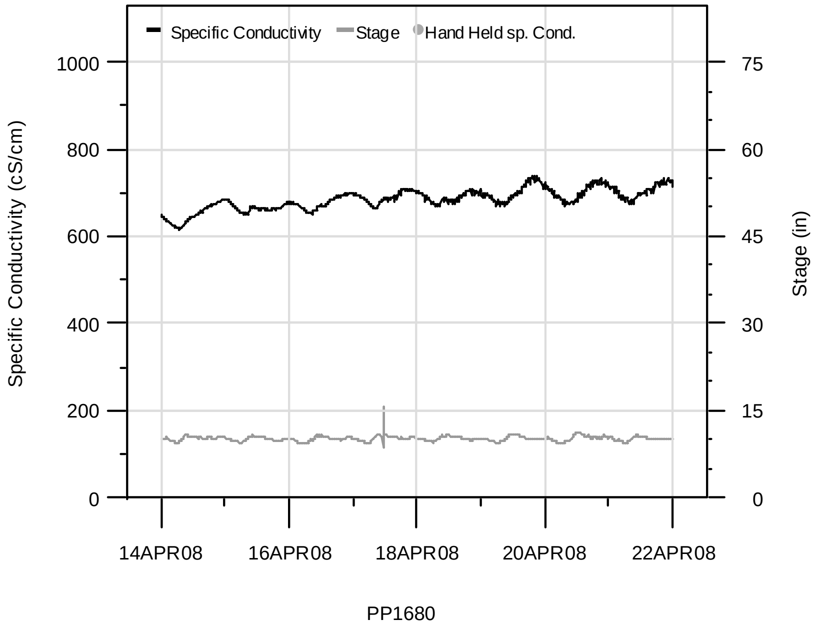

Figure G.86 Continuous Specific Conductivity at Site PP1680, 04/14/08 to 04/22/08

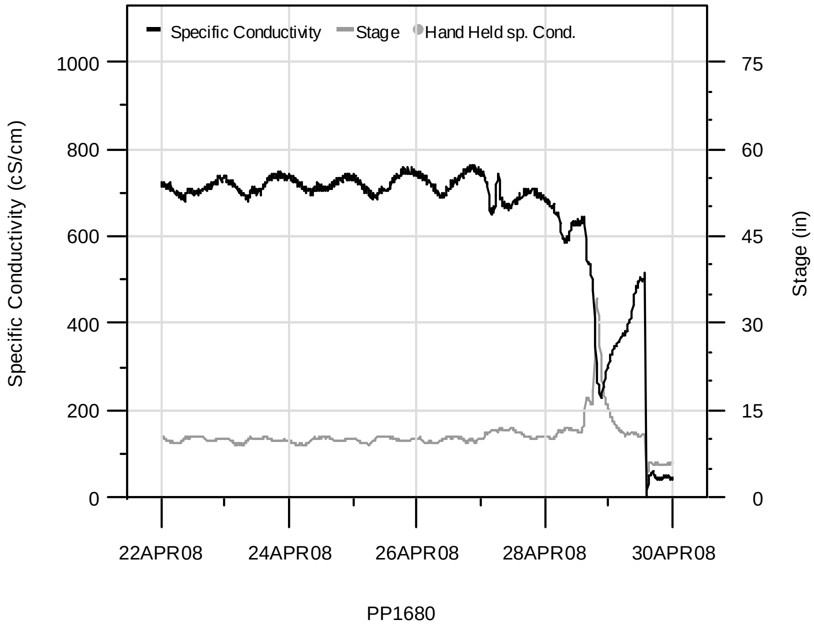

Figure G.87 Continuous Specific Conductivity at Site PP1680, 04/22/08 to 04/30/08

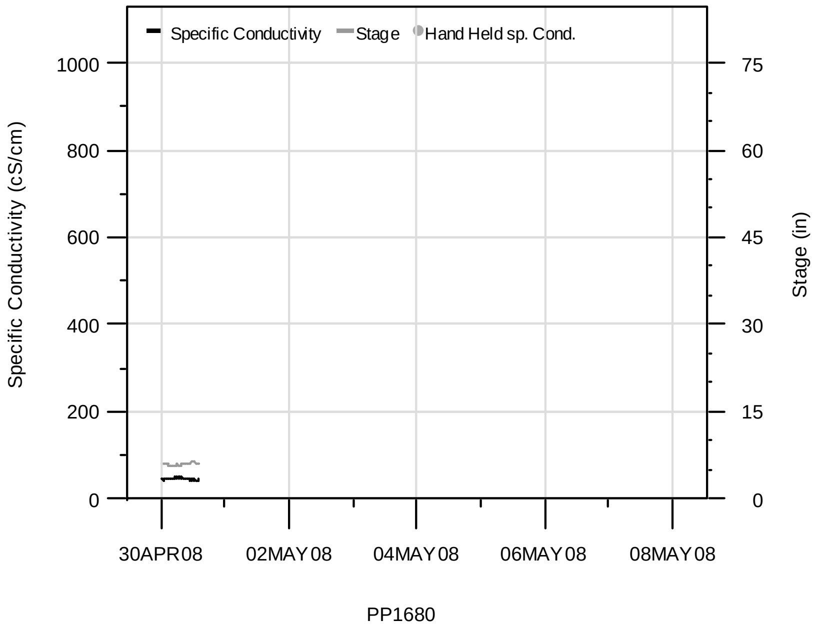

Figure G.88 Continuous Specific Conductivity at Site PP1680, 04/30/08 to 05/08/08

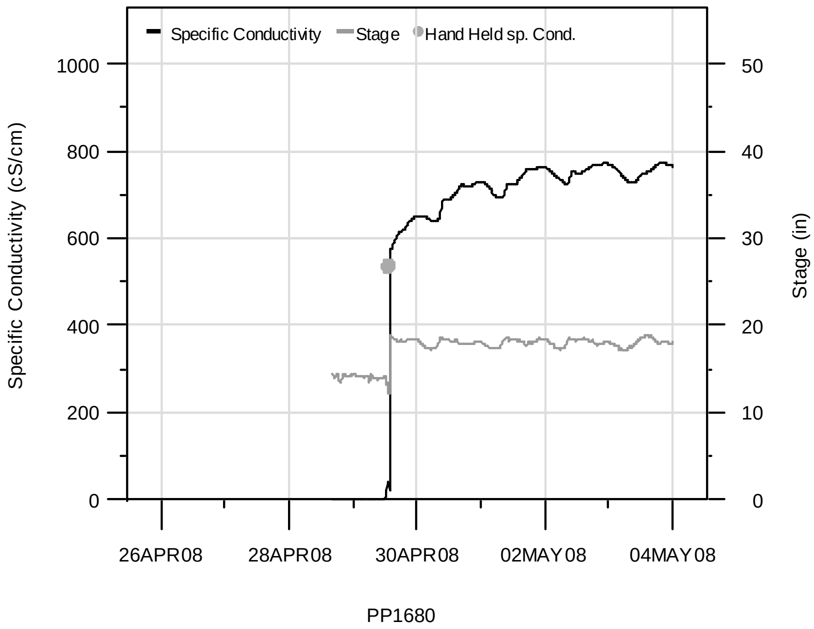

Figure G.89 Continuous Specific Conductivity at Site PP1680, 04/26/08 to 05/04/08

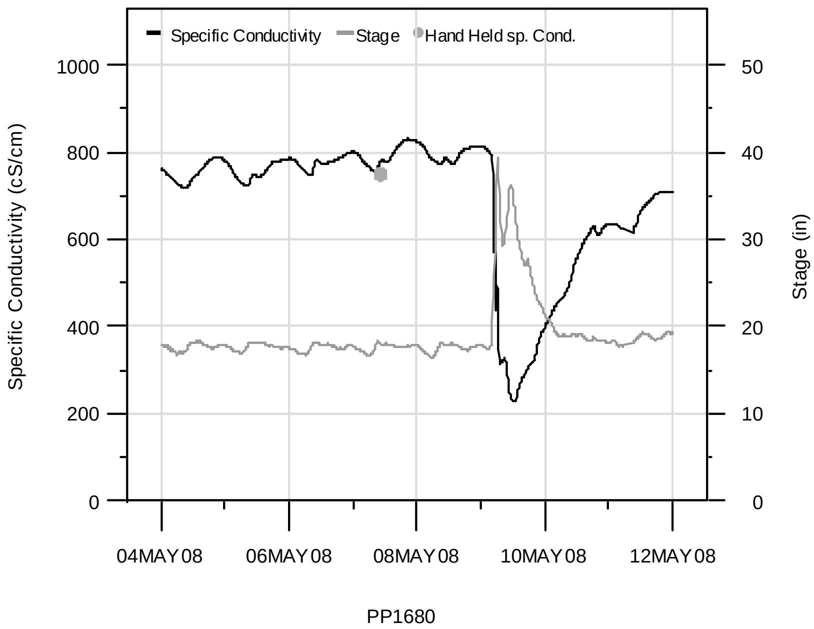

Figure G.90 Continuous Specific Conductivity at Site PP1680, 05/04/08 to 05/12/08

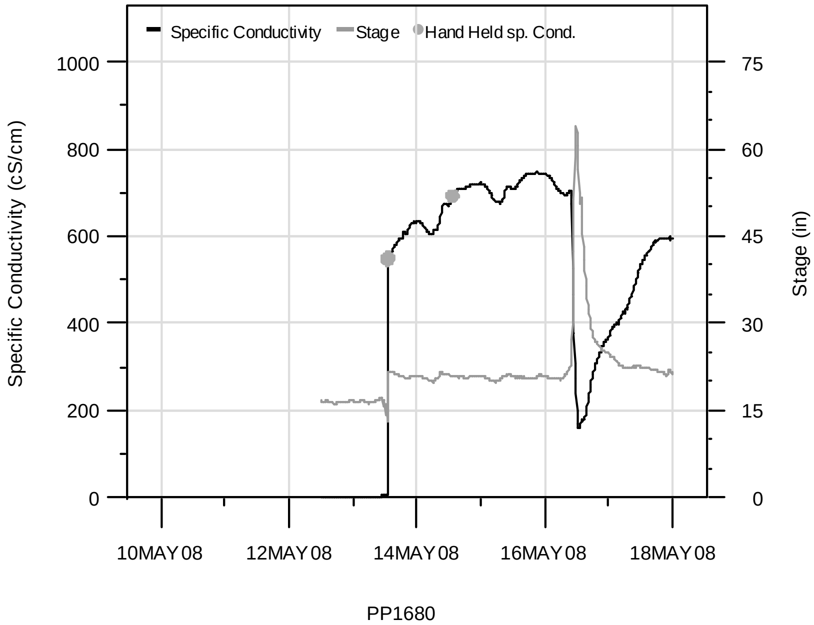

Figure G.91 Continuous Specific Conductivity at Site PP1680, 05/10/08 to 05/18/08

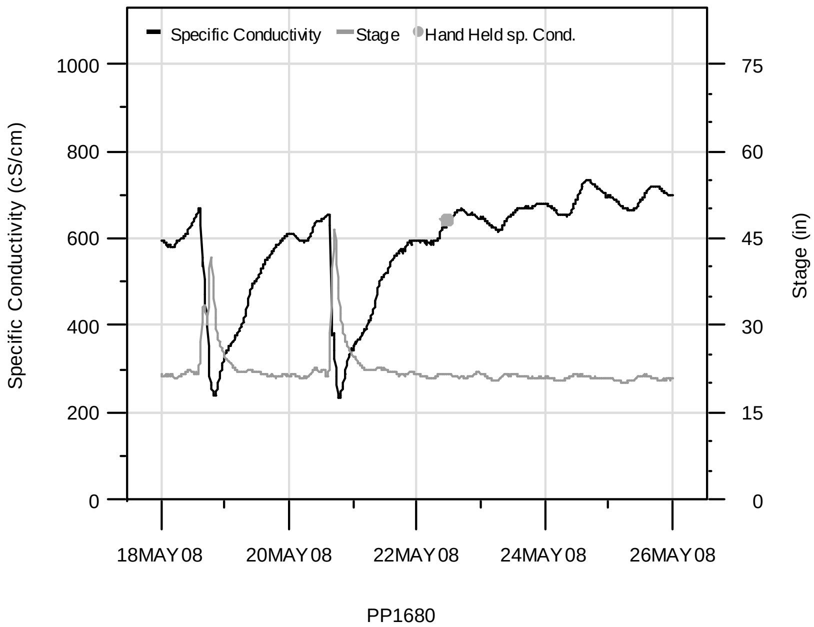

Figure G.92 Continuous Specific Conductivity at Site PP1680, 05/18/08 to 05/26/08

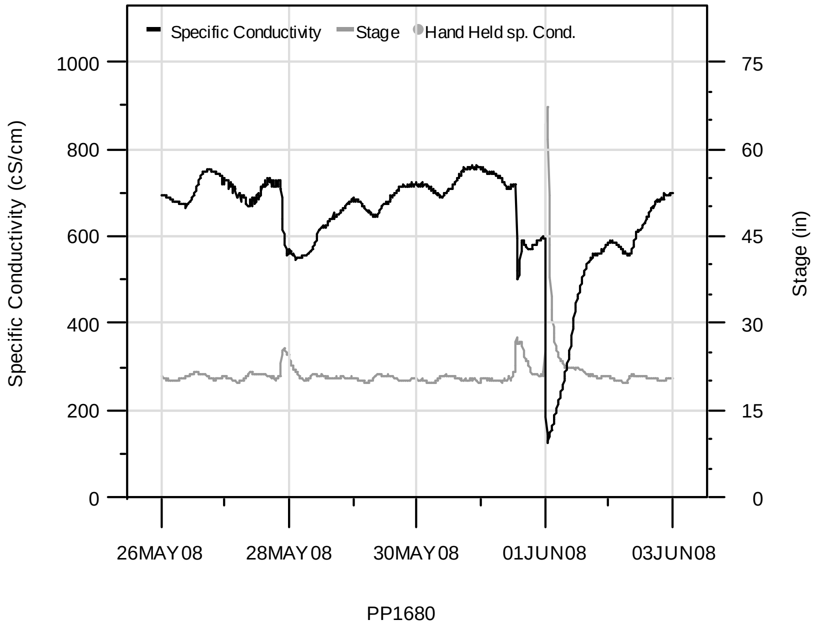

Figure G.93 Continuous Specific Conductivity at Site PP1680, 05/26/08 to 06/03/08

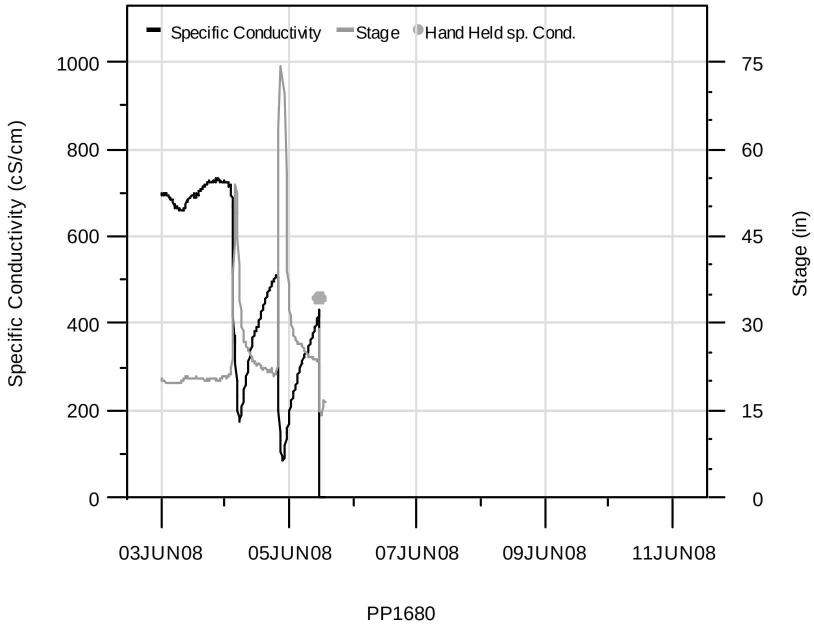

Figure G.94 Continuous Specific Conductivity at Site PP1680, 06/03/08 to 06/11/08

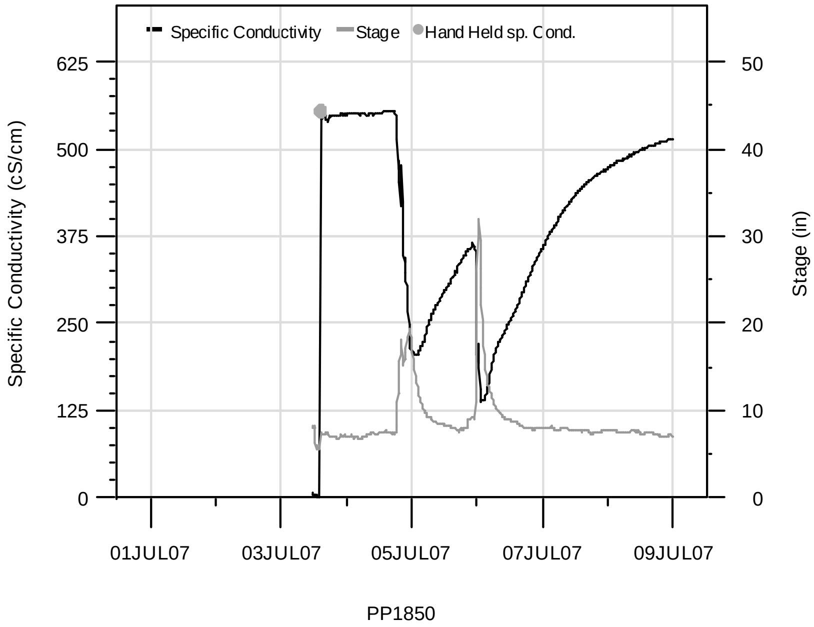

Figure G.95 Continuous Specific Conductivity at Site PP1850, 07/01/07 to 07/09/07

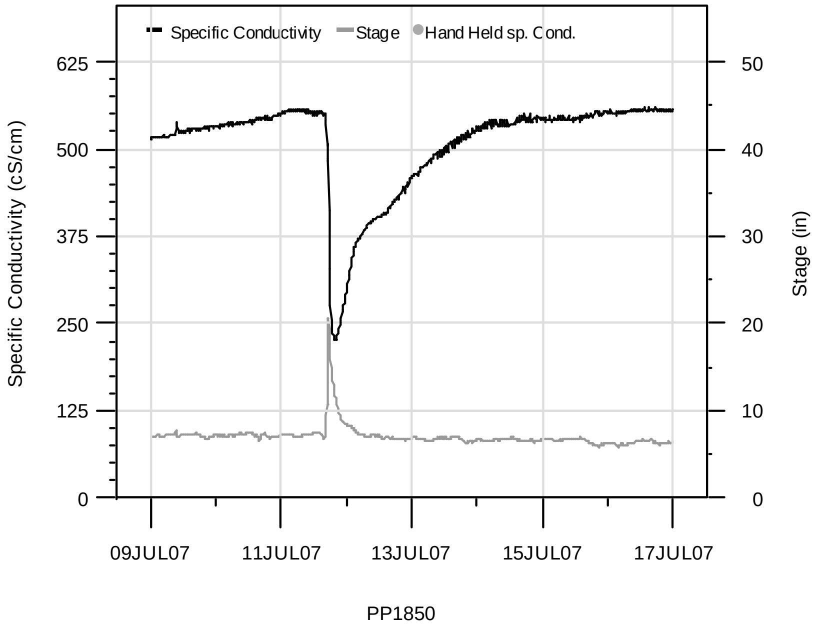

Figure G.96 Continuous Specific Conductivity at Site PP1850, 07/09/07 to 07/17/07

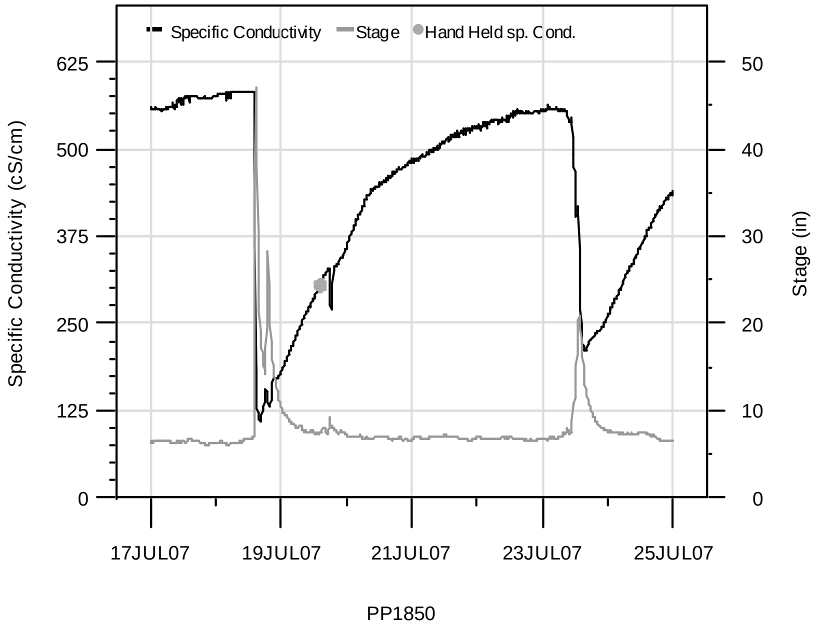

Figure G.97 Continuous Specific Conductivity at Site PP1850, 07/17/07 to 07/25/07

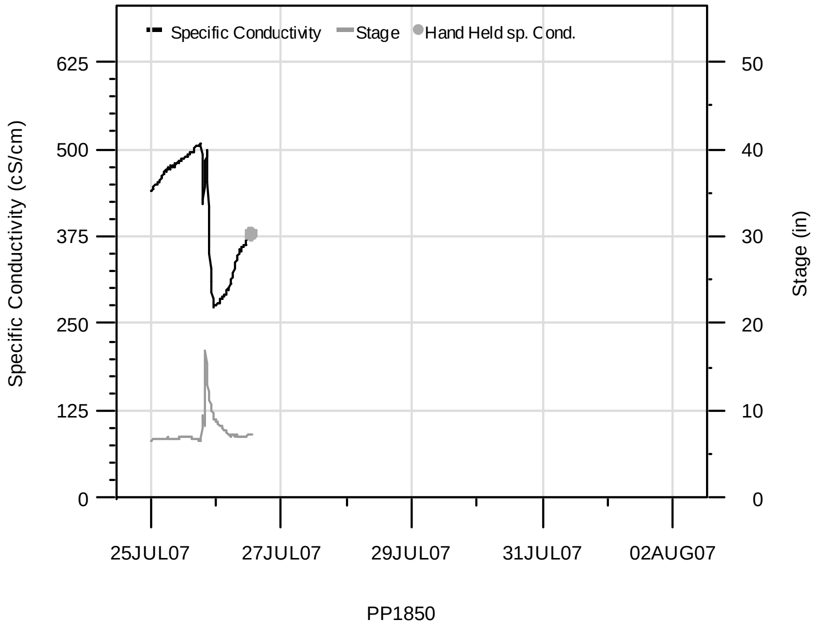

Figure G.98 Continuous Specific Conductivity at Site PP1850, 07/25/07 to 08/02/07

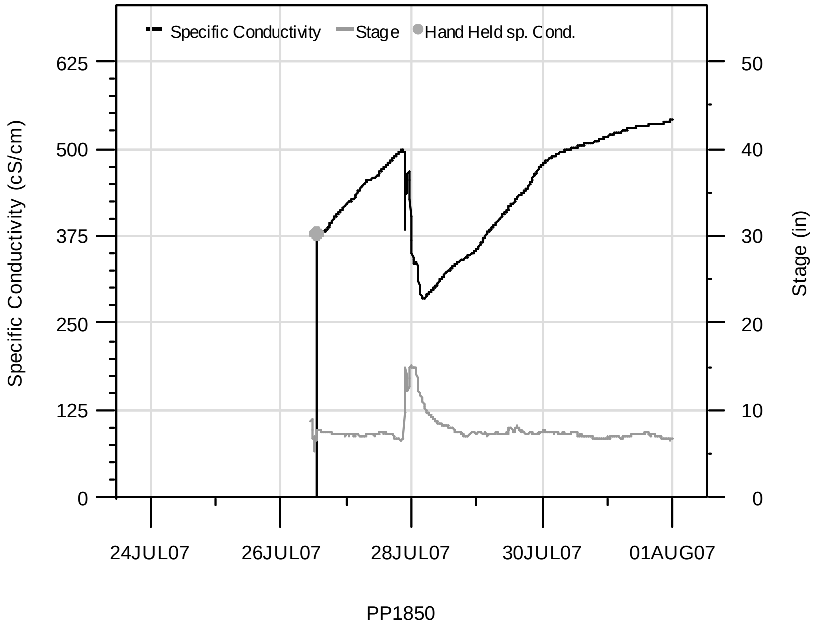

Figure G.99 Continuous Specific Conductivity at Site PP1850, 07/24/07 to 08/01/07

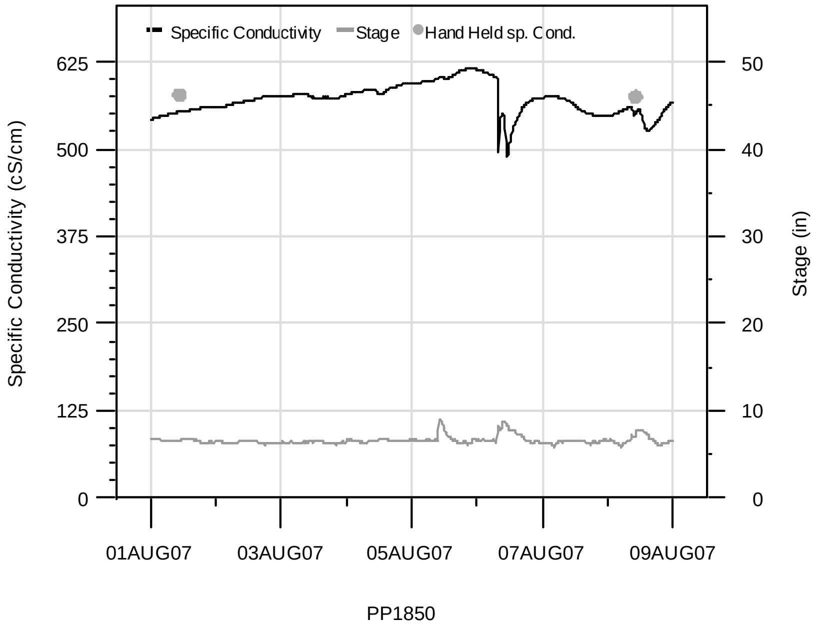

Figure G.100 Continuous Specific Conductivity at Site PP1850, 08/01/07 to 08/09/07

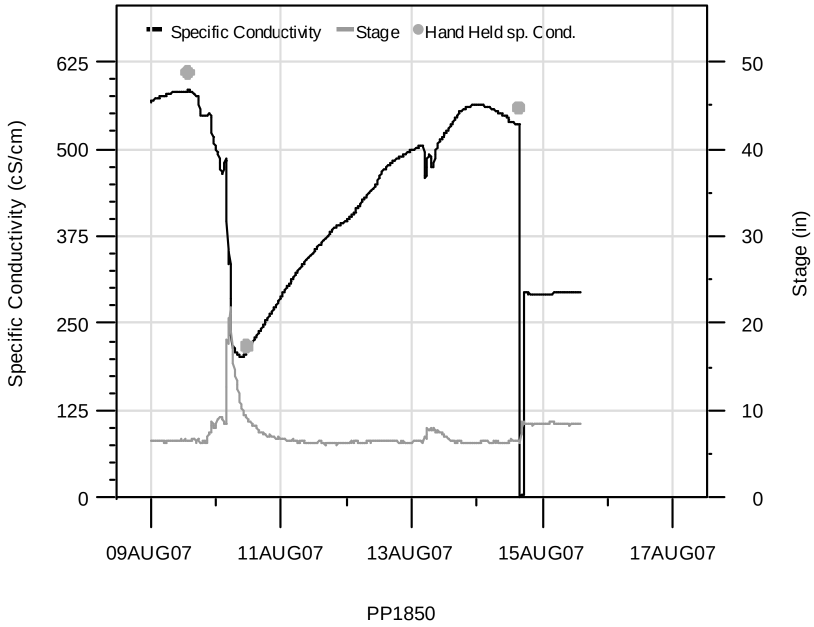

Figure G.101 Continuous Specific Conductivity at Site PP1850, 08/09/07 to 08/17/07

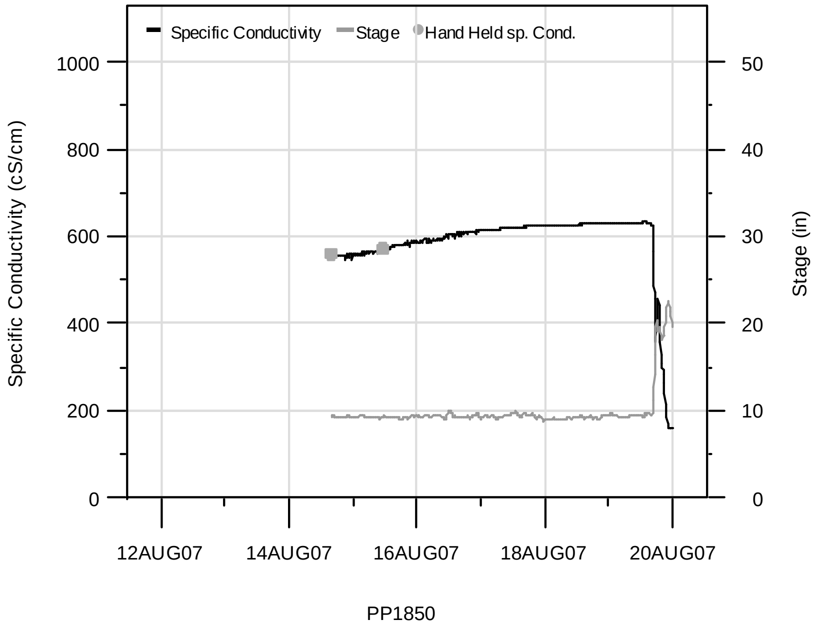

Figure G.102 Continuous Specific Conductivity at Site PP1850, 08/12/07 to 08/20/07

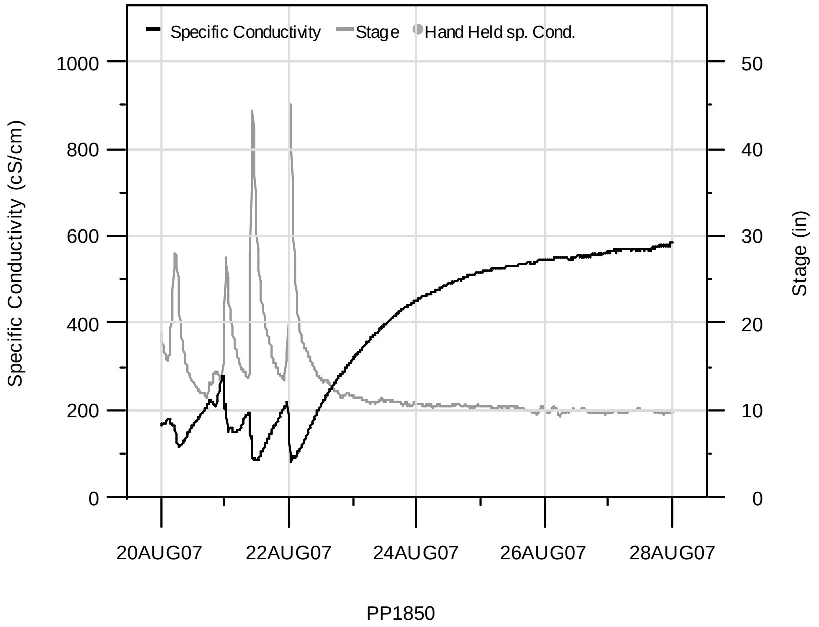

Figure G.103 Continuous Specific Conductivity at Site PP1850, 08/20/07 to 08/28/07

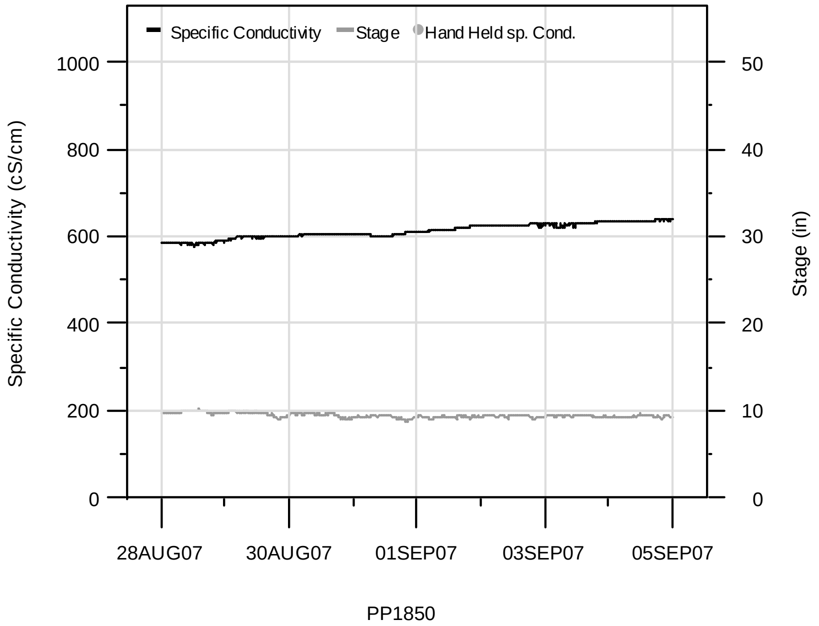

Figure G.104 Continuous Specific Conductivity at Site PP1850, 08/28/07 to 09/05/07

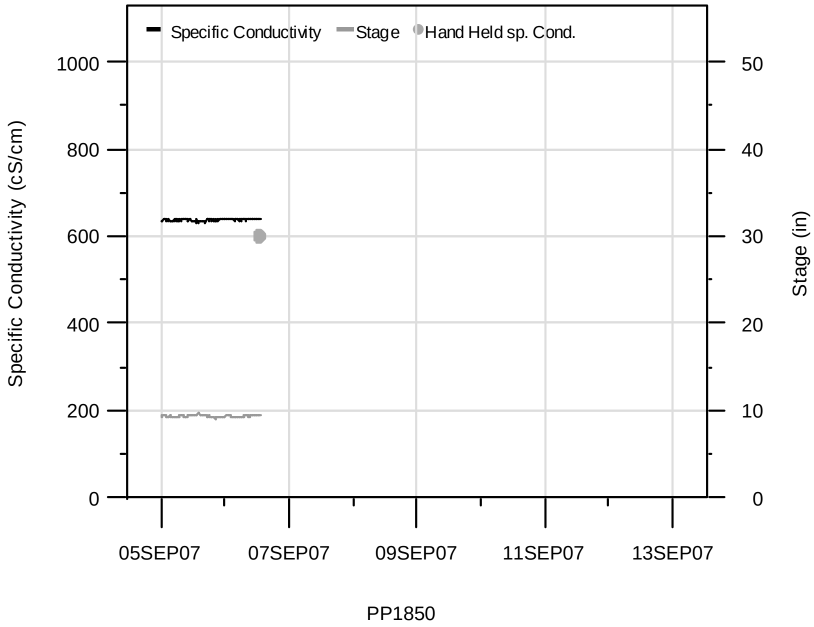

Figure G.105 Continuous Specific Conductivity at Site PP1850, 09/05/07 to 09/13/07

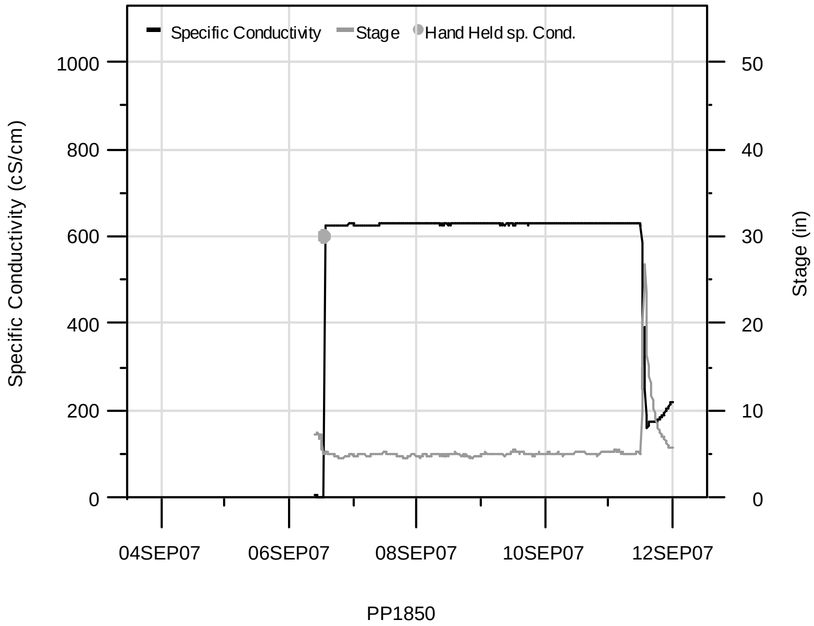

Figure G.106 Continuous Specific Conductivity at Site PP1850, 09/04/07 to 09/12/07

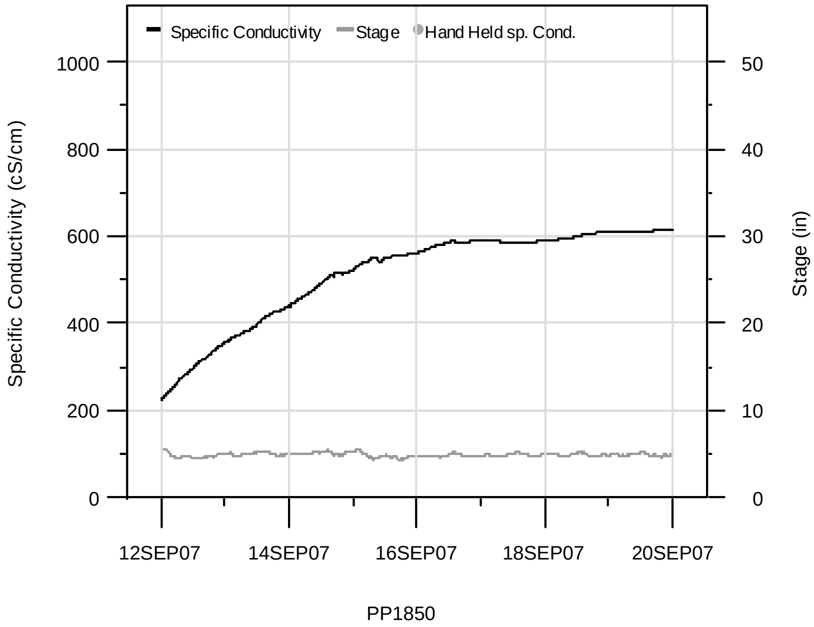

Figure G.107 Continuous Specific Conductivity at Site PP1850, 09/12/07 to 09/20/07

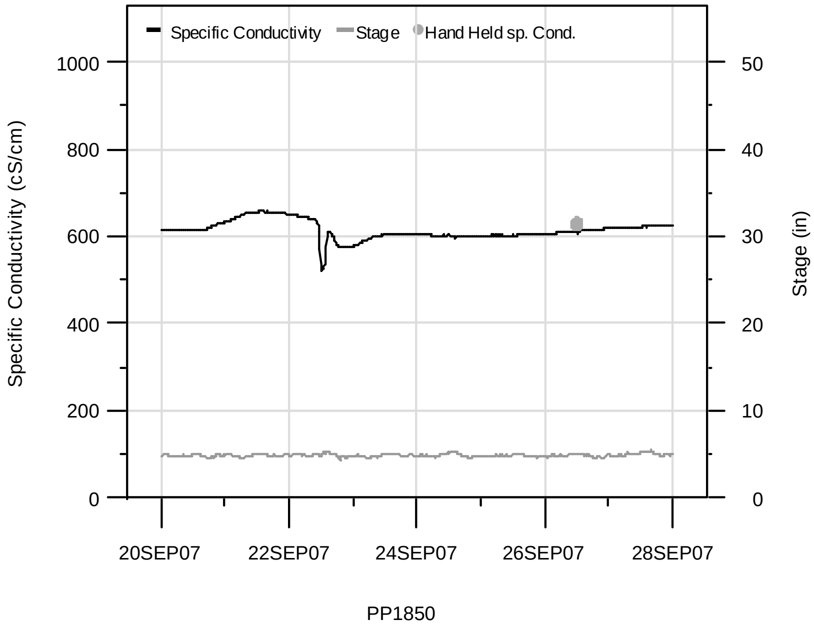

Figure G.108 Continuous Specific Conductivity at Site PP1850, 09/20/07 to 09/28/07

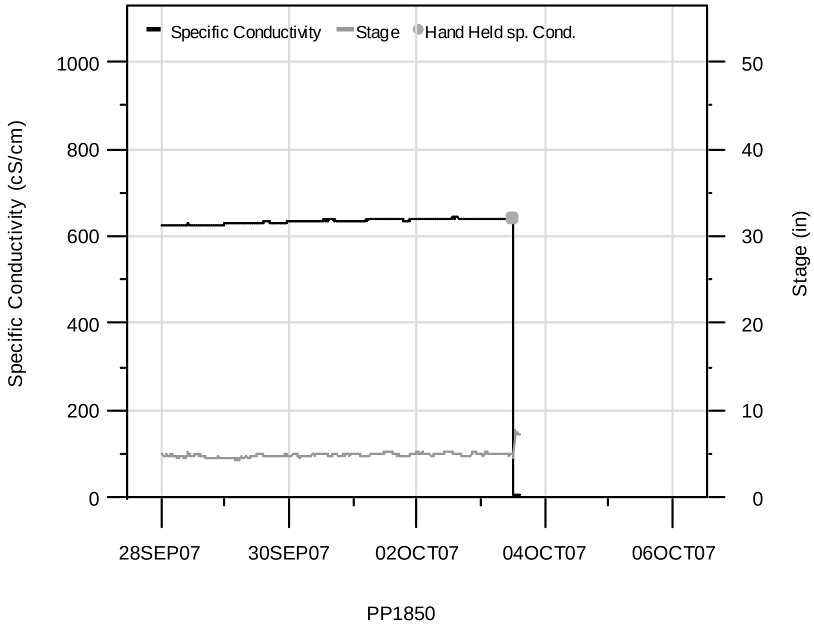

Figure G.109 Continuous Specific Conductivity at Site PP1850, 09/28/07 to 10/06/07

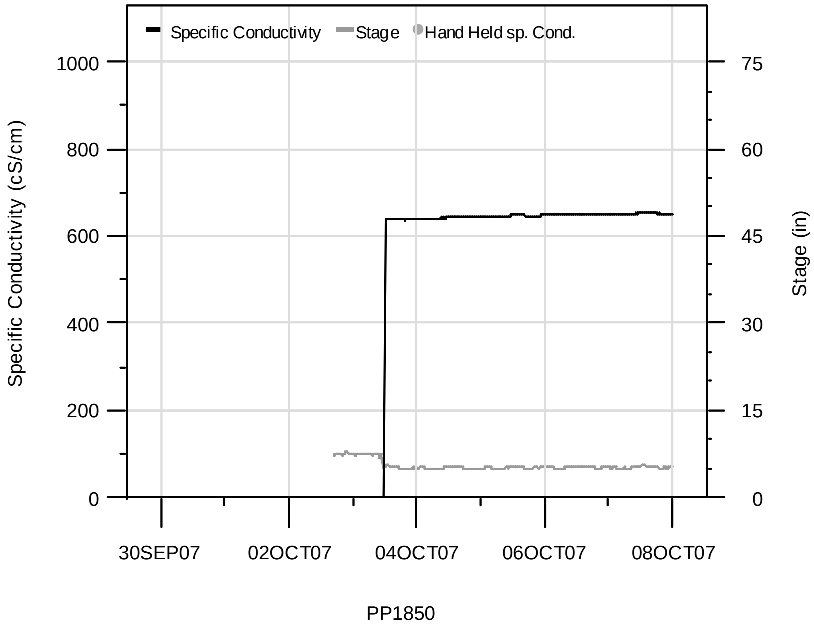

Figure G.110 Continuous Specific Conductivity at Site PP1850, 09/30/07 to 10/08/07

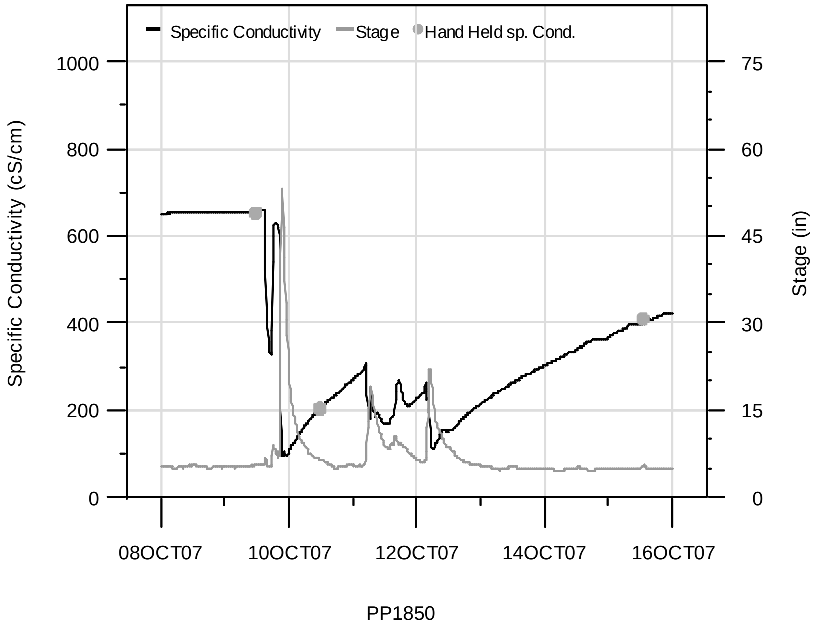

Figure G.111 Continuous Specific Conductivity at Site PP1850, 10/08/07 to 10/16/07

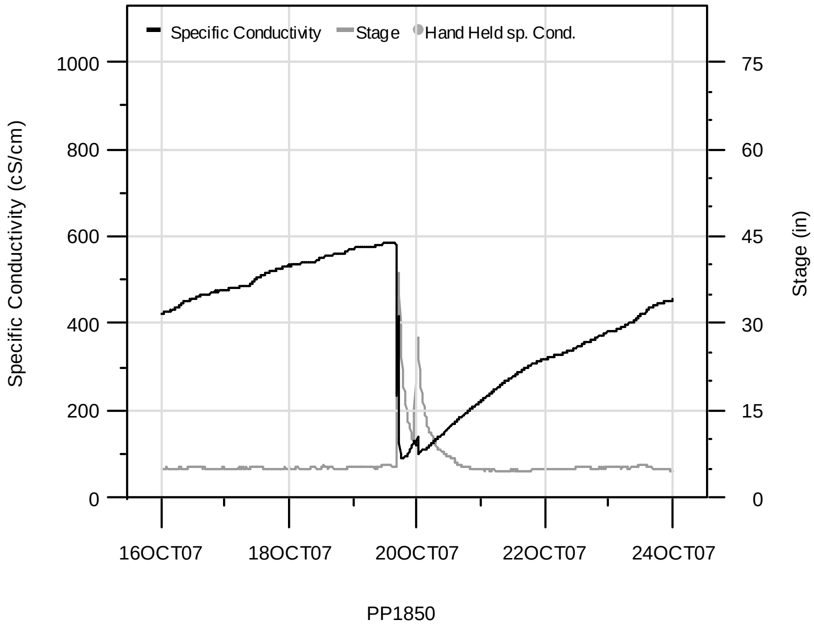

Figure G.112 Continuous Specific Conductivity at Site PP1850, 10/16/07 to 10/24/07

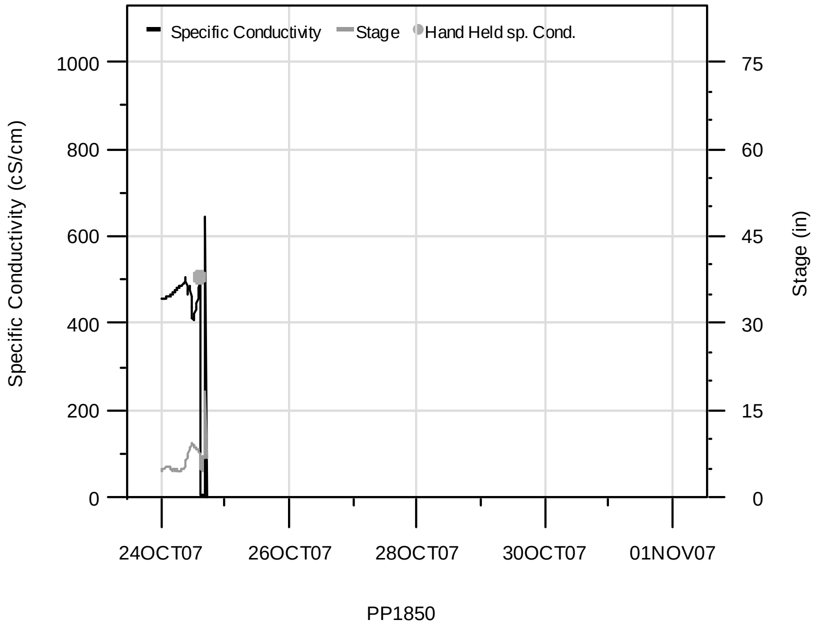

Figure G.113 Continuous Specific Conductivity at Site PP1850, 10/24/07 to 11/01/07

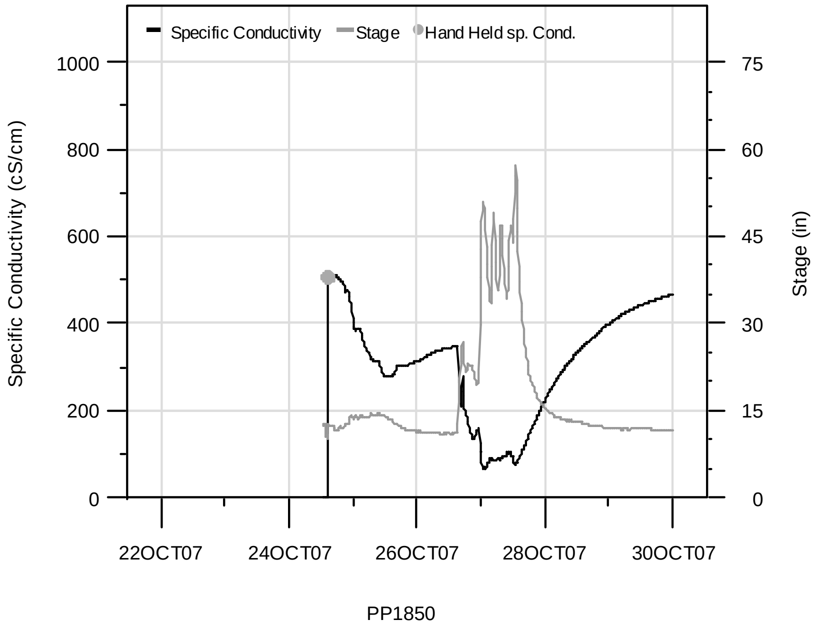

Figure G.114 Continuous Specific Conductivity at Site PP1850, 10/22/07 to 10/30/07

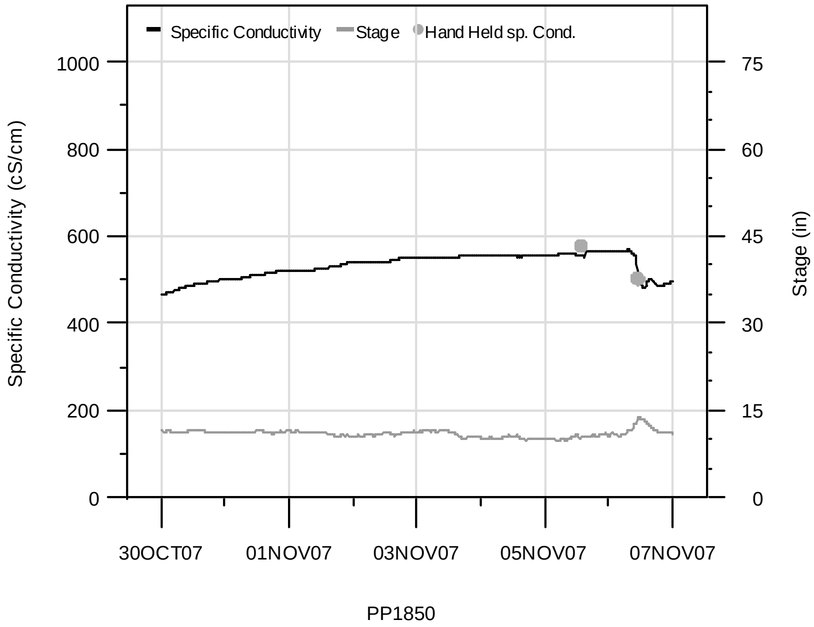

Figure G.115 Continuous Specific Conductivity at Site PP1850, 10/30/07 to 11/07/07

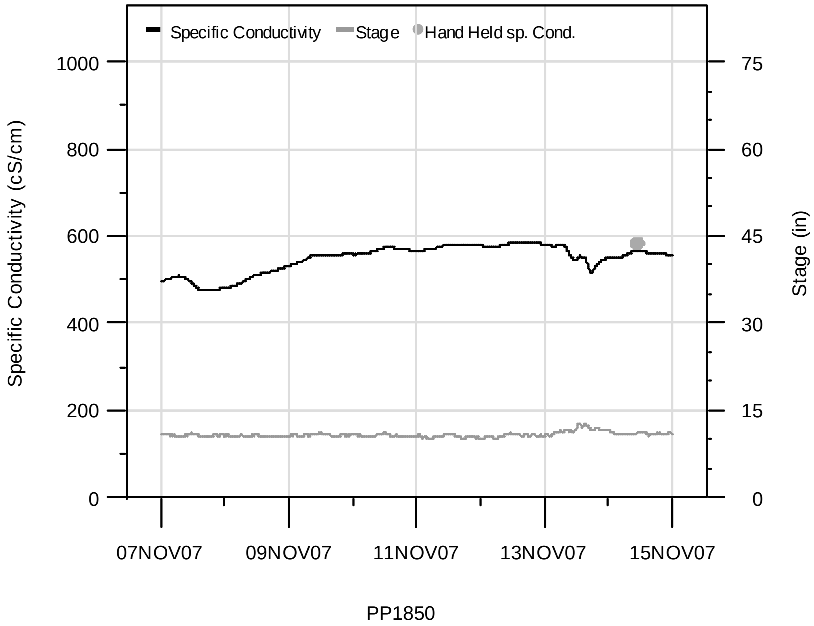

Figure G.116 Continuous Specific Conductivity at Site PP1850, 11/07/07 to 11/15/07

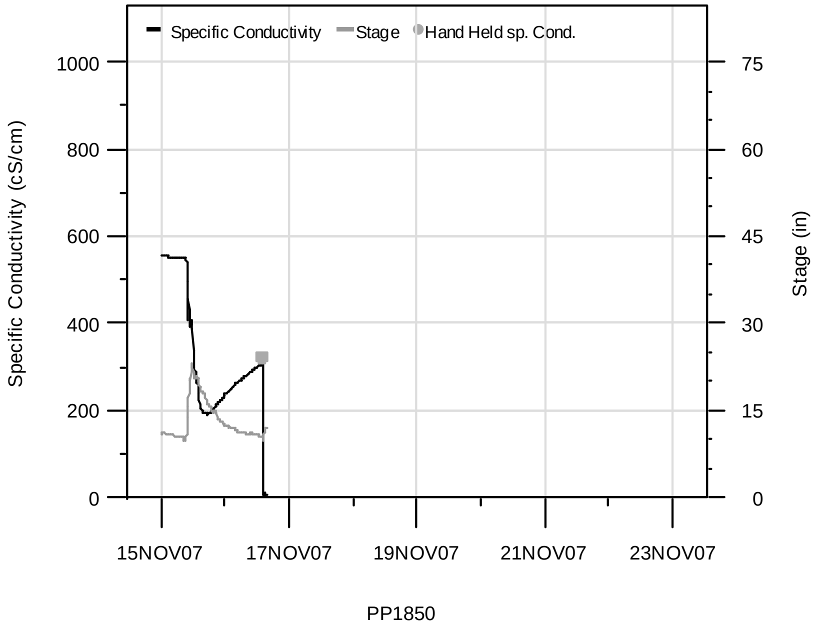

Figure G.117 Continuous Specific Conductivity at Site PP1850, 11/15/07 to 11/23/07

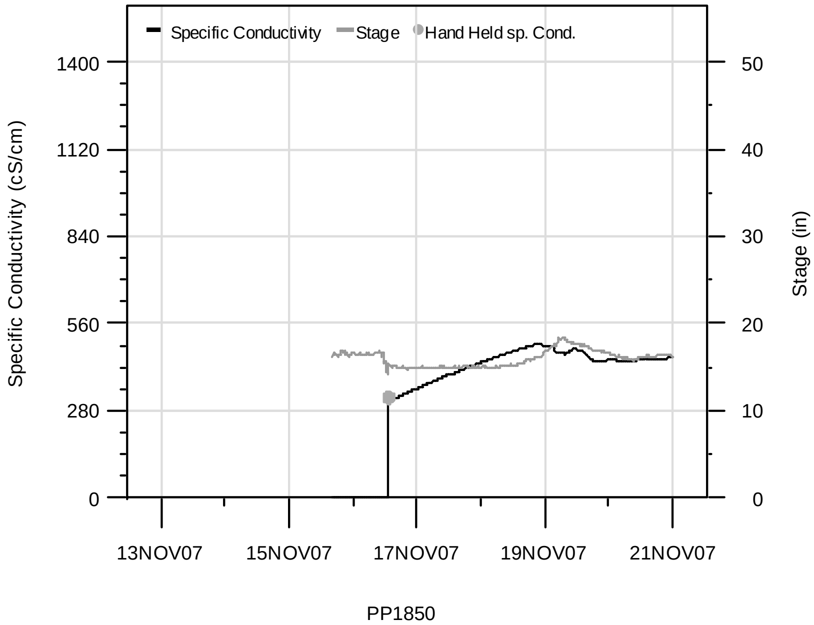

Figure G.118 Continuous Specific Conductivity at Site PP1850, 11/13/07 to 11/21/07

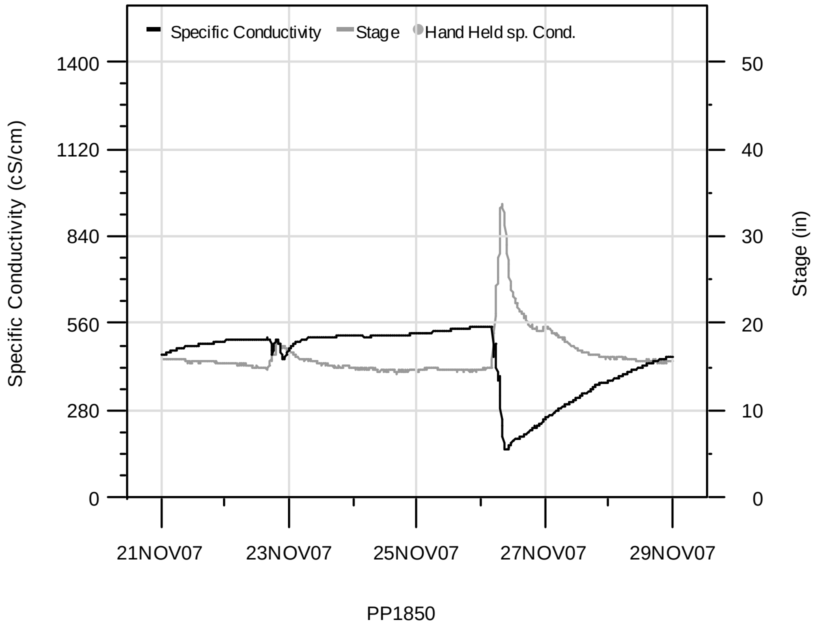

Figure G.119 Continuous Specific Conductivity at Site PP1850, 11/21/07 to 11/29/07

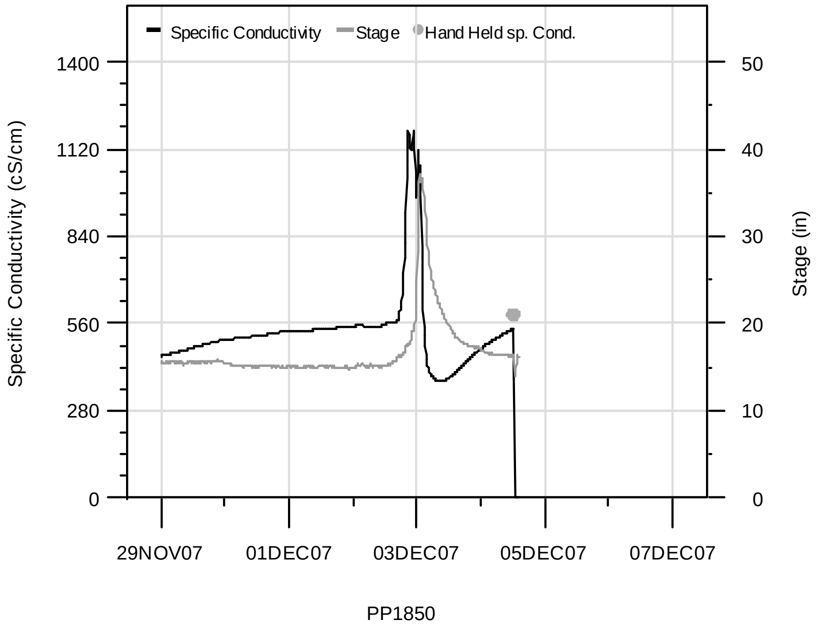

Figure G.120 Continuous Specific Conductivity at Site PP1850, 11/29/07 to 12/07/07

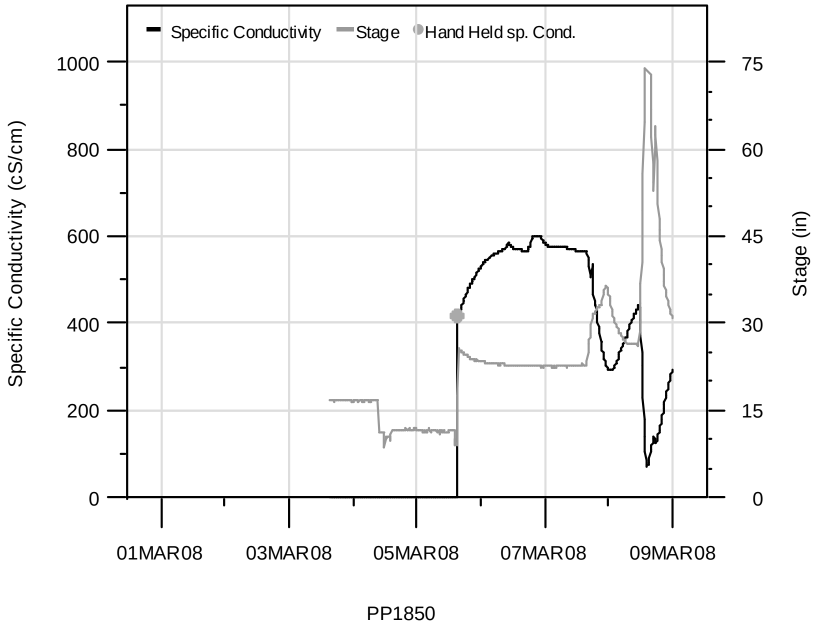

Figure G.121 Continuous Specific Conductivity at Site PP1850, 03/01/08 to 03/09/08

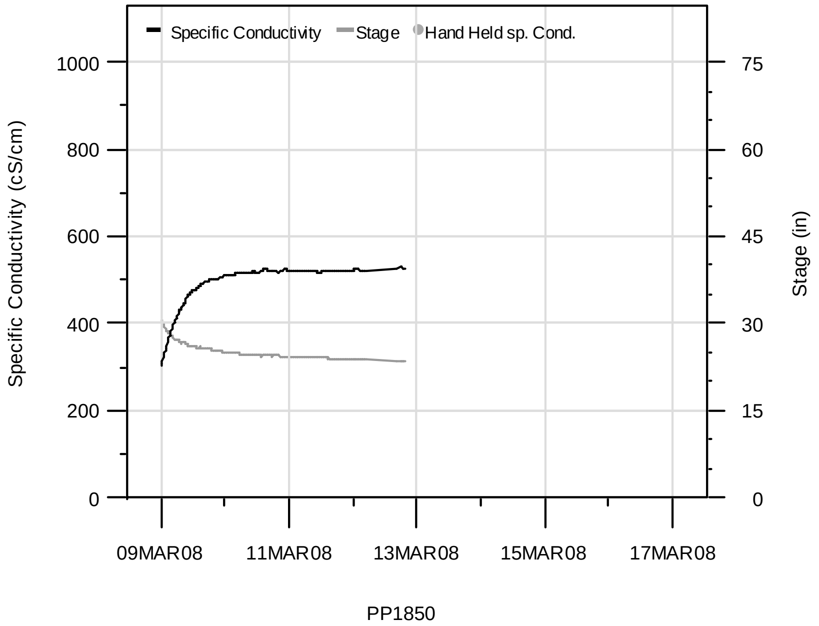

Figure G.122 Continuous Specific Conductivity at Site PP1850, 03/09/08 to 03/17/08

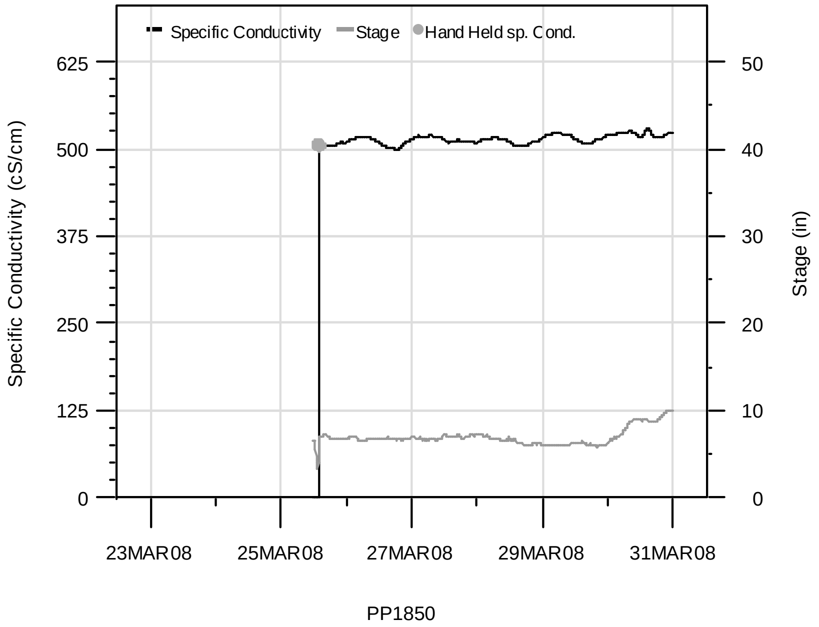

Figure G.123 Continuous Specific Conductivity at Site PP1850, 03/23/08 to 03/31/08

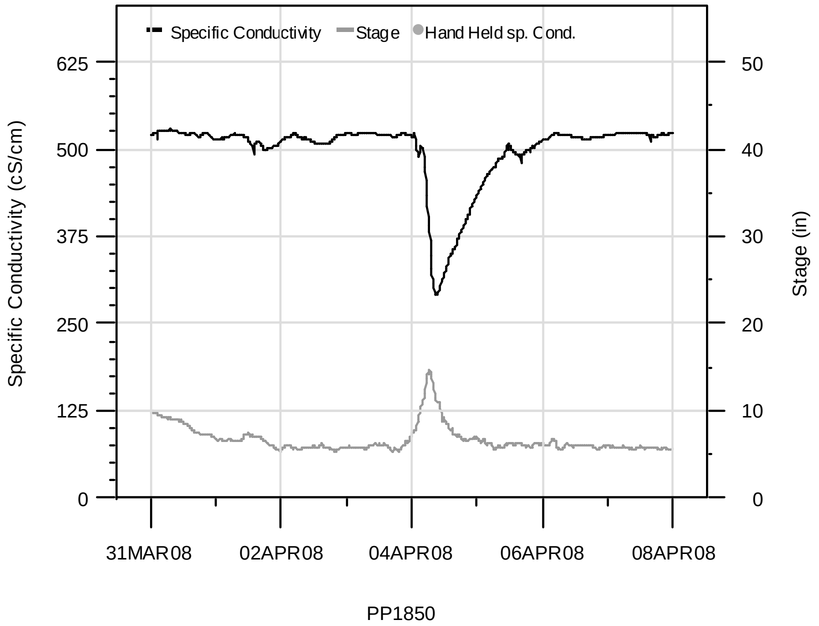

Figure G.124 Continuous Specific Conductivity at Site PP1850, 03/31/08 to 04/08/08

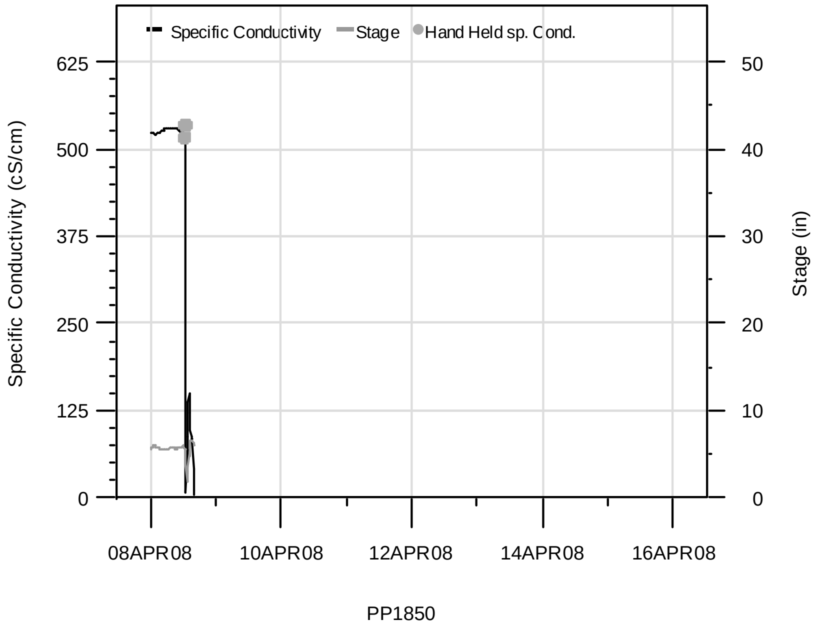

Figure G.125 Continuous Specific Conductivity at Site PP1850, 04/08/08 to 04/16/08

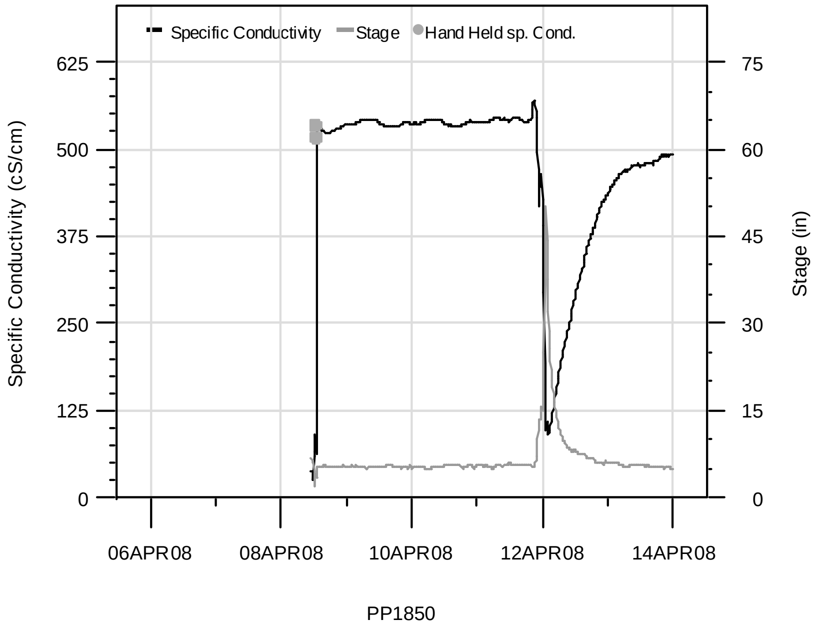

Figure G.126 Continuous Specific Conductivity at Site PP1850, 04/06/08 to 04/14/08

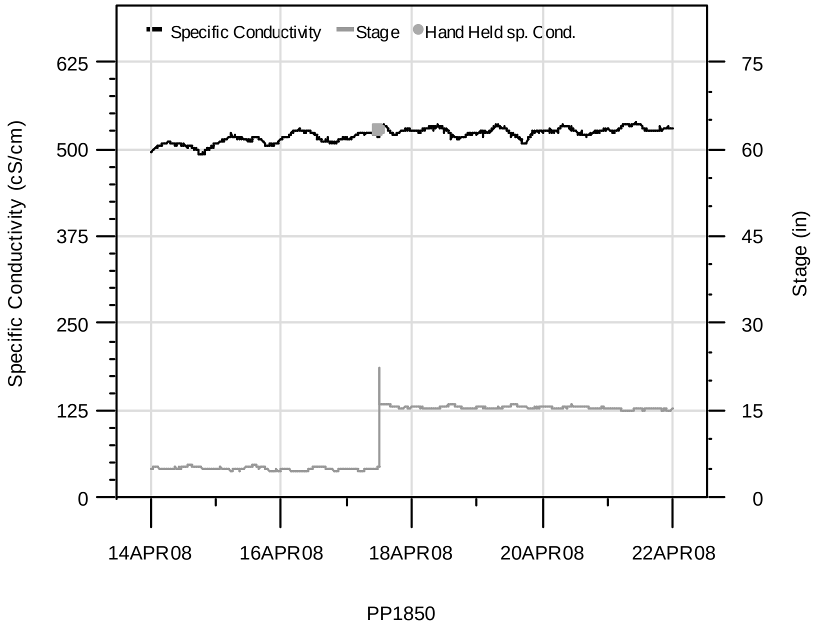

Figure G.127 Continuous Specific Conductivity at Site PP1850, 04/14/08 to 04/22/08

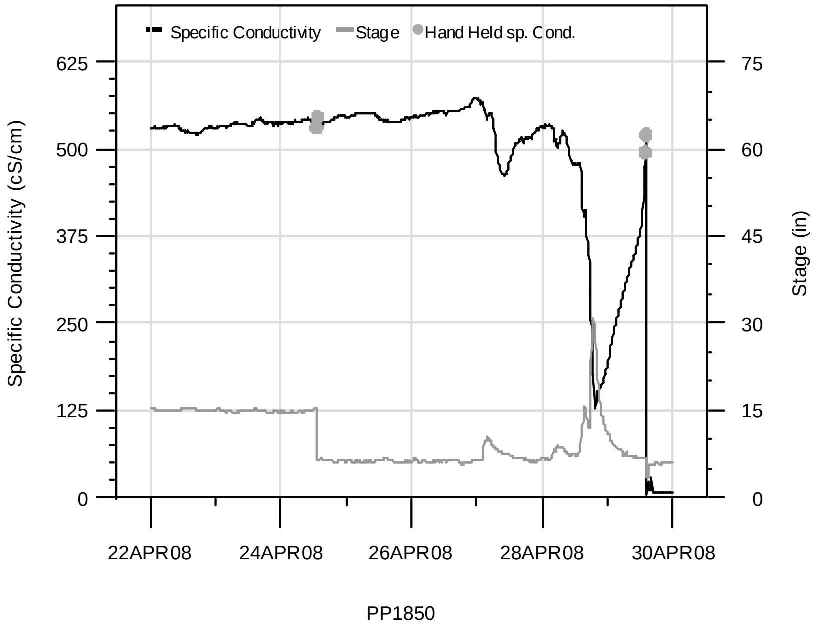

Figure G.128 Continuous Specific Conductivity at Site PP1850, 04/22/08 to 04/30/08

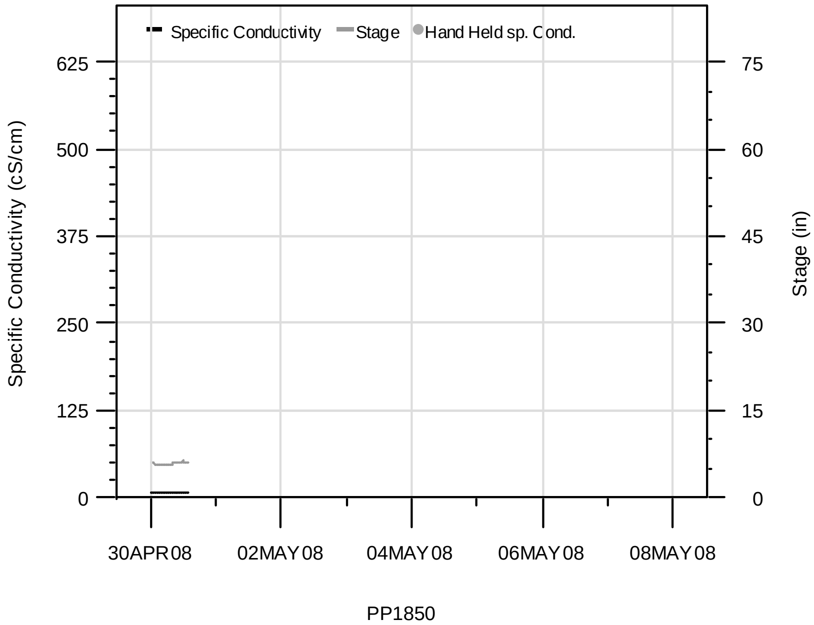

Figure G.129 Continuous Specific Conductivity at Site PP1850, 04/30/08 to 05/08/08

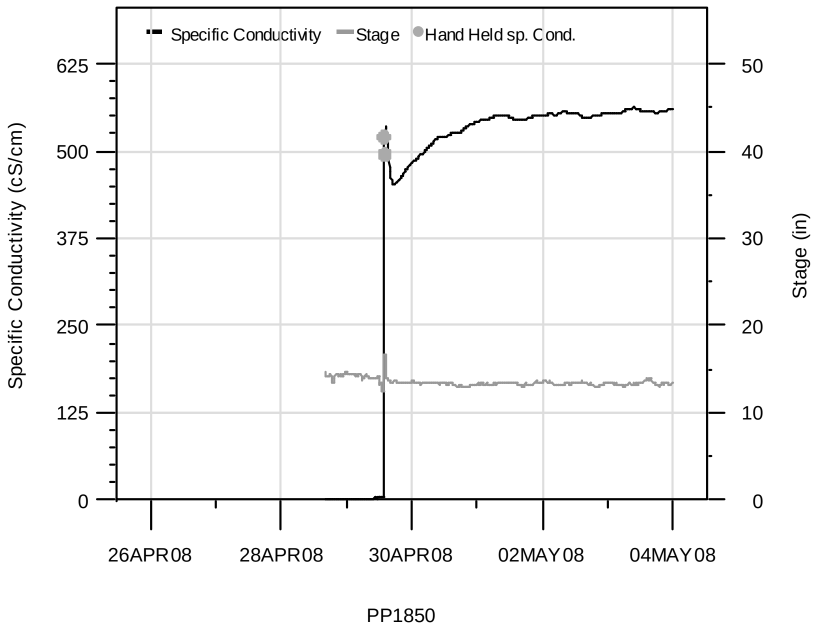

Figure G.130 Continuous Specific Conductivity at Site PP1850, 04/26/08 to 05/04/08

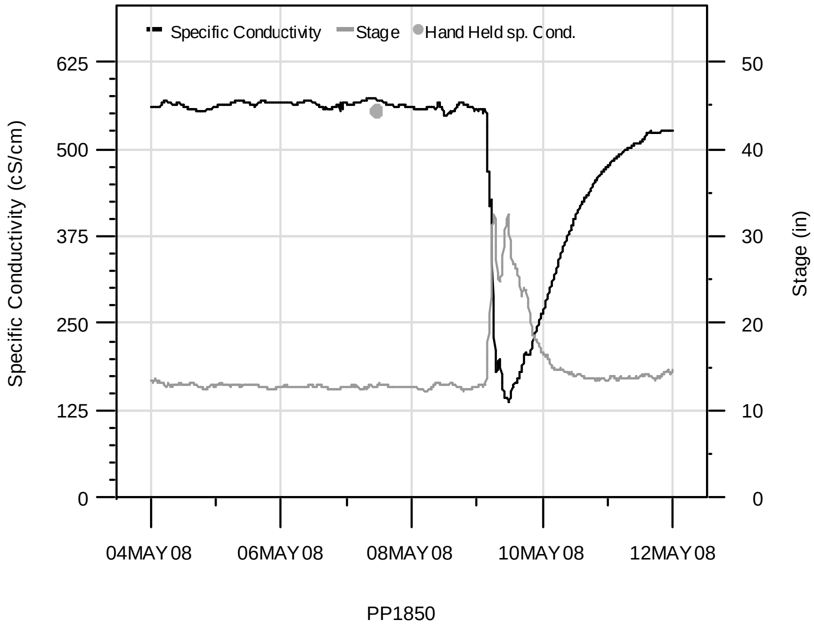

Figure G.131 Continuous Specific Conductivity at Site PP1850, 05/04/08 to 05/12/08

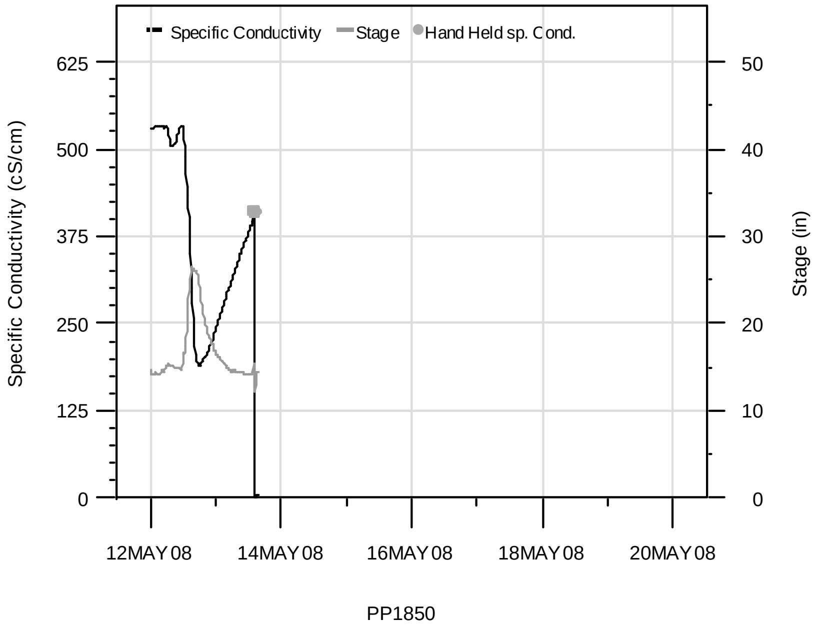

Figure G.132 Continuous Specific Conductivity at Site PP1850, 05/12/08 to 05/20/08

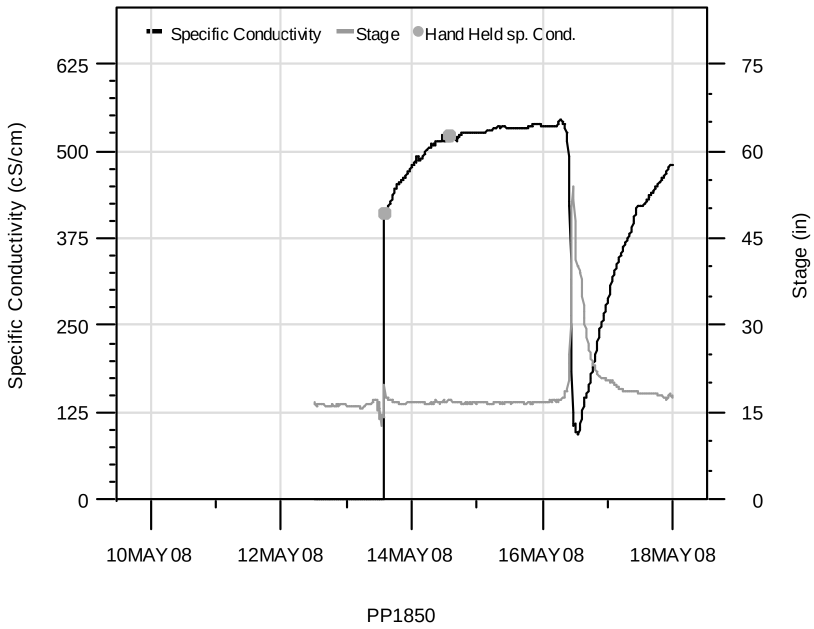

Figure G.133 Continuous Specific Conductivity at Site PP1850, 05/10/08 to 05/18/08

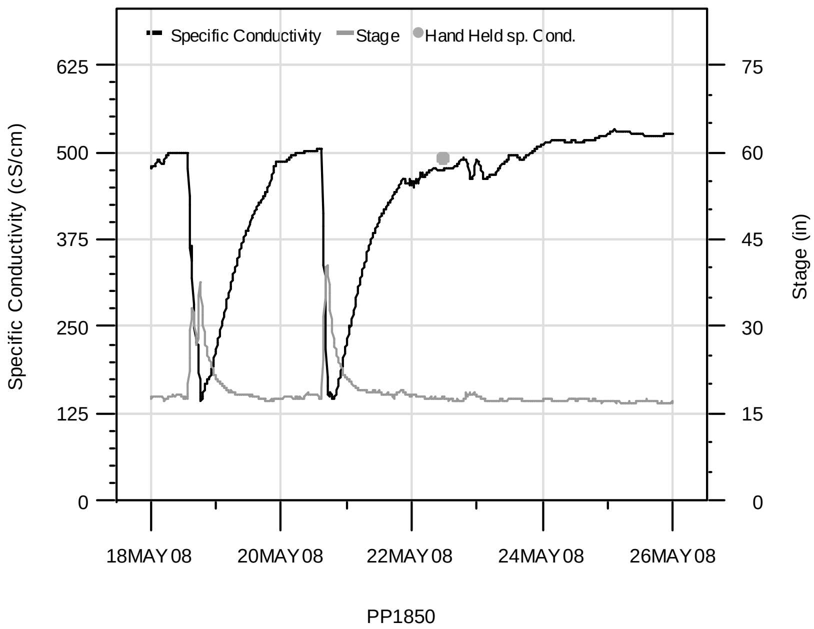

Figure G.134 Continuous Specific Conductivity at Site PP1850, 05/18/08 to 05/26/08

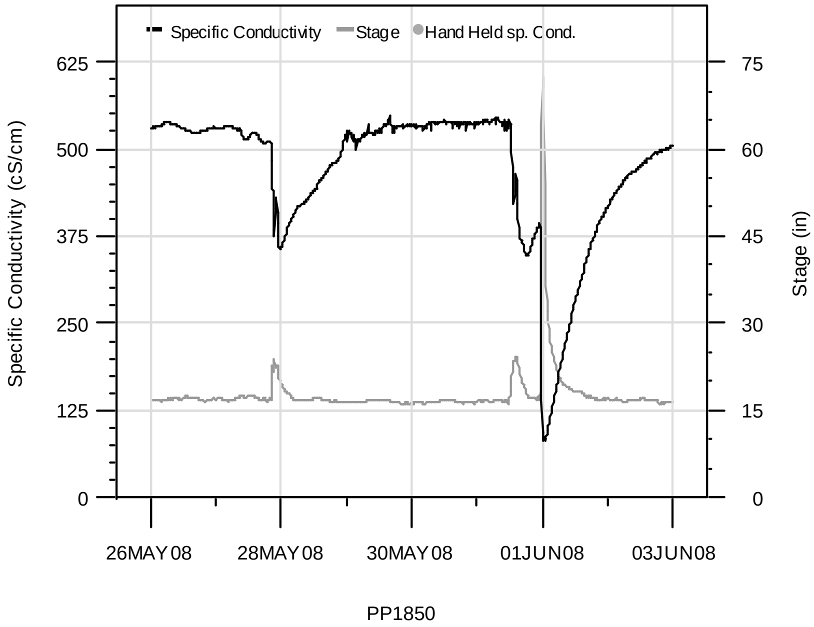

Figure G.135 Continuous Specific Conductivity at Site PP1850, 05/26/08 to 06/03/08

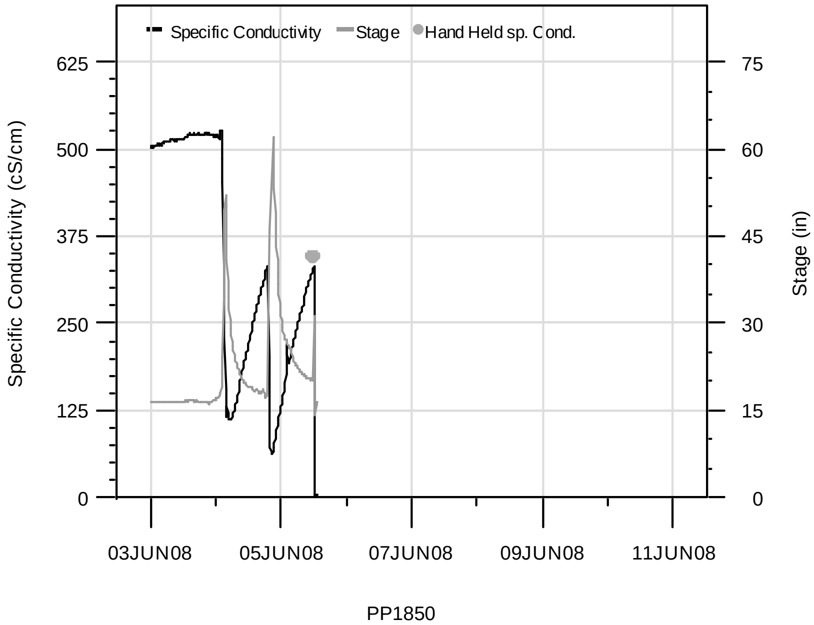

Figure G.136 Continuous Specific Conductivity at Site PP1850, 06/03/08 to 06/11/08

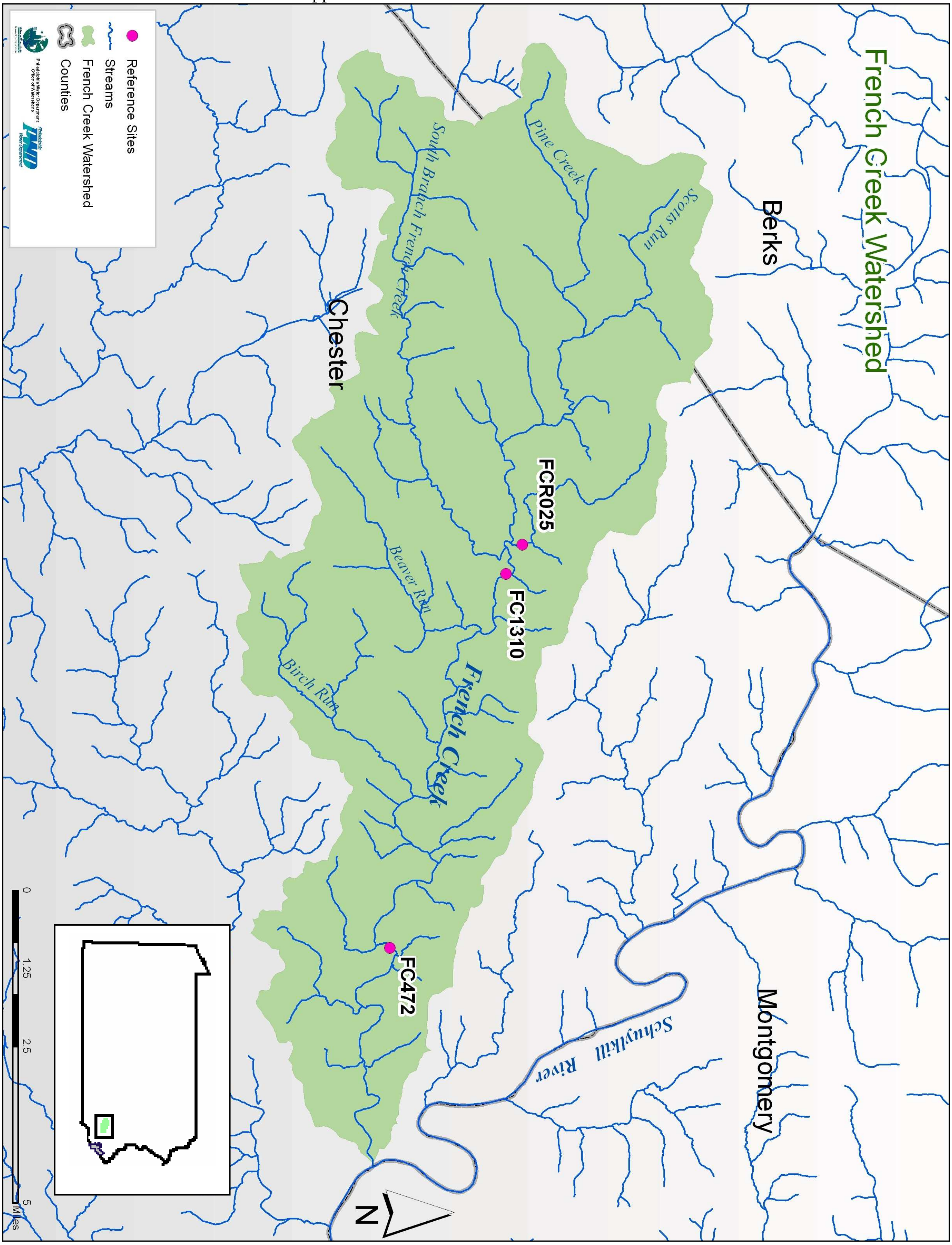

Figure H.1 French Creek Reference Sites

Table I.1 List of Unique Taxa found within Pennypack Creek Watershed, 2007

Order	Family	Genus	Taxon HBI	Tolerance
[3]Coleoptera	Ameletidae	Ameletus	0	Intolerant
[2]Ephemeroptera	Heptageniidae	Epeorus	0	Intolerant
[3]Ephemeroptera	Ameletidae	Ameletus	0	Intolerant
[2]Plecoptera	Perlidae	Acroneuria	0	Intolerant
Trichoptera	Glossosomatidae	Glossosoma	0	Intolerant
[1]Trichoptera	Philopotamidae	Dolophilodes	0	Intolerant
[2]Ephemeroptera	Ephemerellidae	Ephemerella	1	Intolerant
[2]Ephemeroptera	Ephemerellidae	Drunella	1	Intolerant
[2]Plecoptera	Taeniopterygidae	Oemopteryx	1	Intolerant
[2]Plecoptera	Peltoperlidae	Tallaperla	1	Intolerant
[2]Trichoptera	Brachycentridae	Brachycentrus	1	Intolerant
[2]Trichoptera	Rhyacophilidae	Rhyacophila	1	Intolerant
[3]Coleoptera	Elmidae	Ancyronyx	2	Intolerant
Coleoptera	Elmidae	Promoresia	2	Intolerant
Coleoptera	Elmidae	Macronychus	2	Intolerant
[2]Diptera	Simuliidae	Prosimulium	2	Intolerant
[2]Ephemeroptera	Ephemerellidae	no tails	2	Intolerant
[3]Ephemeroptera	Ephemerellidae	Attenella	2	Intolerant
[2]Plecoptera	Nemouridae	Ostrocerca	2	Intolerant
[2]Plecoptera	Nemouridae	n/a no tail, gillls	2	Intolerant
Diptera	Tipulidae	Antocha	3	Intolerant
[2]Ephemeroptera	Isonychidae	Isonychia	3	Intolerant
[2]Ephemeroptera	Heptageniidae	Stenonema	3	Intolerant
[2]Ephemeroptera	Heptageniidae	n/a	3	Intolerant
[1]Plecoptera	Nemouridae	Amphinemura	3	Intolerant
[2]Trichoptera	Uenoidae	Neophylax	3	Intolerant
[3]Bivalvia	Corbiculidae	Corbicula	4	Moderately Tolerant
[2]Coleoptera	Psephenidae	Psephenus	4	Moderately Tolerant
[1]Coleoptera	Elmidae	Optioservus	4	Moderately Tolerant
Diptera	Tipulidae	Tipula	4	Moderately Tolerant
[2]Megaloptera	Corydalidae	Corydalus	4	Moderately Tolerant
Trichoptera	Philoptamidae	Chimarra	4	Moderately Tolerant
Coleoptera	Elmidae	Stenelmis	5	Moderately Tolerant
[2]Diptera	Empididae	Clinocera	5	Moderately Tolerant
Trichoptera	Hydropsychidae	Hydropsyche	5	Moderately Tolerant
[3]Amphipoda	Gammaridae	Gammarus	6	Moderately Tolerant
[3]Amphipoda	Crangonyctidae	Cragonyx	6	Moderately Tolerant

[2]Diptera	Ephydridae	-----	6	Moderately Tolerant
[3]Diptera	Ceratopogonidae	Ceratopogon	6	Moderately Tolerant
Diptera	Simuliidae	Simulium	6	Moderately Tolerant
Diptera	Empididae	Hemerodromia	6	Moderately Tolerant
Diptera	Chironomidae	n/a	6	Moderately Tolerant
[1]Diptera	Ceratopogonidae	n/a	6	Moderately Tolerant
[3]Ephemeroptera	Baetidae	Baetis	6	Moderately Tolerant
Gastropoda	Planorbidae	n/a	6	Moderately Tolerant
[1]Isopoda	Asellidae	Caecidotea	6	Moderately Tolerant
Trichoptera	Hydropsychidae	Cheumatopsyche	6	Moderately Tolerant
[3]Trichoptera	Hydroptillidae	Hydroptilla	6	Moderately Tolerant
[1]Trichoptera	Hydroptilidae	Leucotrichia	6	Moderately Tolerant
[1]Gastropoda	Ancylidae	----	7	Tolerant
[1]Gastropoda	Physidae	----	8	Tolerant
[3]Hirundinea	----	----	8	Tolerant
Tricladida	Planariidae	n/a	9	Tolerant
[1]Diptera	Psychodidae	n/a	10	Tolerant
Oligochaeta	n/a	n/a	10	Tolerant

1Exclusive to Pennypack Tributaries
[2]Exclusive to French Creek
[3]Exclusive to Pennypack Mainstem

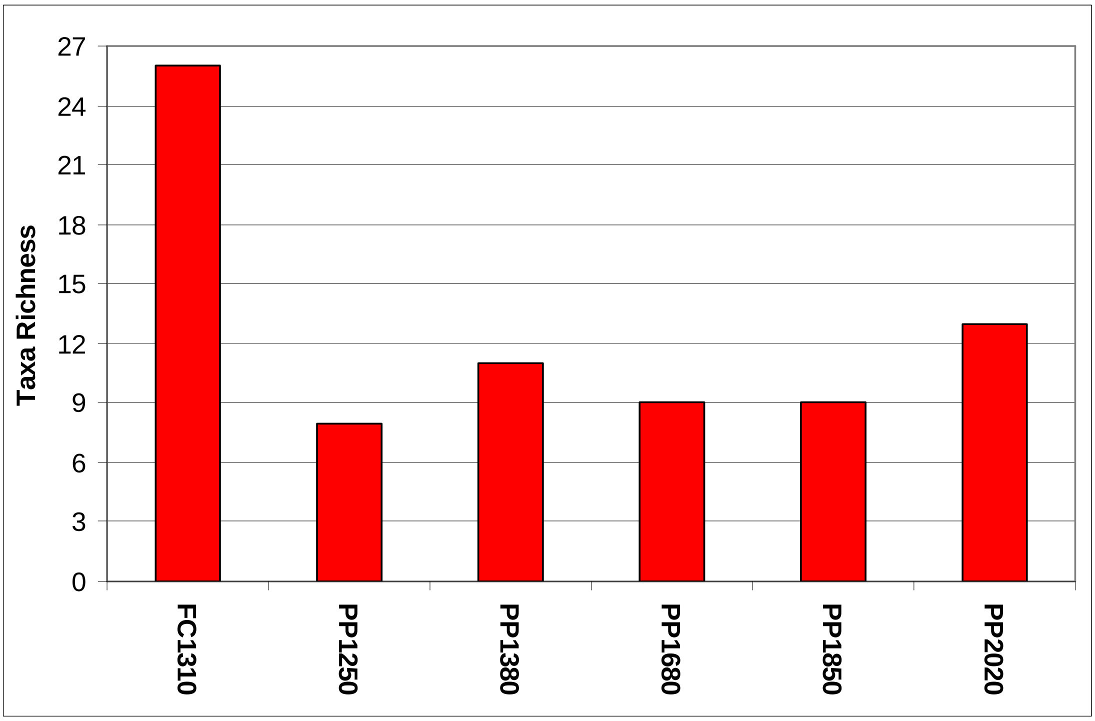

Figure I.1 Taxa Richness at Pennypack Creek (2nd and 3rd Order) Sites and French Creek Reference Reach, 2007

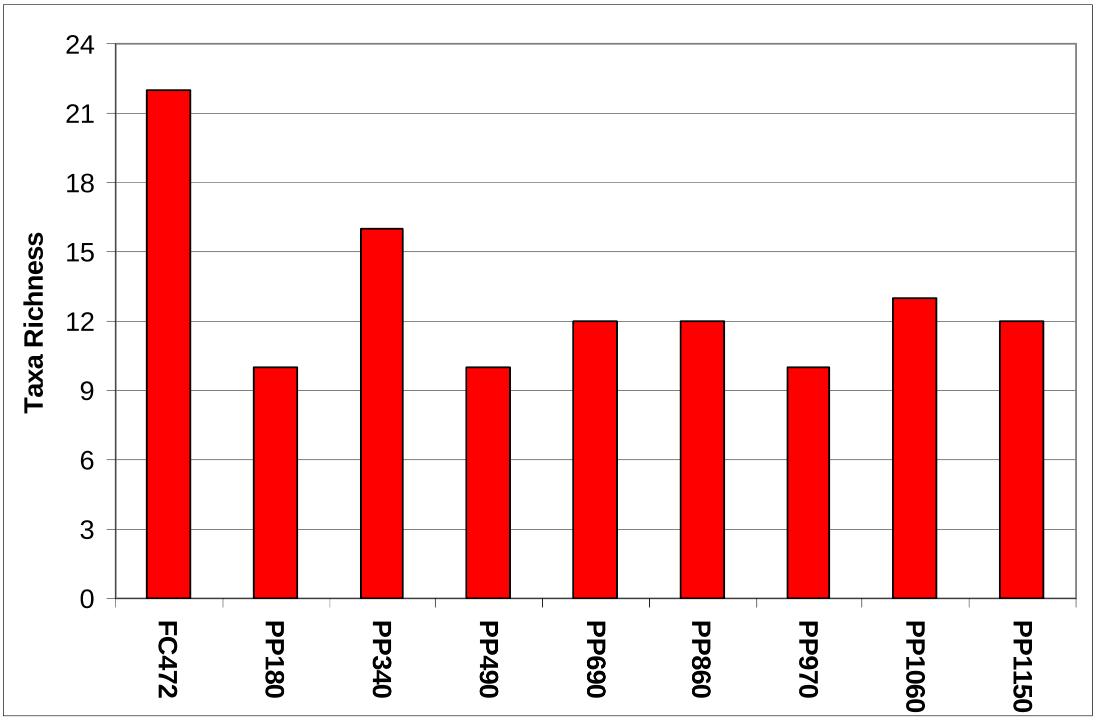

Figure I.2 Taxa Richness at Pennypack Creek (4th Order) Sites and French Creek Reference Reach, 2007

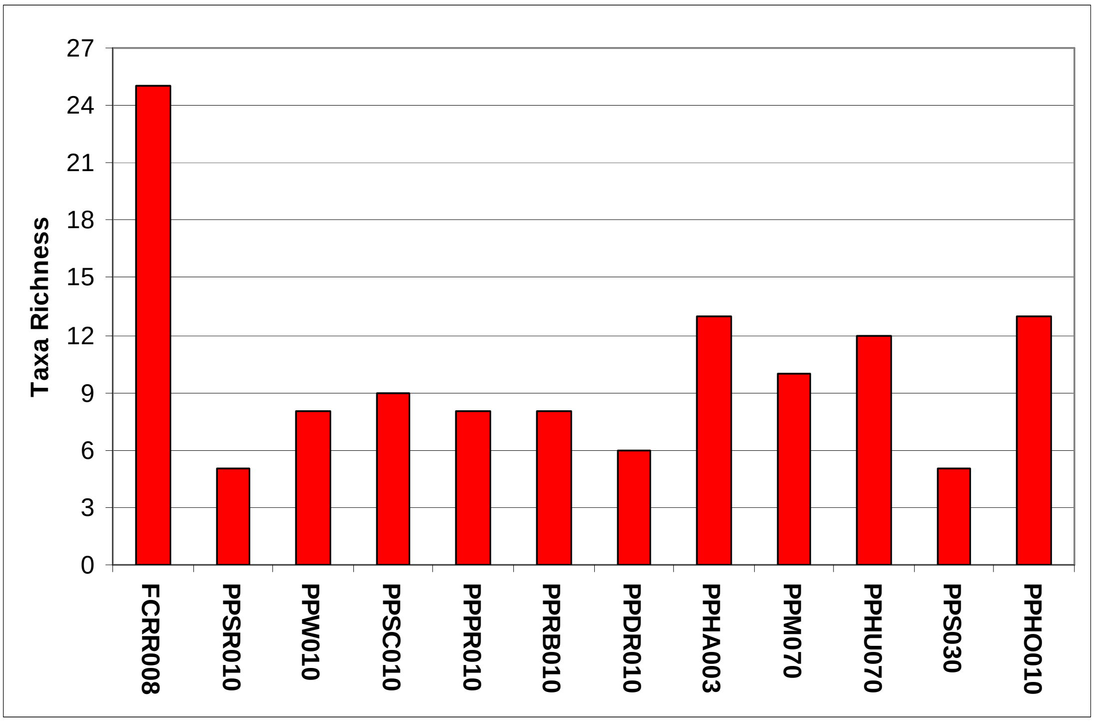

Figure I.3 Taxa Richness at Pennypack Creek Tributary Sites and French Creek Reference Reach, 2007

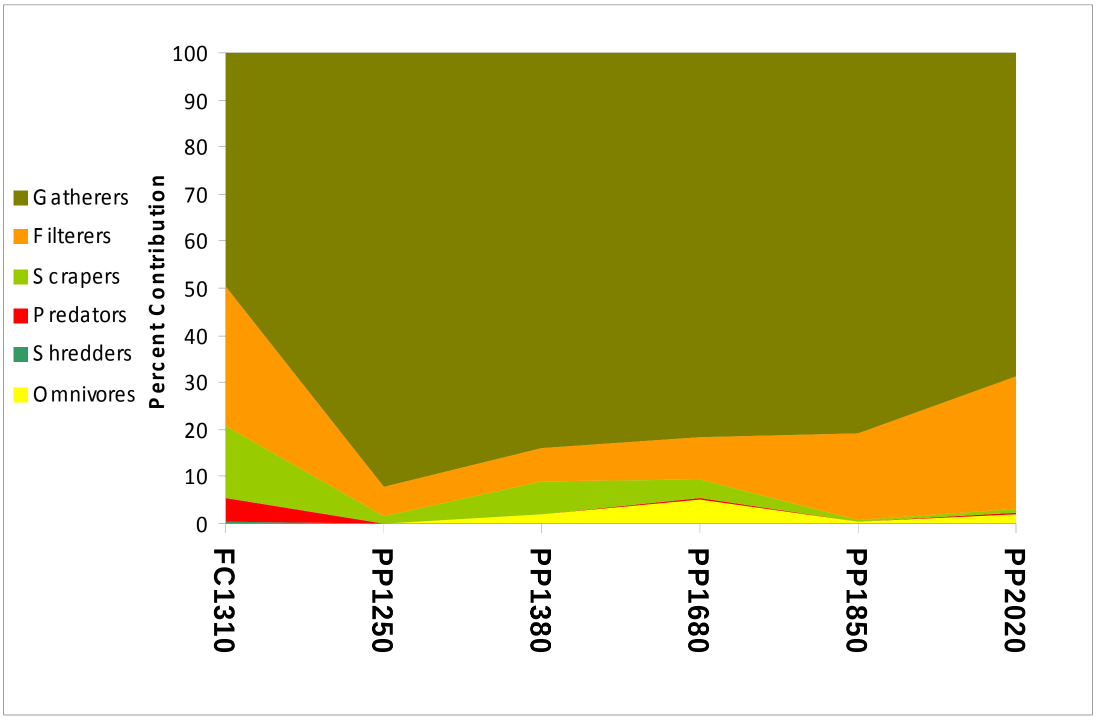

Figure I.4 Trophic Composition at Mainstem Sites (2nd and 3rd Order), Pennypack Creek Watershed, 2007

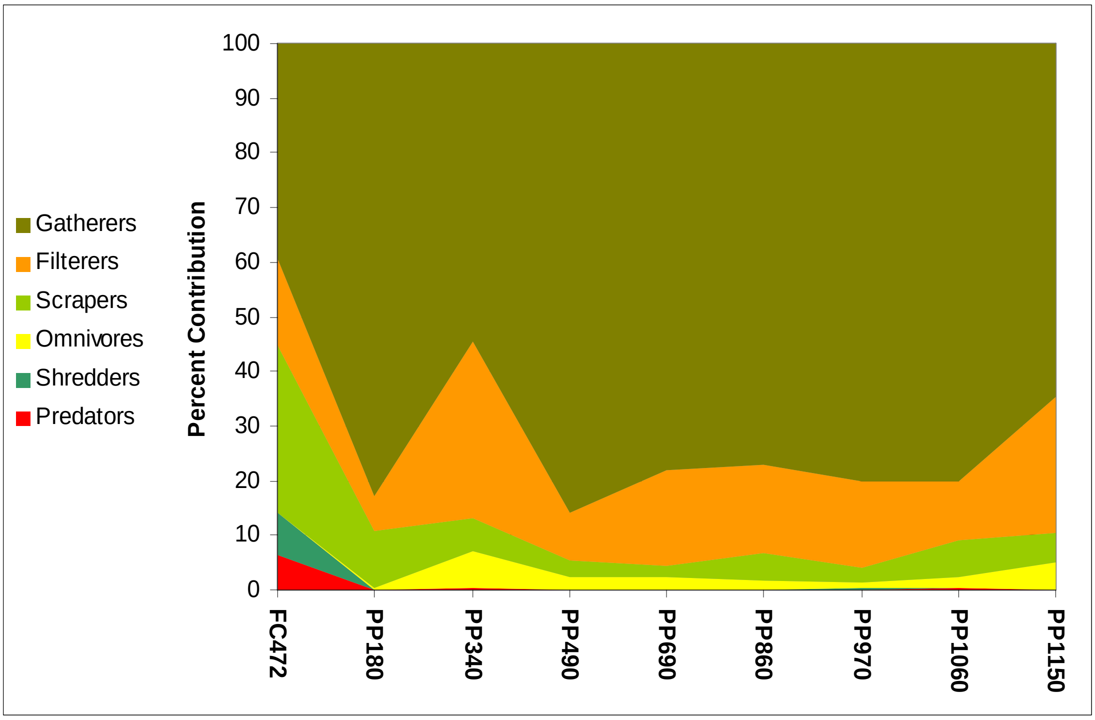

Figure I.5 Trophic Composition at Mainstem Sites (4th Order), Pennypack Creek Watershed, 2007

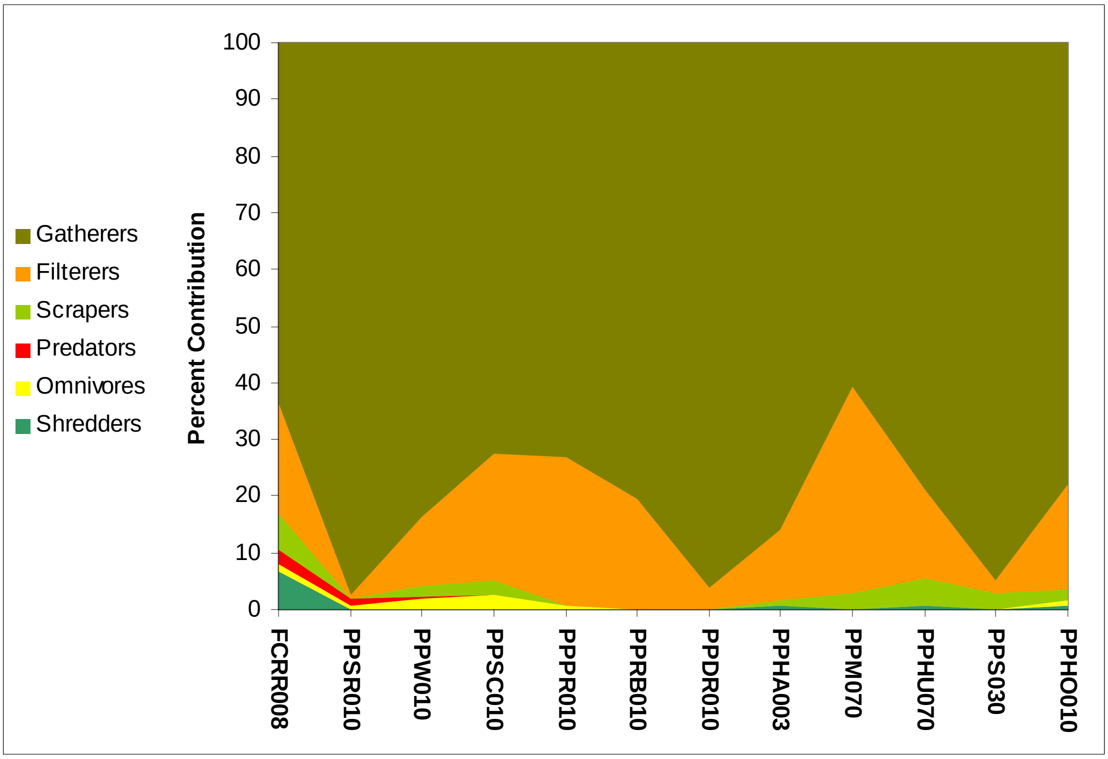

Figure I.6 Trophic Compositions H Tributary Sites (2nd and 3rd Order), Pennypack Creek Watershed, 2007

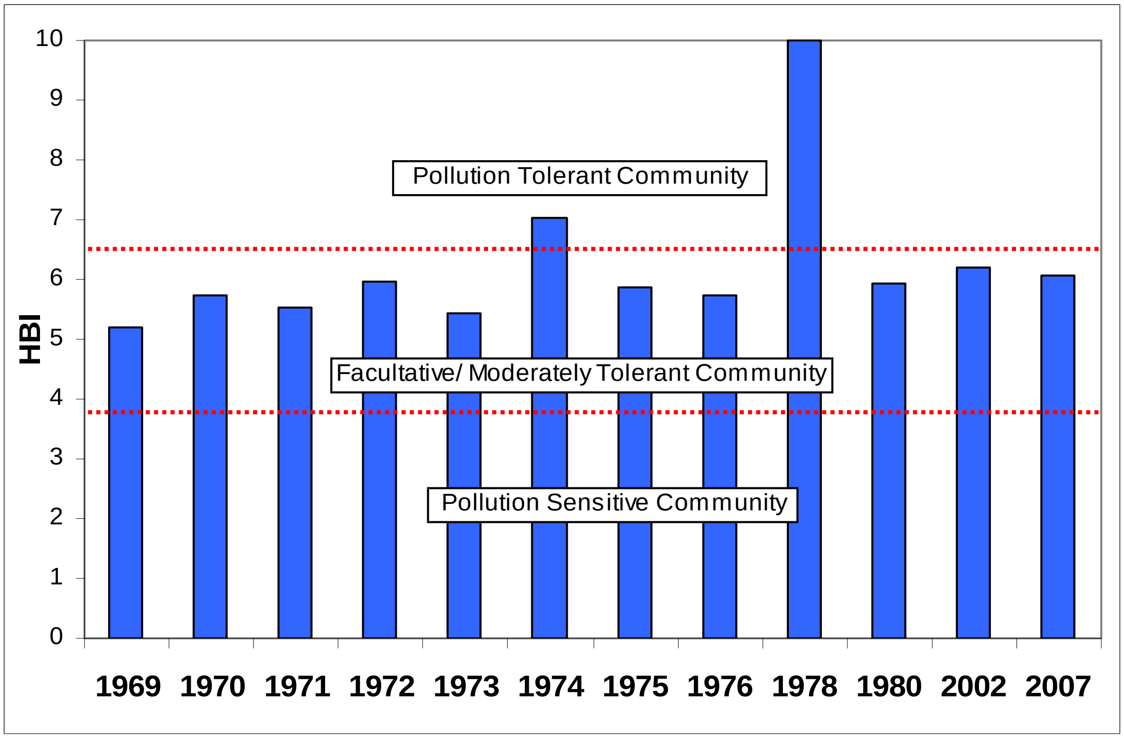

Figure J.1 HBI Values at Mainstem Site PP180, Pennypack Creek Watershed, 1969-1980, 2002, 2007

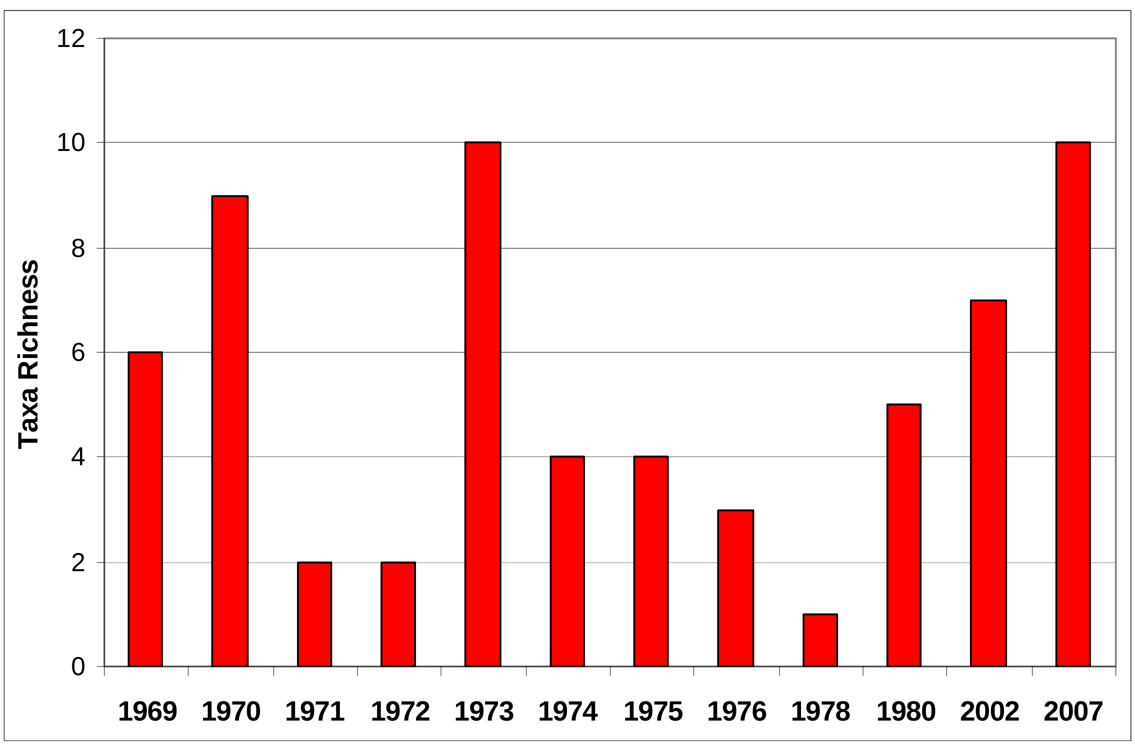

Figure J.2 Taxa Richness at Mainstem Site PP180, Pennypack Creek Watershed, 1969-1980, 2002, 2007

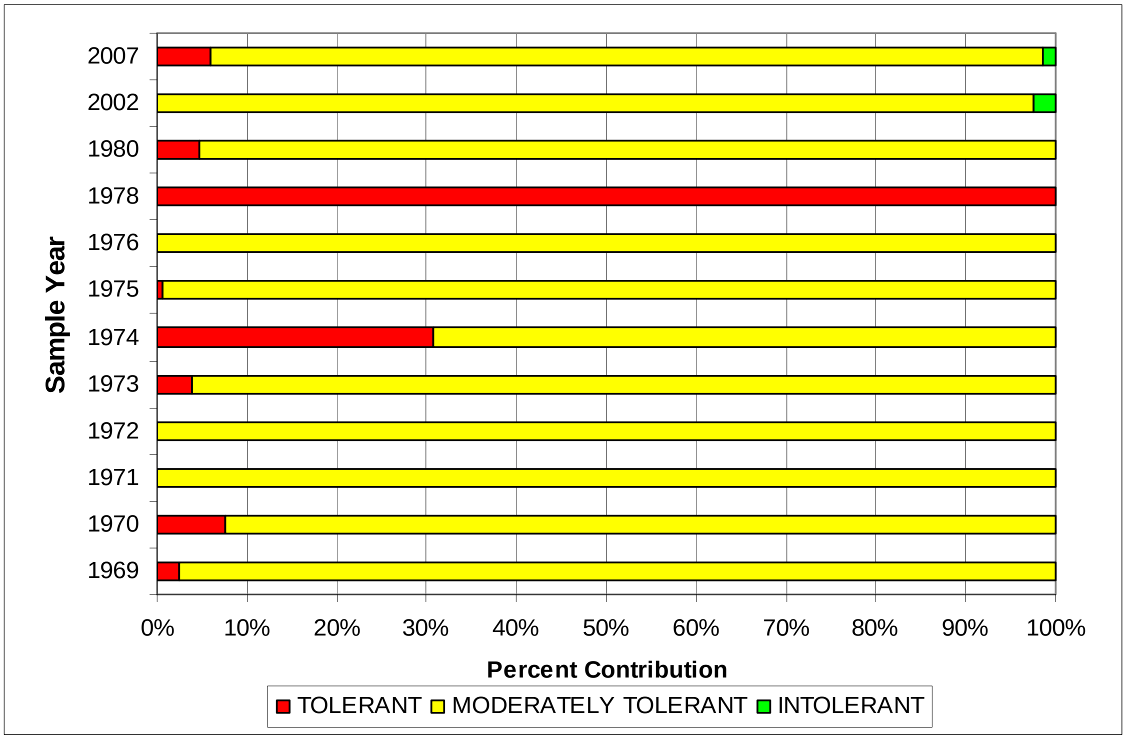

Figure J.3 Tolerance Distribution at Mainstem Site PP180, Pennypack Creek Watershed, 1969-1980, 2002, 2007

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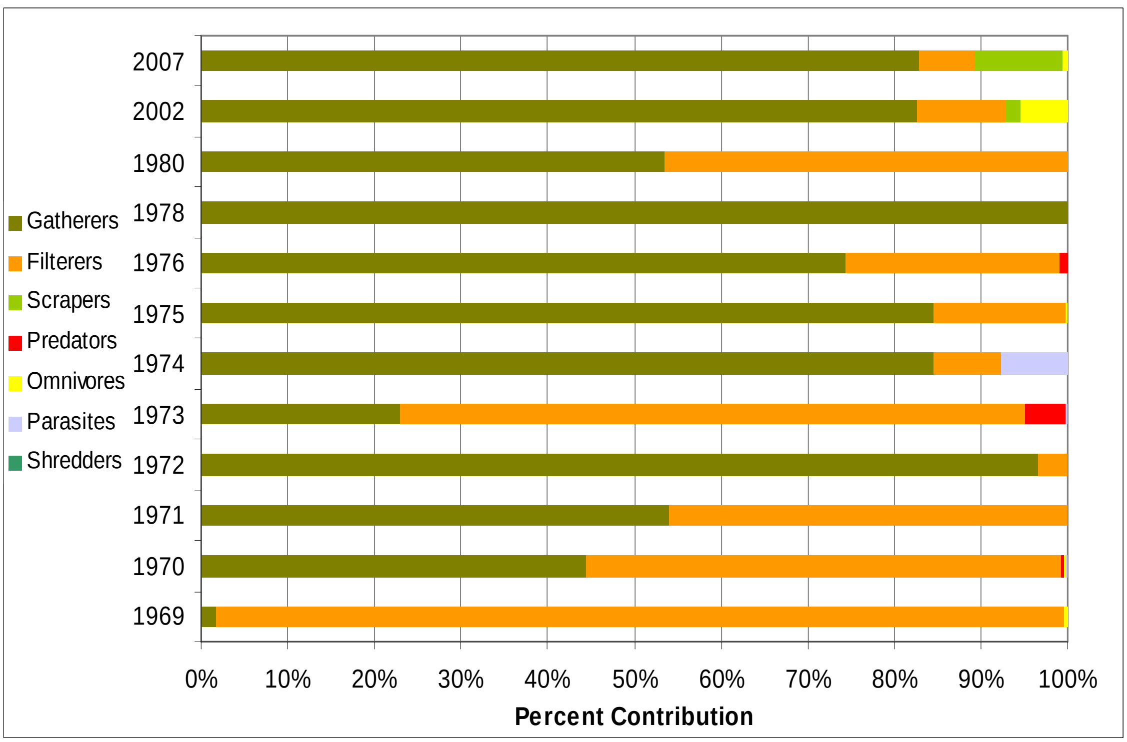


Figure J.4 Trophic Composition at Mainstem Site PP180, Pennypack Creek Watershed, 1969-1980, 2002, 2007

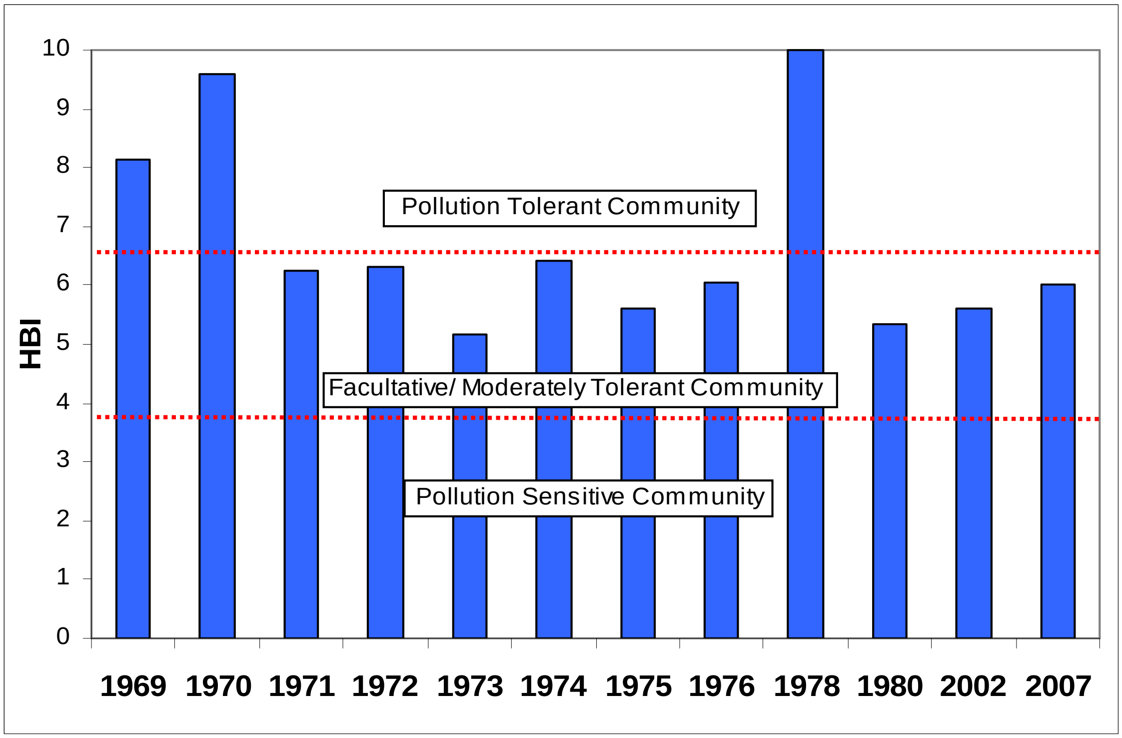


Figure J.5 HBI Values at Mainstem Site PP490, Pennypack Creek Watershed, 1969-1980, 2002, 2007

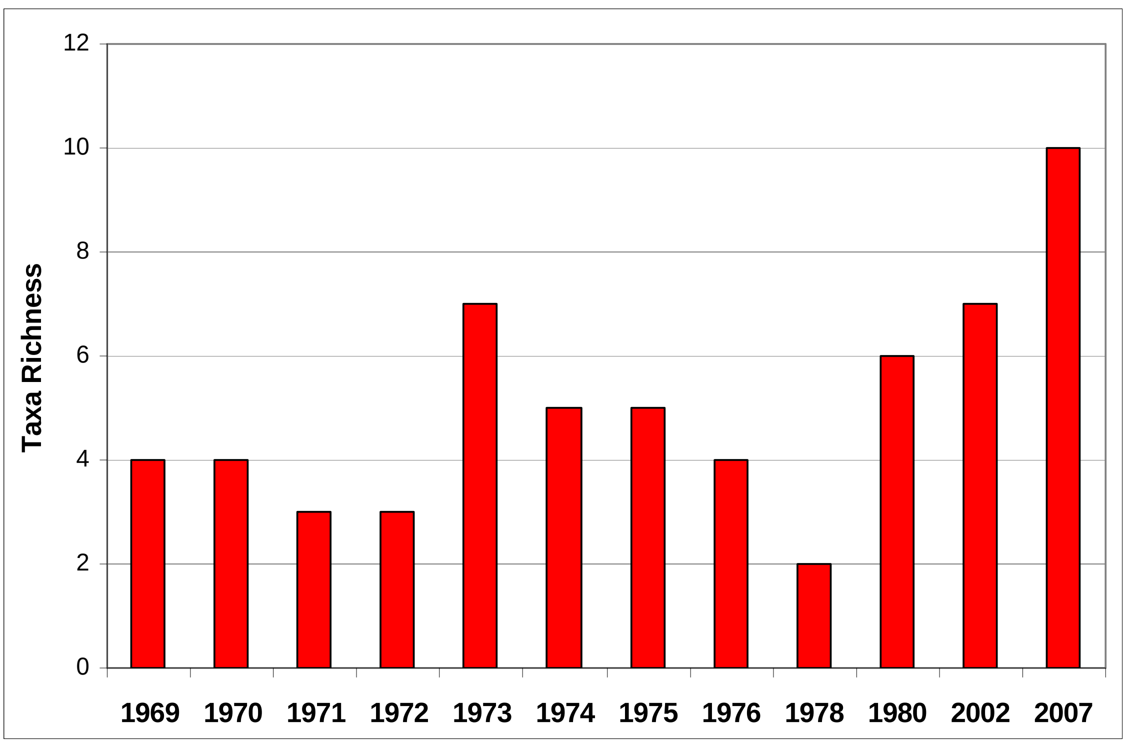


Figure J.6 Taxa Richness at Mainstem Site PP490, Pennypack Creek Watershed, 1969-1980, 2002, 2007

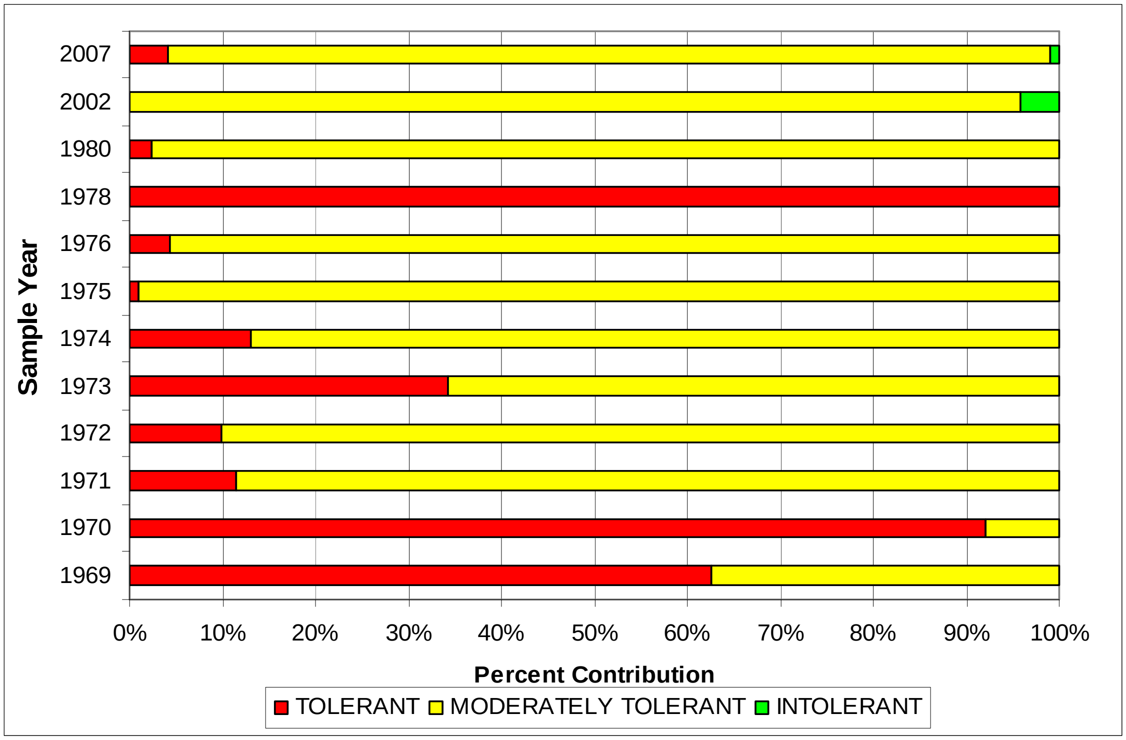


Figure J.7 Tolerance Distribution at Mainstem Site PP490, Pennypack Creek Watershed, 1969-1980, 2002, 2007

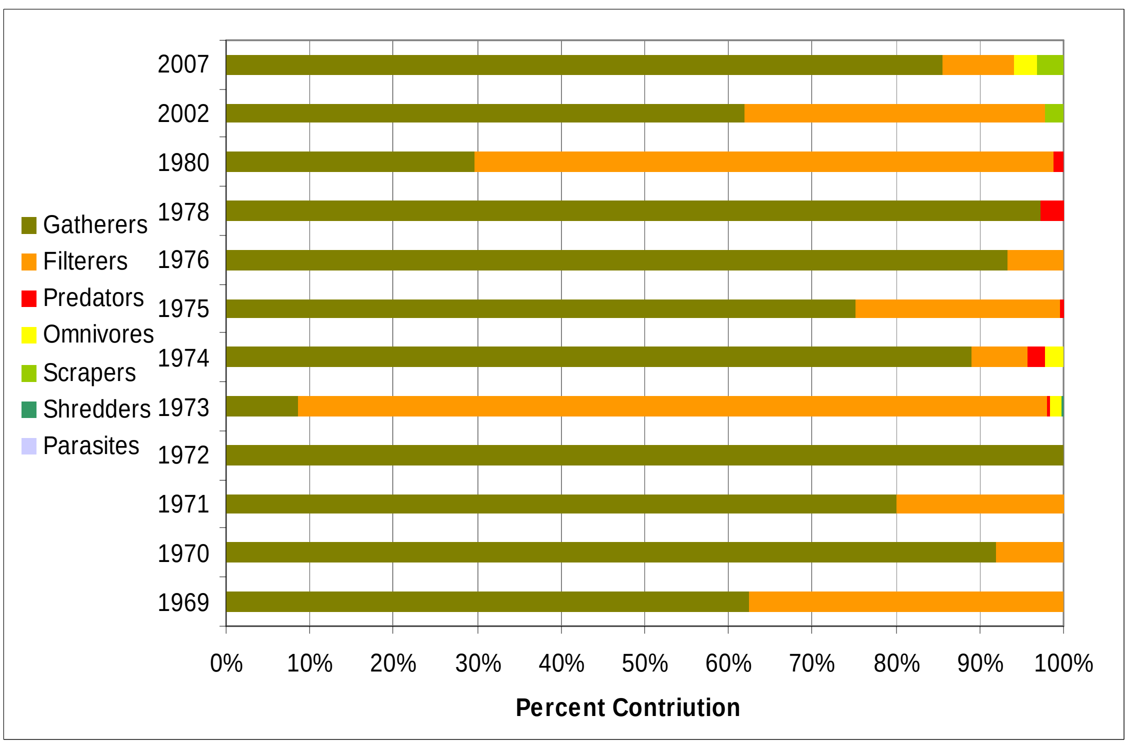
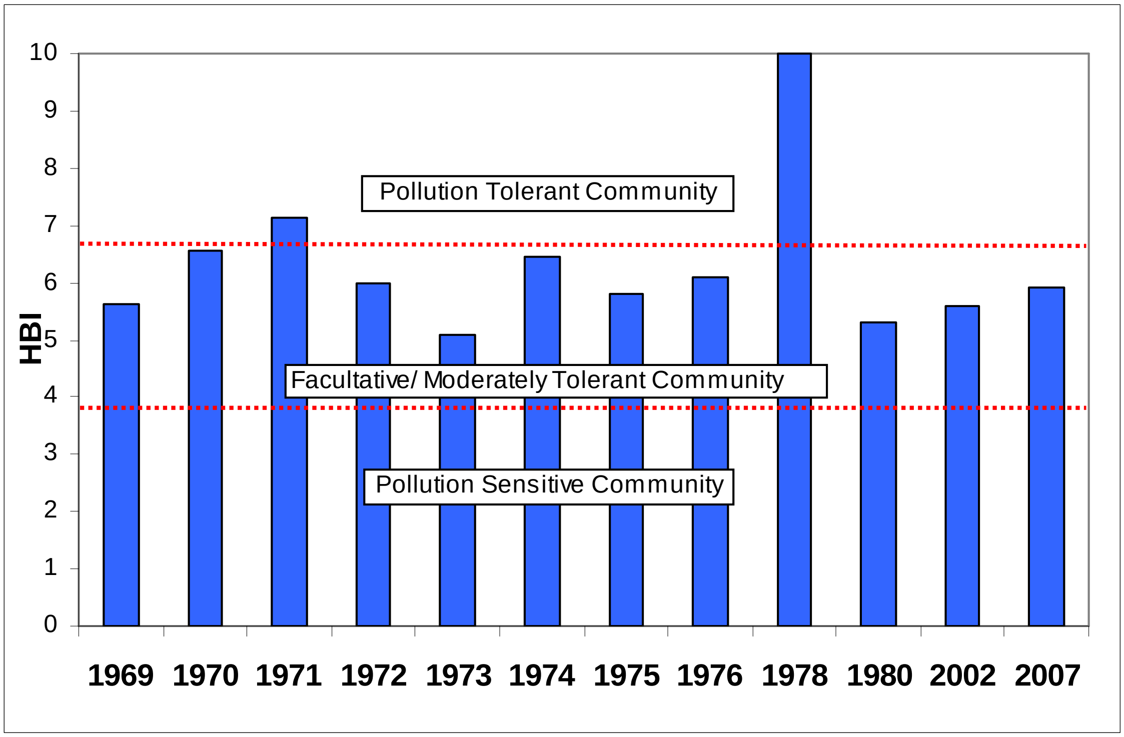


Figure J.8 Trophic Composition at Mainstem Site PP490, Pennypack Creek Watershed, 1969-1980, 2002, 2007



FigureJ.9 HBI Values at Mainstem Site PP690, Pennypack Creek Watershed, 1969-1980, 2002, 2007

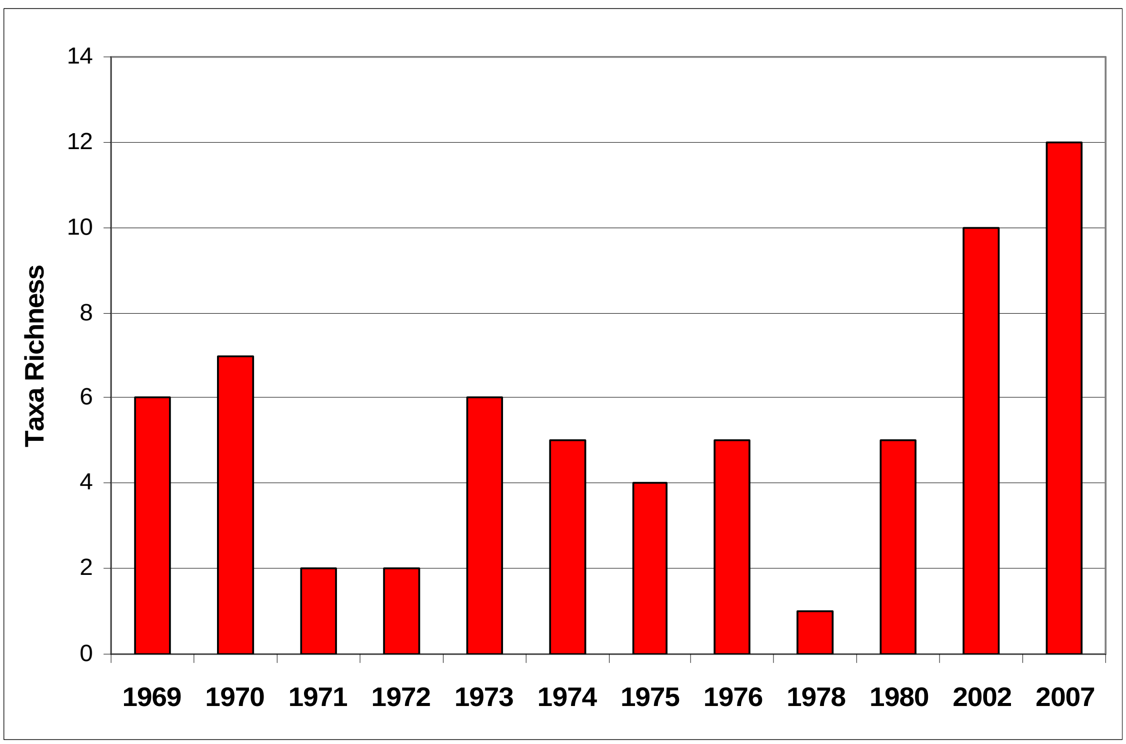


Figure J.10 Taxa Richness at Mainstem Site PP690, Pennypack Creek Watershed, 1969-1980, 2002, 2007

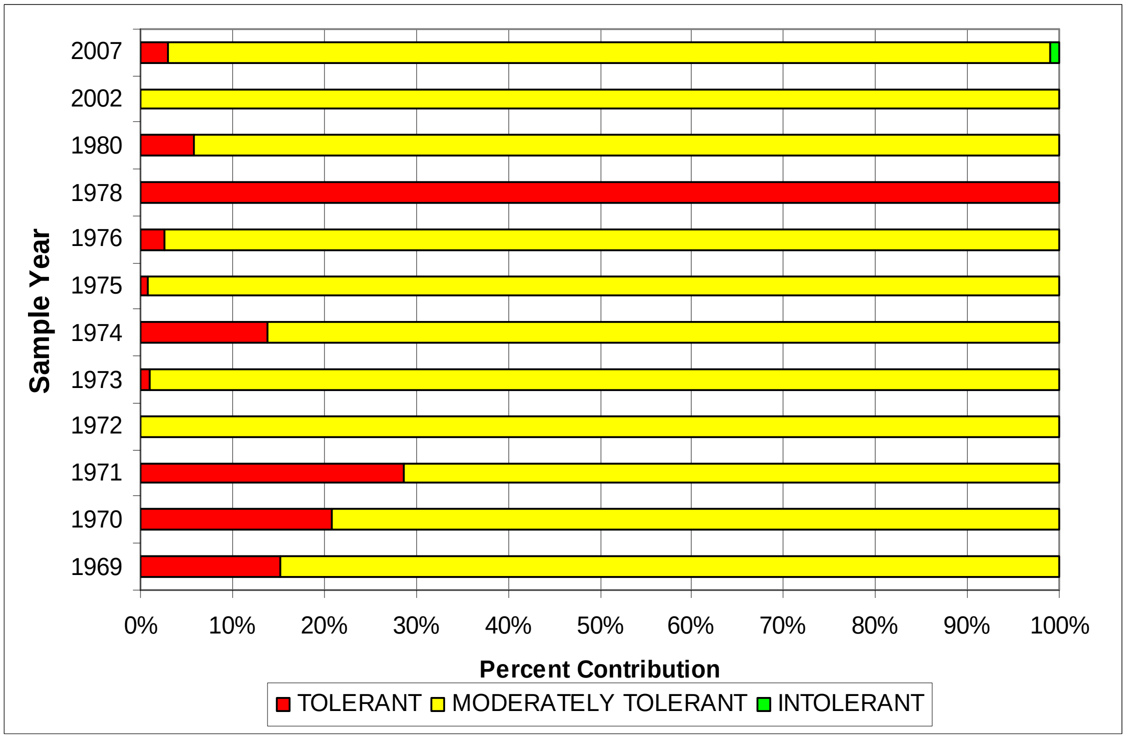


Figure J.11 Tolerance Distribution at Mainstem Site PP690, Pennypack Creek Watershed, 1969-1980, 2002, 2007

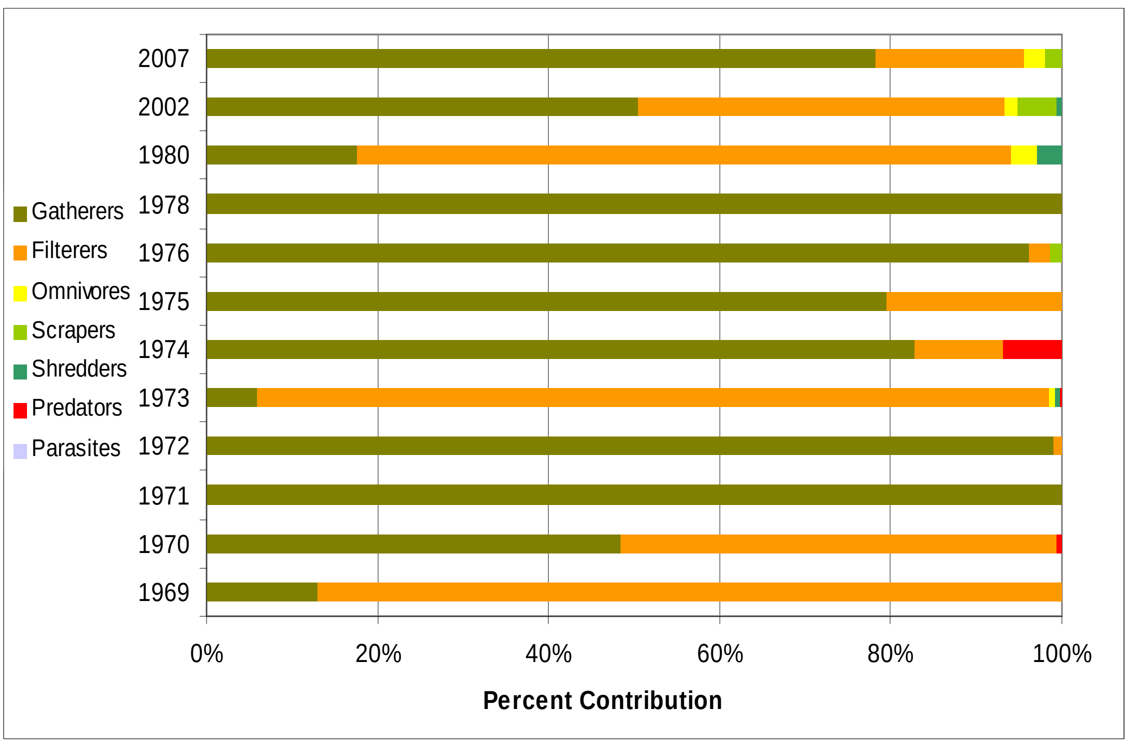


Figure J.12 Trophic Composition at Mainstem Site PP690, Pennypack Creek Watershed, 1969-1980, 2002, 2007

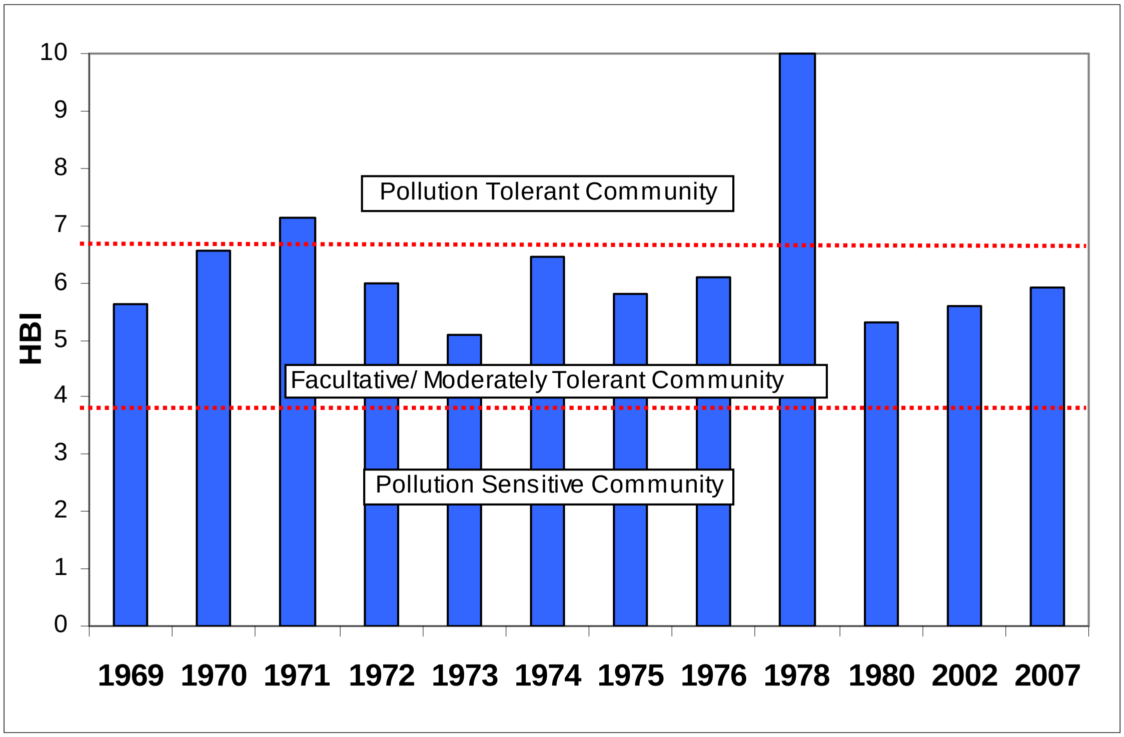


Figure J.13 HBI Values at Mainstem Site PP970, Pennypack Creek Watershed, 1969-1980, 2002, 2007

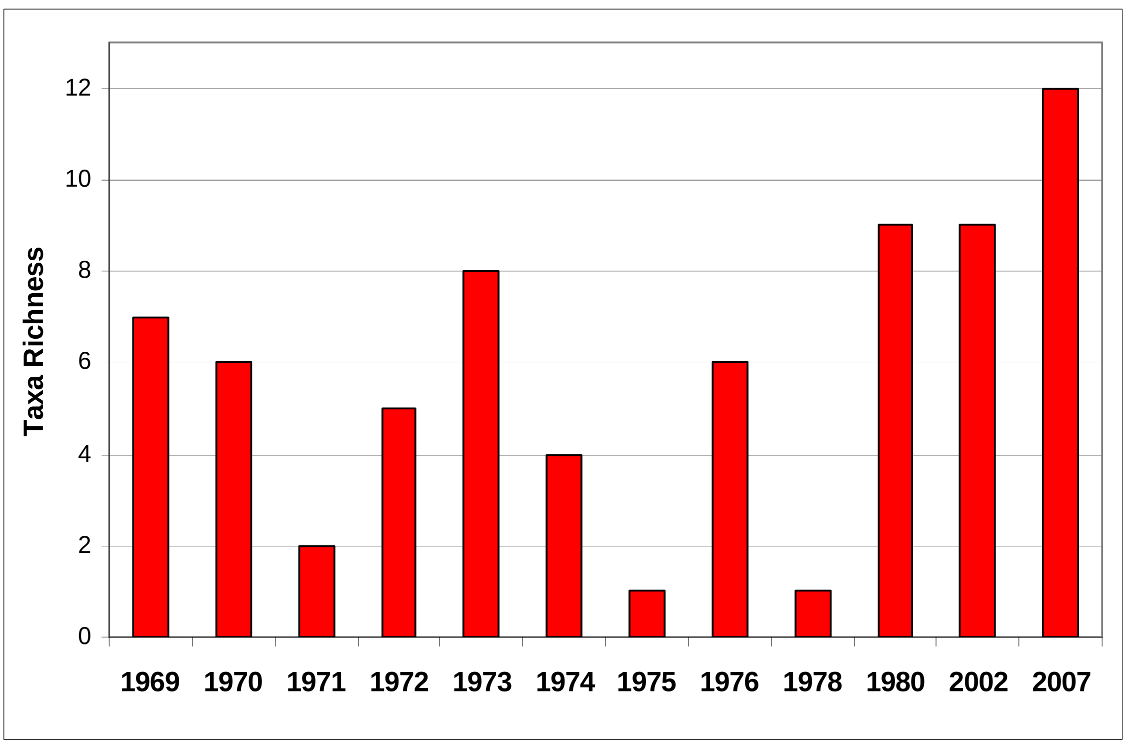


Figure J.14 Taxa Richness at Mainstem Site PP970, Pennypack Creek Watershed, 1969-1980, 2002, 2007

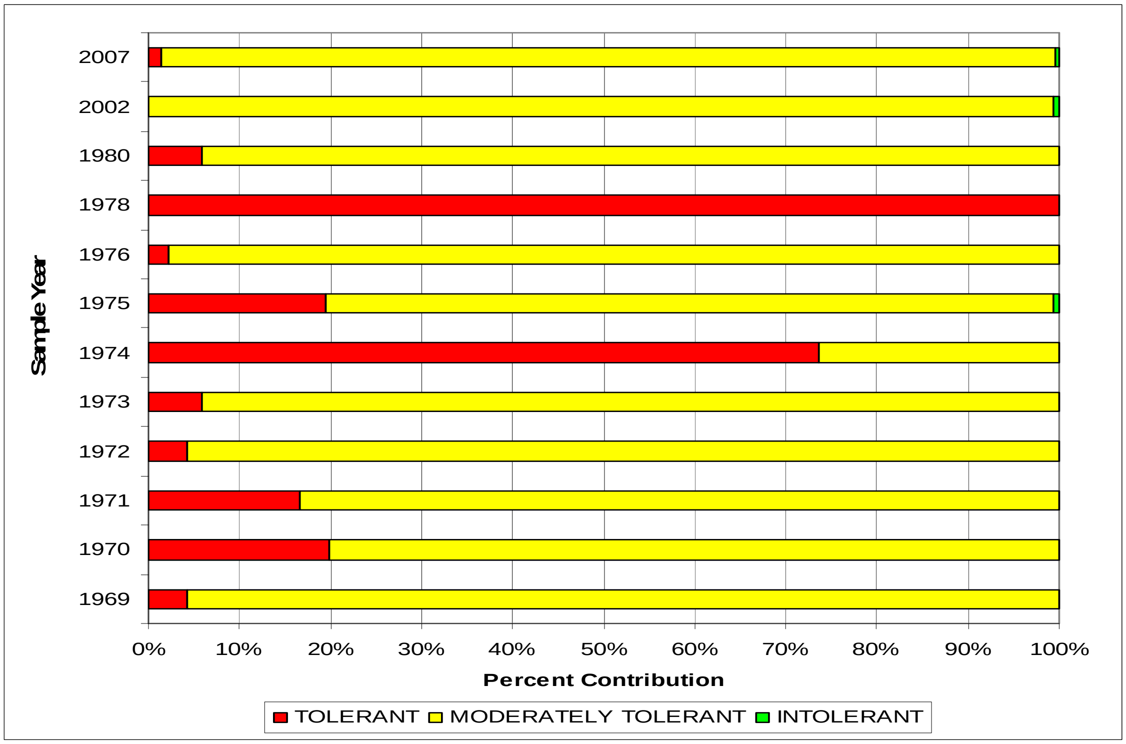


Figure J.15 Tolerance Distribution at Mainstem Site PP970, Pennypack Creek Watershed, 1969-1980, 2002, 2007

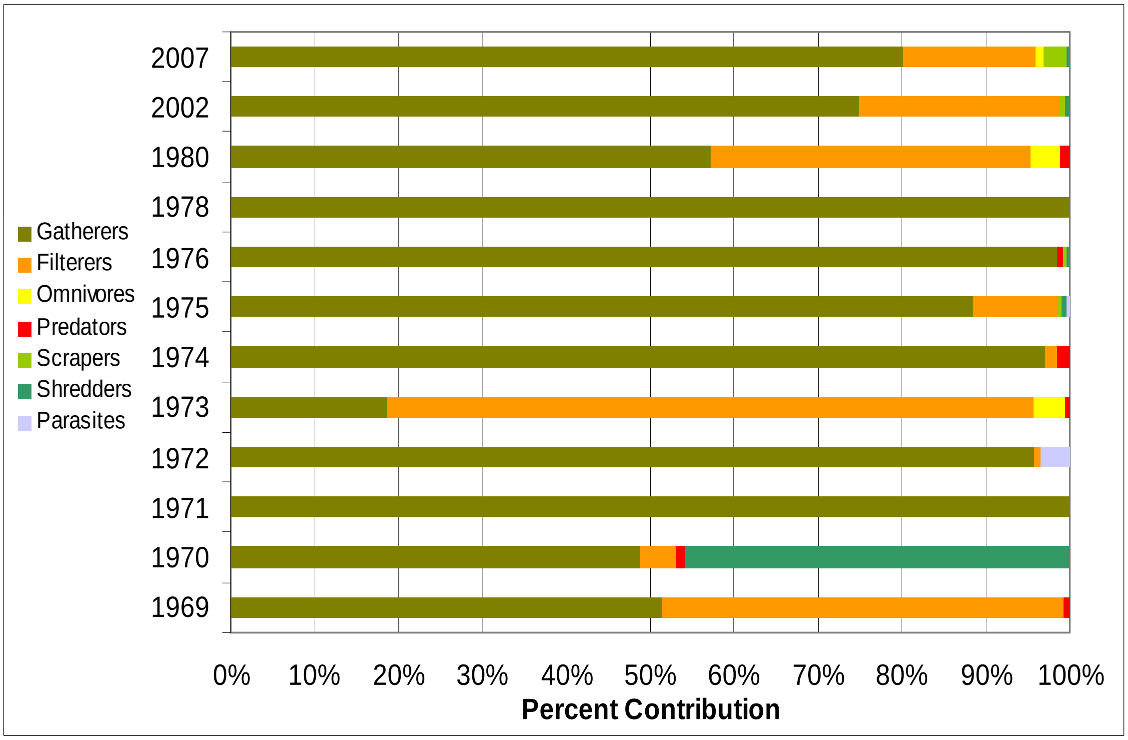


Figure J.16 Trophic Composition at Mainstem Site PP970, Pennypack Creek Watershed, 1969-1980, 2002, 2007

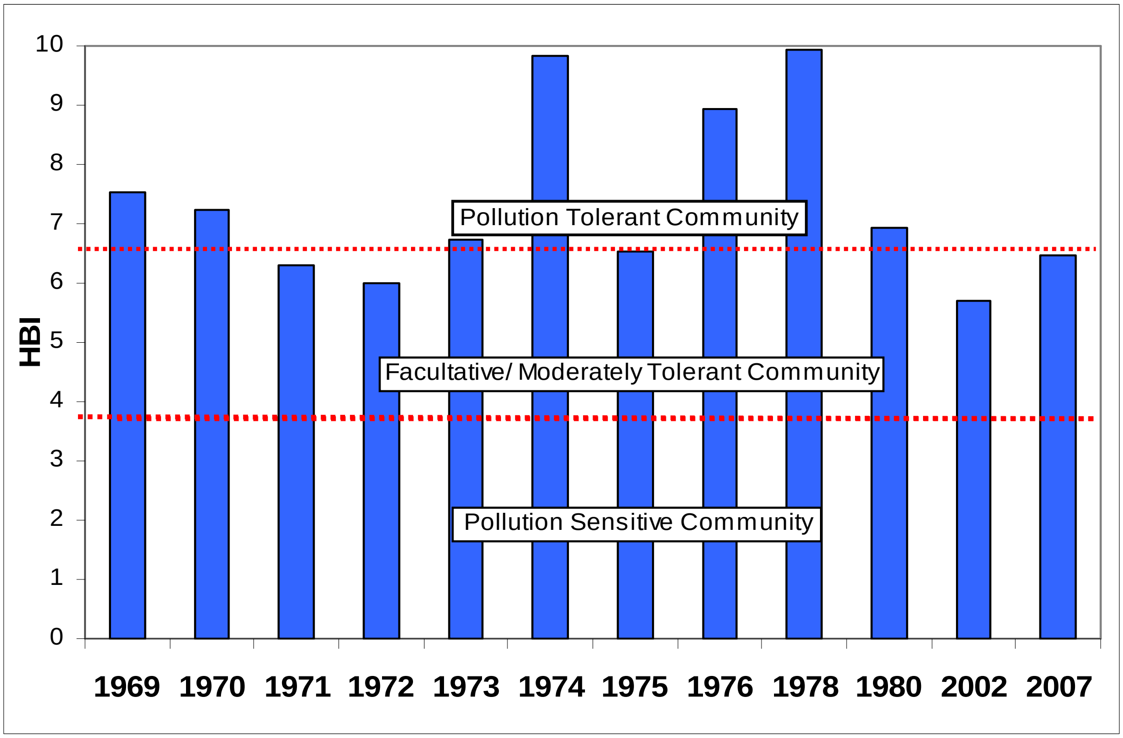


Figure J.17 HBI Values at Mainstem Site PP1250, Pennypack Creek Watershed, 1969-1980, 2002, 2007

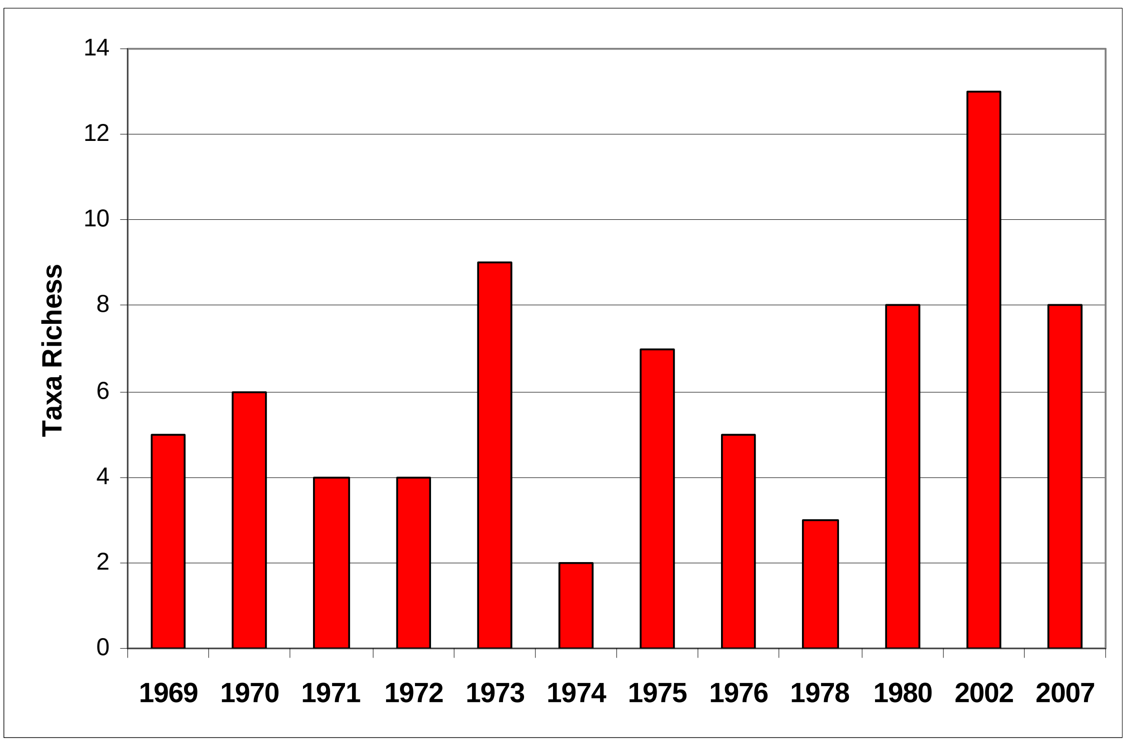


Figure J.18 Taxa Richness at Mainstem Site PP1250, Pennypack Creek Watershed, 1969-1980, 2002, 2007

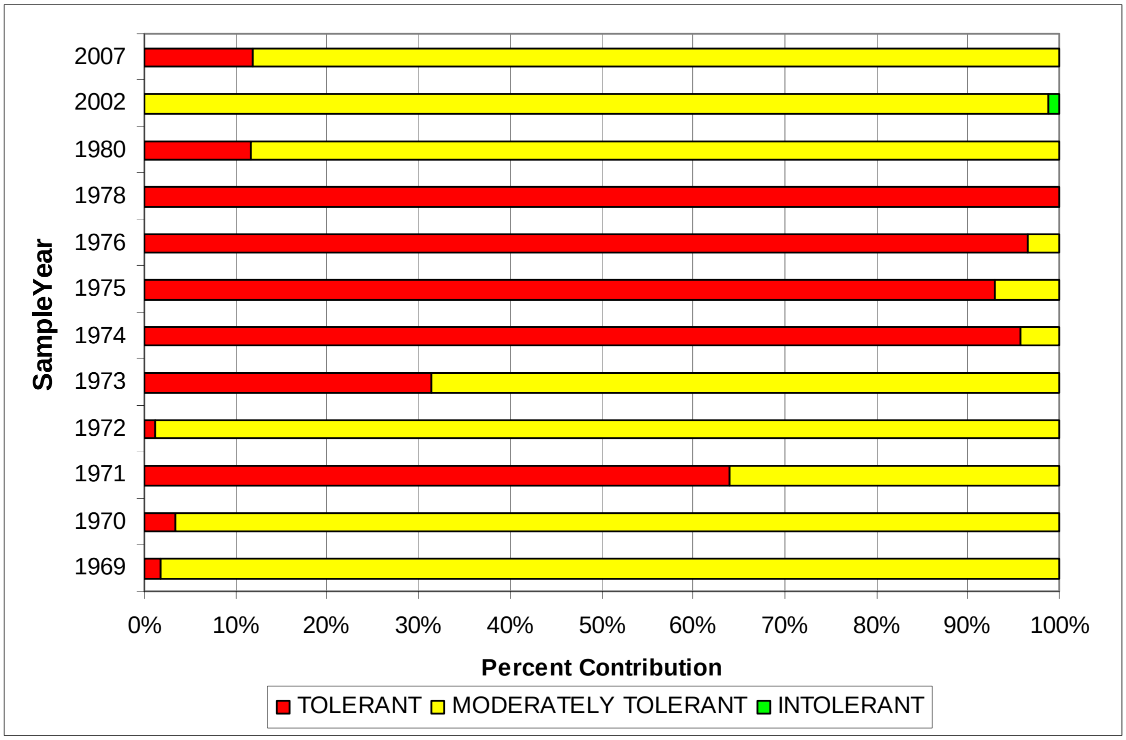


Figure J.19 Tolerance Distribution at Mainstem Site PP1250, Pennypack Creek Watershed, 1969-1980, 2002, 2007

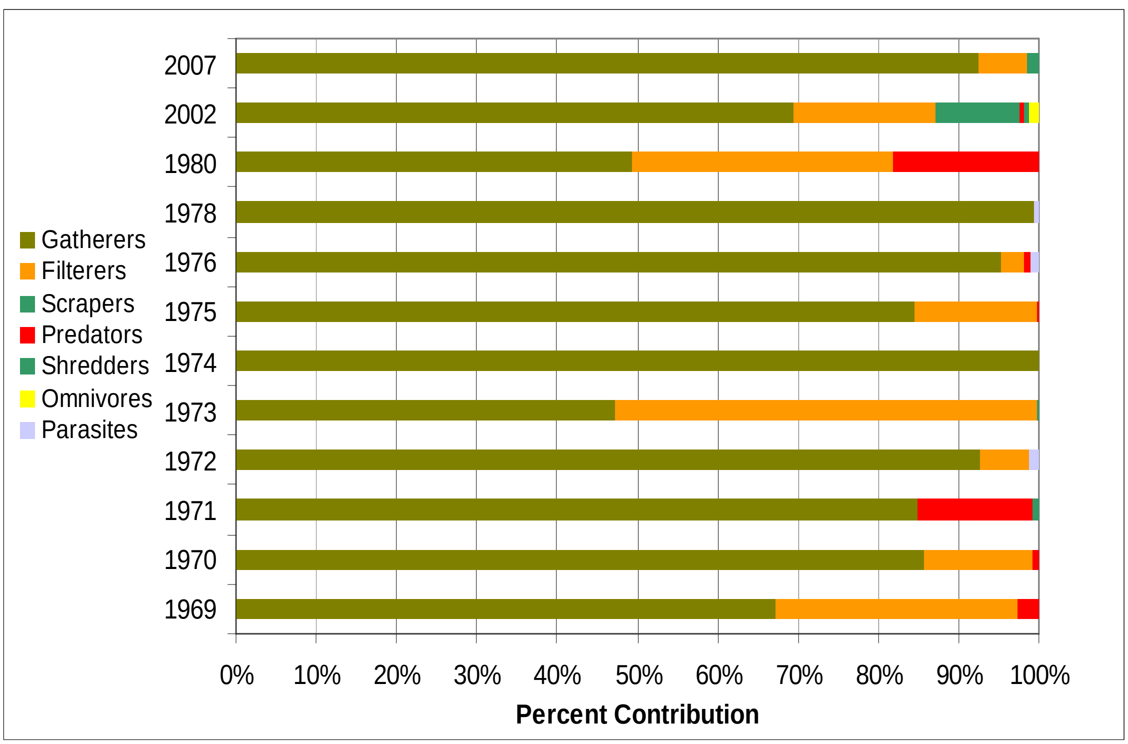


Figure J.20 Trophic Composition at Mainstem Site PP1250, Pennypack Creek Watershed, 1969-1980, 2002, 2007

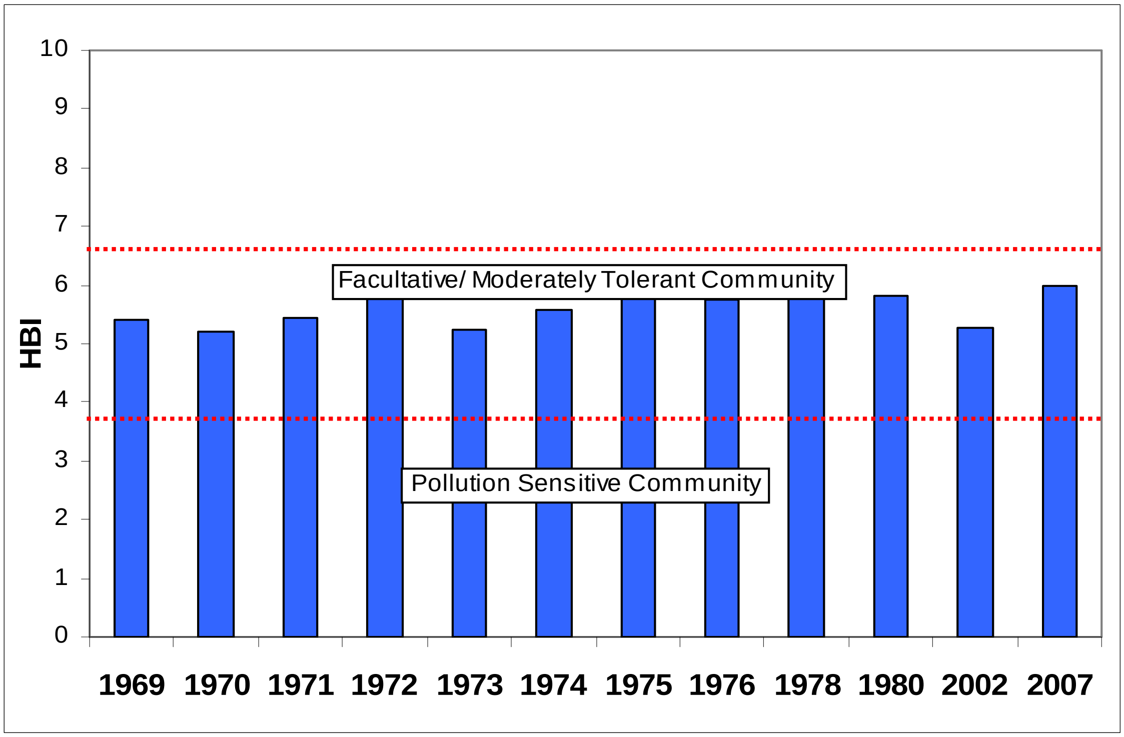


Figure J.21 HBI Values at Mainstem Site PP2020, Pennypack Creek Watershed, 1969-1980, 2002, 2007

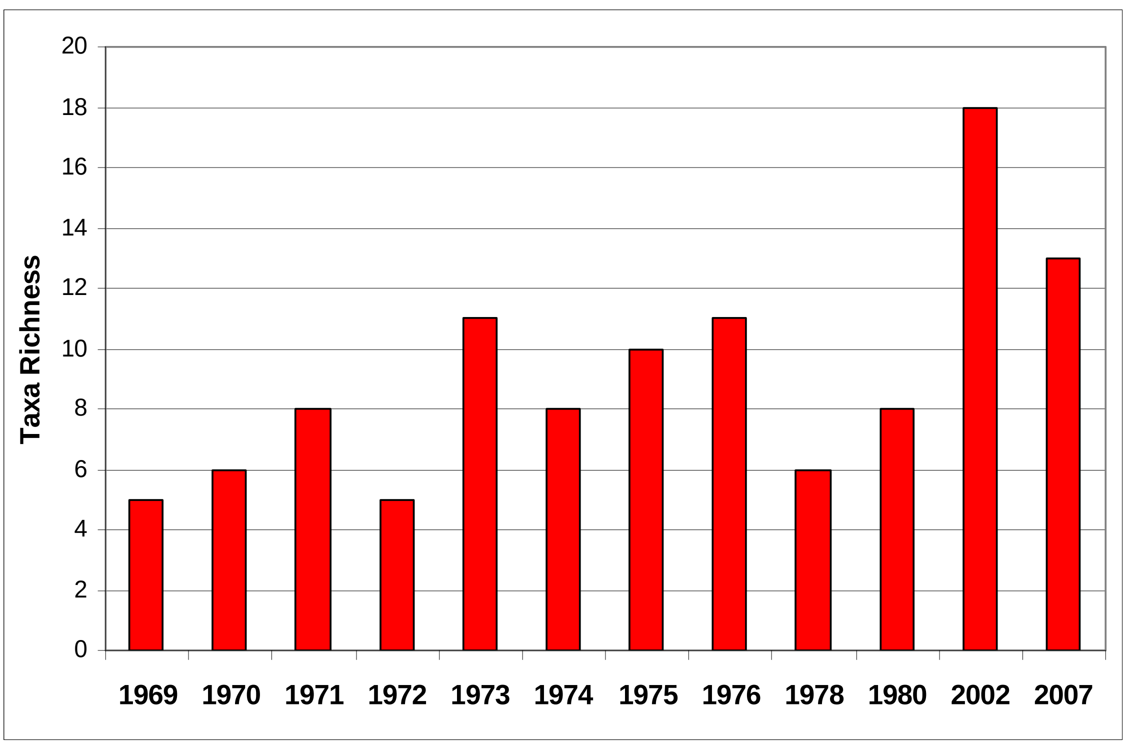


Figure J.22 Taxa Richness at Mainstem Site PP2020, Pennypack Creek Watershed, 1969-1980, 2002, 2007

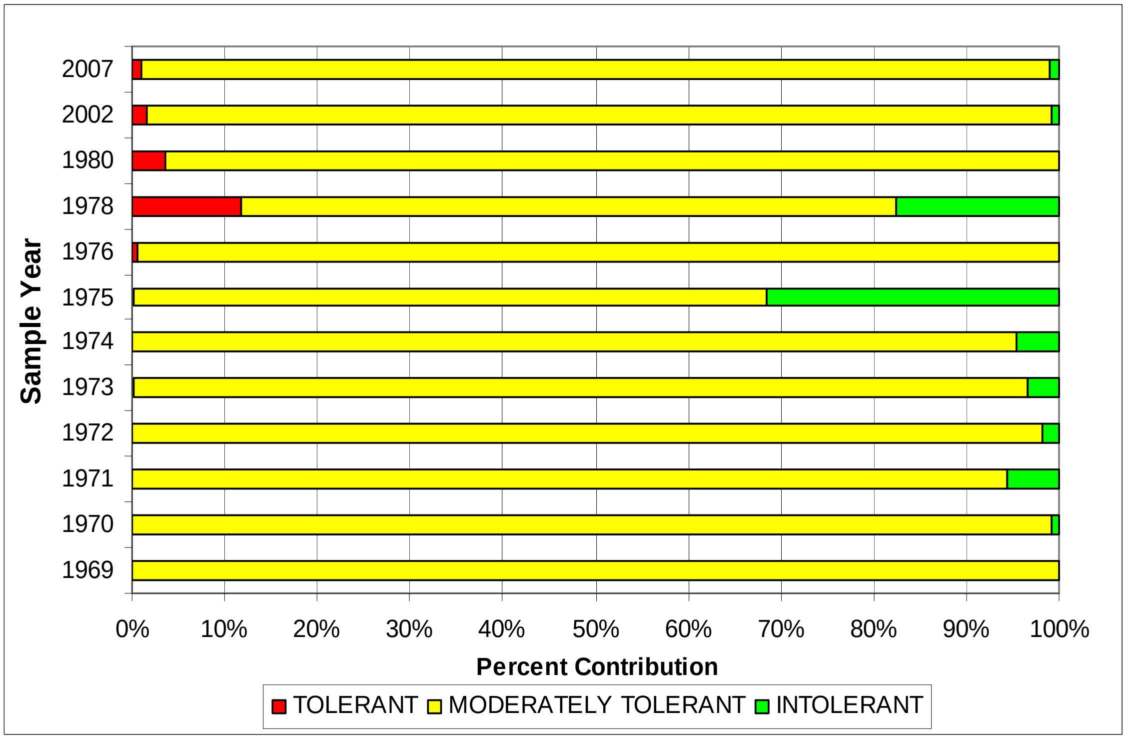


Figure J.23 Tolerance Distribution at Mainstem Site PP2020, Pennypack Creek Watershed, 1969-1980, 2002, 2007

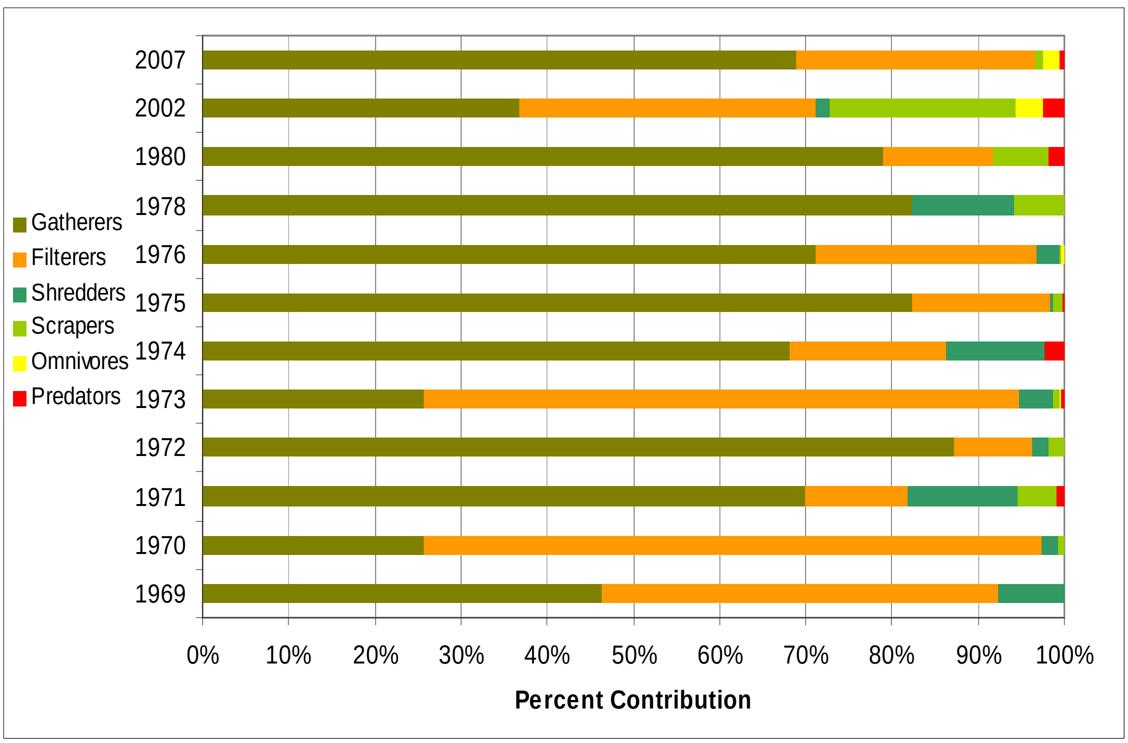


Figure J.24 Trophic Composition at Mainstem Site PP2020, Pennypack Creek Watershed, 1969-1980, 2002, 2007

Table K.1 Physical Habitat Principal Components Analysis (PCA) Loading Factors

	Factor 1	Factor 2
Epifaunal Substrate/Available Cover	-0.866892	0.333582
Pool Substrate Characterization	-0.865862	0.326668
Pool Variability	-0.772155	0.448982
Sediment Deposition	-0.778400	0.037373
Channel Flow Status	-0.702196	0.496830
Channel Alteration	-0.712079	-0.520279
Channel Sinuosity	-0.777719	-0.291987
Left Bank Stability	-0.631432	0.098667
Right Bank Stability	-0.783241	0.024185
Left Bank Vegetative Protection	-0.673240	-0.194442
Right Bank Vegetative Protection	-0.730298	-0.467533
Riparian Vegetative Zone Width (Left)	-0.486717	-0.589842
Riparian Vegetative Zone Width (Right)	-0.558905	-0.626123
Embeddedness	-0.871250	0.202929
Velocity/Depth Regime	-0.794133	0.476467
Frequency of Riffles (or bends)	-0.629410	-0.359323

Table L.1 HSI Variable Matrix

HSI Model Variable Matrix	Variable Type	Blacknose Dace	Common shiner	Creek Chub	Longnose Dace	Redbreast Sunfish	Smallmouth Bass	Brown Trout	Rainbow Trout
Total number of HSI variables		**16***	**9**	**20**	**6**	**10**	**13***	**18**	**18**
Avg. Temperature during growing season (May-Oct.)	**temperature**	X					X		
Average Temperature in spawning season**		X	X			X	X		
Maximum Temperature during warmest period of year								x	x
Maximum Temperature during embryo development								x	x
Maximum Temperature sustained for 1 week			X		X	X			
Maximum Temperatures within pools during spawning**									
Maximum Midsummer Temperature within pools									
Average Summer Temperature (Jul-Sep)				X					
Average temperature during spring (May-Jun)				X					
Average Turbidity (JTU)***	**water quality**	X	X	X		X	X		
Average yearly pH value			X				X		
Least suitable pH value (instantaneous)						X			
pH range during summer growing season									
pH fluctuation classification				X					
Levels of late summer nitrate-nitrogen (mg/l)								x	
Annual maximum or minimum pH								x	x
Minimum dissolved oxygen during late growing season								x	x
Minimum dissolved oxygen concentration				X		X	X		
Minimum dissolved oxygen conc. During spring				X					
% instream cover during average summer flow	**general stream characteristics**			X	X	X	X		
% instream cover during late growing season									x
Instream cover classification									
% shading of stream between 1000 and 1500 hrs.		X		X				x	x
% vegetative cover						X		x	
Average % vegetation along stream banks during summer								x	x
Avg. % rooted veg. and stable rocky ground cover along banks								x	x
Availability of thermal refugia (winter)				X					
Stream gradient (m/km)		X		X			X		
Average velocity over spawning areas								x	x
Average stream velocity during average summer flow				X	X				
Dominant substrate characterization						X			
Stream width		X		X		X			
Average thalweg depth during late growing season									x

Mode of stream depth during average summer flow									
Water level fluctuations							X		
Average size of substrate in spawning areas									x
Stream margin substrate characterization		X							
Average velocity along stream margins		X		X					
Stream margin vegetation characterization				X					
% area consisting of two spawning gravel size classes								x	
% substrate used for winter and escape cover								x	x
Average annual peak flow								x	
Average annual base flow in summer or winter low-flow								x	x
% average daily flow during the season of upstream migration									x
Substrate food production potential				X					
% riffles	riffles				X				
Dominant substrate type in riffles for food production	riffles							x	x
Riffle substrate characterization	riffles	X	X	X	X				
% fines in riffles and spawning areas during avg. summer flows	riffles							x	x
Average velocity in riffles	riffles	X	X	X					
Average depth of riffles	riffles	X							
Average maximum depth of riffles	riffles				X				
% pools	pools	X	X	X		X	X	x	x
Pool substrate characterization	pools	X					X		
% bottom of pool covered with vegetation, rocks, or debris	pools								
Pool classification	pools		X	X				x	x
Average depth of pools	pools			X			X		
Average current velocity within pools during summer flow	pools								
Average current velocity within pools during spawning**	pools								
Average velocity at 0.6 depth in pools	pools	X	X						

*some variables used more than once, applied to different life stages
**spawning season varies by species
***Turbidity relationships developed using Jackson Candle Units (JTU); cannot be converted to NTU values

Table M.1 Blacknose Dace HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Percent shaded	60	1.0	30	0.61	30	0.61	65	1.0	80	1.0	85	1.0
Percent pools	26.72	0.834	24.22	0.803	23.53	0.794	26.90	0.836	41.80	1.0	23.81	0.798
Stream gradient (m/km)	1.19	0.050	1.86	0.050	0.94	0.050	0.82	0.050	1.75	0.050	8.97	0.804
Stream Width (m)	19.15	0.150	15.74	0.150	13.71	0.291	16.19	0.150	9.35	0.754	4.12	1.0
Temperature (growing season) (C)	20.54	1.0	20.34	1.0	20.34	1.0	20.34	1.0	19.48	0.82	18.88	1.0
Turbidity (growing season)**	8.54	1.0	6.38	1.0	6.38	1.0	6.38	1.0	5.26	1.0	5.34	1.0
Riffle substrate category	D	0.60	D	0.60	D	0.60	D	0.60	D	0.60	D	0.60
Riffle Depth (cm)	13.02	1.0	17.68	1.0	14.94	1.0	17.37	1.0	16.76	1.0	16.75	1.0
Riffle Velocity (cm/s)	28.65	1.0	47.46	0.877	36.92	1.0	43.69	1.0	61.98	0.151	2.50	0
Temperature (spawning season) (C)	22.46	1.0	21.16	1.0	21.16	1.0	21.16	1.0	19.48	1.0	18.30	1.0
Pool substrate category	A	0.800	D	1.0	D	1.0	D	1.0	C	1.0	D	1.0
Pool velocity (cm/s)	6.49	1.0	13.41	1.0	29.57	1.0	18.29	1.0	6.71	1.0	3.93	1.0
Riffle substrate category (juvenile habitat)	D	0.50	D	0.50	D	0.50	D	0.50	D	0.50	D	0.50
Riffle velocity (juvenile) (cm/s)	28.65	1.0	47.46	0.548	36.92	1.0	43.69	0.660	61.98	0.285	2.50	0.333
Stream margin substrate category (fry)	D	0.30	D	0.30	D	0.30	C	0.40	D	0.30	A	1.0
Stream margin velocity (cm/s)	9.0	1.0	9.0	1.0	9.0	1.0	9.0	1.0	9.0	1.0	9.0	1.0
Food Cover Component	0.050		0.050		0.900		0.050		0.050		0.050	
Water Qualtiy Component	1.0		1.0		1.0		1.0		0.877		1.0	
Reproduction Component	0.940		0.912		0.940		0.940		0.151		0	
Adult Component	0.894		1.0		1.0		1.0		1.0		1.0	
Juvenile Component	0.707		0.524		0.707		0.574		0.285		0.333	
Fry Component	0.300		0.300		0.300		0.400		0.300		1.0	
HSI	0.300		0.300		0.300		0.400		0.151		0	
HSS	0.440		0.470		0.630		0.400		0.350		0.660	
Abundance	30		18		168		50		44		290	
Biomass (g)	72.87		33.29		507.75		154.39		1737.93		568.73	
Estimated surface area (m^2)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m^3)	719.71		558.18		356.56		727.01		892.73		94.0	
Biomass/surface area	0.041		0.021		0.389		0.087		0.975		1.379	
Biomass/volume	0.101		0.060		1.424		0.212		1.947		6.050	

Correlations	r value
HSI:Abundance/SA	0.015
HSI:abundance	-0.698
HSI:biomass/surface area	-0.941
HSI:biomass/volume	-0.922

Table M.2 Brown Trout HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Maximum Temperature during warmest period of year	27.82	0	26.78	0.028	26.78	0.028	26.78	0.028	29.35	0	27.88	0
Levels of late summer nitrate-nitrogen (mg/l)	4.25	0	4.51	0	4.92	0	5.13	0	8.90	0	1.73	0.25
Annual maximum or minimum pH	9.04	0.271	6.16	0.644	6.16	0.644	0.644	0.644	4.72	0	4.32	0
Minimum dissolved oxygen during late growing season	5.92	0	5.92	0	5.59	0	5.59	0	1.53	0	4.39	0
% shading of stream between 1000 and 1500 hrs.	60	1.0	30	0.720	30	0.720	65	1.0	80	0.959	85	0.912
% vegetative cover	7.5	0.228	12.5	0.255	5	0.217	15	0.272	10	0.239	10	0.239
Average % vegetation along stream banks during summer	135	0.981	135	0.981	135	0.981	135	0.981	112.5	0.897	135	0.981
Avg. % rooted veg. and stable rocky ground cover along banks	80	1.0	65	0.941	65	0.941	65	0.941	75	1.0	85	1.0
Average velocity over spawning areas	17.57	0.103	30.44	0.617	33.24	0.729	30.99	0.639	34.34	0.774	3.22	0
% area consisting of two spawning gravel size classes	32.6	1.0	13.23	1.0	35.6	1.0	33.8	1.0	39.6	1.0	24.3	1.0
% substrate used for winter and escape cover	29.5	1.0	34.7	1.0	50.8	1.0	25.8	1.0	28.9	1.0	49.2	1.0
Average annual peak flow	5	0.533	5	0.533	5	0.533	5	0.533	5	0.533	5	0.533
Average annual base flow in summer or winter low-flow	81.93	1.0	81.93	1.0	81.93	1.0	81.93	1.0	81.93	1.0	81.93	1.0
Dominant substrate type in riffles for food production	A	1.0	B	0.6	A	1.0	A	1.0	A	1.0	B	0.6
% fines in riffles and spawning areas during avg. summer flows	36.46	0.294	10.8	0.979	7.15	1.0	21	0.707	25.9	0.576	13	0.92
% pools	26.72	0.534	24.22	0.484	23.53	0.471	26.90	0.538	41.80	0.836	23.81	0.476
Pool classification	A	1.0	A	1	A	1.0	A	1.0	B	0.6	B	0.6
HSI	0		0.0275		0.0275		0.0275		0		0	
Abundance	17		8		6		16		0		0	
Biomass (g)	2689.40		1338.82		972.80		2527.91		0		0	
Estimated surface area (m^2)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m^3)	719.70		558.183		356.559		727.011		892.727		94.002	
Biomass/ surface area	1.502		0.854		0.745		1.419		0		0	
Biomass/ volume	3.737		2.399		2.728		3.477		0		0	

Correlations	r value
HSI:Abundance:SA	0.405
HSI: abundance	0.319
HSI: biomass/ suraface area	0.422

HSI: biomass/ volume	0.5344

Table M.3 Common Shiner HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Max summer temperature	21.37	1.0	21.81	1.0	21.81	1.0	21.81	1.0	23.25	0.71	21.44	1.0
Least suitable pH throughout year	6.16	0.80	6.71	1.0	6.71	1.0	6.71	1.0	4.72	0	4.32	0
Turbidity*	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0
Riffle substrate category	D	0.80	D	0.80	D	0.80	D	0.80	D	0.80	D	0.80
Percent pools	26.72	0.59	24.22	0.53	23.53	0.49	26.90	0.59	41.80	0.94	23.81	0.49
Pool velocity (cm/s)	6.49	0.95	13.41	1	29.57	0.7	18.29	0.95	6.71	0.96	3.93	0.85
Pool class category	A	0.4	A	0.4	A	0.4	A	0.4	B	1.0	B	1.0
Adequate Spring temperature (spawning)	22.46	0	21.16	0	21.16	0	21.16	0	19.48	0.11	18.30	0.83
Riffle velocity (cm/s)	28.65	0.60	47.46	0.03	36.92	0.25	43.69	0.07	61.98	0	2.50	0
Food/Cover component	0.40		0.40		0.40		0.40		0.925		0.785	
Water quality component	0.747		1.0		1.0		1.0		0		0	
Reproduction component	0		0		0		0		0		0	
HSI	0.546		0.562		0.562		0.562		0		0	
Abundance	1		0		71		89		0		0	
Biomass	4.30		----		1108.78		913.79		----		0	
Estimated surface area (m^2)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m^3)	719.71		558.18		356.56		727.01		892.73		94.0	
Biomass/surface area	0.0024		----		0.849		0.513		----		----	
Biomass/volume	0.006		----		3.109		1.257		----		----	

Correlations	r value
HSI:Abundance/ SA	0.514
HSI:Abundance	0.510
HSI:biomass/surface area	0.489
HSI:biomass/volume	0.454

Table M.4 Creek Chub HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Percent pools	26.72	0.795	24.22	0.725	23.53	0.705	26.901	0.805	41.80	1.0	23.81	0.712
Pool class category	A	1.0	A	1.0	A	1.0	A	1.0	B	0.60	B	0.60
Percent hard cover	15	0.438	25	0.745	10	0.307	30	0.879	20	0.591	20	0.591
Winter cover available	YES	0.503	YES	0.614	YES	0.401	YES	0.691	NO	0.508	NO	0.432
Stream gradient (km/m)	2.55	0.199	1.75	0.276	8.97	0.187	0.82	0.173	1.86	0.270	0.94	1.0
Stream width (m)	19.15	0.219	15.74	0.282	13.71	0.346	16.19	0.274	9.35	0.633	4.12	1.0
Turbidity*	10	1.0	10	1.0	10	1.0	10	1.0	10	1.0	10	1.0
pH category	A	1.0	A	1.0	A	1.0	A	1.0	A	1.0	A	1.0
Vegetation Index	1.35	1.0	1.35	1.0	1.35	1.0	1.35	1.0	1.13	1.0	1.35	1.0
Food substrate category	B	0.70	B	0.70	B	0.70	C	0.50	B	0.70	B	0.70
Average summer temperature (C)	21.68	1.0	21.56	1.0	21.56	1.0	21.57	1.0	23.27	1.0	21.14	1.0
Minimum summer DO (mg/L)	5.92	1.0	5.59	1.0	5.59	1.0	5.59	1.0	1.53	0.046	4.39	0.937
Average velocity	17.57	1.0	30.44	1.0	33.25	1.0	30.99	1.0	34.34	1.0	3.93	0.400
Average spring temperature (C)	22.05	0.631	20.27	0.931	20.27	0.931	20.27	0.931	16.83	1.0	15.39	1.0
Minimum spring DO (mg/L)	6.02	0.935	6.50	1.0	6.50	1.0	6.50	1.0	11.16	1.0	6.73	1.0
Average spring riffle velocity (cm/s)	28.65	1.0	47.46	1.0	36.92	1.0	43.69	1.0	61.98	1.0	2.50	0.130
Riffle substrate index	105.0	1.0	98.0	1.0	132.10	1.0	118.0	1.0	115.30	1.0	1.05	0.001
Average stream margin velocity (cm/s)	9.0	1.0	9.0	1.0	9.0	1.0	9.0	1.0	9.0	1.0	9.0	1.0
Percent shade (summer)	60.0	0.922	30.0	0.472	30.0	0.472	65.0	0.960	80.0	1.0	85.0	1.0
Average max depth (m)	0.402	0.957	0.357	0.889	0.271	0.745	0.41	0.96	0.50	0.969	0.28	0.762
Food component	0.350		0.350		0.350		0.25		0.35		0.35	
Cover component	0.748		0.832		0.665		0.89		0.75		0.59	
Water quality component	0.984		0.860		0.860		0.99		1.0		1.0	
Reproduction component	0.900		0.986		0.986		0.99		1.0		0.05	
Other component	0.522		0.483		0.426		0.47		0.62		0.92	
HSI	0.655		0.654		0.610		0.63		0.69		0.39	
HSS	0.465		0.421		0.536		0.40		0.51		0.68	
Abundance	2		0		2		0		9		72	
Biomass	11.75		0		10.20		0		27.02		766.04	
Estimated surface area (m^2)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m^3)	719.71		558.18		356.56		727.01		892.73		94.0	
Biomass/surface area	0.007		----		0.008		----		0.015		1.858	
Biomass/volume	0.016		----		0.029		----		0.030		8.149	

Correlations	r value
HSI:Abundance:SA	-0.960
HSI:abundance	-0.936
HSI:biomass/surface area	-0.953
HSI:biomass/volume	-0.953

Table M.5 Longnose Dace HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Avgerage velocity (cm/s)	14.40	0.22	22.70	0.48	29.20	0.70	18.50	0.34	10.90	0.12	3.00	0.02
Max. riffle depth (m)	0.40	1.0	0.36	1.0	0.27	1.0	0.41	1.0	0.50	1.0	0.28	1.0
Percent riffles	25.86	1.0	16.41	0.66	41.18	1.0	10.53	0.42	4.92	0.20	19.05	0.76
Percent substrate >5cm	29.5	0.59	34.7	0.70	39.2	0.78	25.8	0.52	28.9	0.58	49.2	0.98
Spring/Summer max. temperature (C)	21.50	0.4	21.44	0.45	21.44	0.45	21.44	0.45	20.14	0.89	19.45	0.96
Percent cover	15	0.15	25	1.0	10	0.1	30	1.0	20	0.2	20	0.2
HSI	0.15		0.448		0.1		0.339		0.121		0.018	
HSS	0.08		0.02		0.07		0.06		0.05		0.01	
Abundance	7		4		0		0		0		0	
Biomass (g)	34.20		23.40		0		0		0		0	
Estimated surface area (m²)	1790.31		1567.9 3		1306.08		1781.89		1781.89		412.29	
Estimated volume (m³)	719.70		558.18		356.56		727.01		892.73		94.0	
Biomass/surface area	0.019		0.015		-----		-----		-----		-----	
Biomass/volume	0.048		0.042		-----		-----		-----		-----	

Correlations	r value
HSI:Abundance:SA	0.260
HSI:abundance	0.281
HSI:biomass/surface area	0.398
HSI:biomass/volume	0.444

Table M.6 Rainbow Trout HSI Data

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
% instream cover during late growing season	15	0.842	25	1.0	10	0.68864	30	1.0	20	0.941	20	0.941
Average thalweg depth during late growing season	35.6	0.802	35.6	0.802	27.3	0.505	40.8	0.941	50.1	1.0	22.8	0.326
% pools	26.72	0.870	24.22	0.831	23.53	0.820	26.901	0.874	41.80	1.0	23.81	0.820
Pool classification	A	1.0	A	1.0	A	1.0	A	1.0	B	0.60	B	0.60
HSI_{ADULT} (Non-compensatory)	0.154		0.695		0.692		0.791		0.572		0.276	
Cother	0.782		0.772		0.821		0.810		0		0	
*C_{OQ} (water quality)	0.178		0.791		0.791		0.791		0.654		0.384	
Abundance	11		6		10		9		2		0	
Biomass (g)	1853.91		1248.42		1994.63		1904.30		683.90		0	
Estimated surface area (m^2)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m^3)	719.71		558.18		356.56		727.01		892.73		94.0	
Biomass/ surface area	1.036		0.796		1.527		1.069		0.384		0	
Biomass/ volume	2.576		2.237		5.594		2.619		0.766		0	

Correlations	r value
HSI:Abundance:SA	-0.279
HSI: Abundance	0.158
HSI: Biomass/ suraface area	0.410
HSI: Biomass/ volume	0.413

Table M.7 Redbreast sunfish HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Percent cover	15	0.76	25	1.0	10	0.64	30	1.0	20	0.88	20	0.88
Vegetated cover	7.5	0.55	12.5	0.65	5	0.5	15	0.7	10	0.6	10	0.6
Spawning temperature (summer) (℃)	22.36	1.0	22.36	1.0	22.36	1.0	22.36	1.0	20.39	1.0	22.36	1.0
Percent pools	26.72	1.0	24.22	1.0	23.53	1.0	26.90	1.0	41.80	1.0	23.81	0.4
Percent sand/gravel	54.1	1.0	15.4	0.3848	39.2	1.0	44.73	1.0	52.35	1.0	73.5	1.0
Least suitable pH	9.04	0.339	8.05	1.0	8.05	1.0	8.05	1.0	8.05	1.0	8.92	0.504
Minimum DO category	A	1.0	A	1.0	A	1.0	A	1.0	A	1.0	A	1.00
Turbidity	60.0	1.0	60	1.0	60	1.0	60	1.0	60	1.0	60	1.0
Max. temperature (growing season) (℃)	24.27	0.8	24.50	0.8	24.50	0.8	24.50	0.8	24.58	0.8	24.27	0.8
Stream width (m)	19.15	1.0	15.74	1.0	13.71	1.0	16.19	1.0	9.35	1	4.12	0.589
HSI	0.34		0.38		0.50		0.70		0.60		0.50	
Abundance	104		133		19		99		30		49	
Biomass (g)	2309.12		3502.84		528.40		1810.73		680.55		1137.77	
Estimated surface area (m²)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m³)	719.70		558.18		356.55		727.01		892.73		94.0	
Biomass/surface area	1.29		2.23		0.40		1.02		0.38		2.76	
Biomass/volume	3.21		6.28		1.48		2.49		0.76		12.10	

Correlations	r value
HSI:Abundance:SA	-0.279
HSI:abundance	-0.361
HSI:biomass/surface area	-0.386
HSI:biomass/volume	-0.261

Table M.8 Smallmouth bass HSI Model

HSI Variable	PP490	SI	PP690	SI	PP970	SI	PP1060	SI	PP1680	SI	PP2020	SI
Substrate category	A	0.2	C	1.0	C	1.0	C	1.0	B	0.3	C	1.0
Percent pools	26.72	0.48	24.22	0.43	23.53	0.41	26.90	0.49	41.80	0.72495	23.81	0.42
Average pool depth (m)	0.70	0.58	0.61	0.51	0.53	0.44	0.63	0.53	0.75	0.62	0.39	0.33
Percent cover	15	0.6	25	1.0	10	0.4	30	1.0	20	0.8	20	0.8
Average pH	7.63	0.99	7.53	0.99	7.53	0.99	7.53	0.99	7.27	0.94	7.64	0.99
Minimum DO (mg/L)	5.92	0.94	5.59	0.85	5.59	0.85	5.59	0.85	1.82	0	0.48	0.48
Turbidity*	10	1.0	10	1.0	10	1.0	10	1.0	10	1.0	10	1.0
Temperature (adult) (growing season) (C)	20.54	0.88	23.34	1.0	23.34	0.97	23.34	0.97	19.50	0.83	18.88	0.79
Temperature (embryo) (spawning)	22.46	1.0	21.16	1.0	21.16	1.0	21.16	1.0	18.84	1.0	17.65	1.0
Temperature (fry) (growing season) (C)	20.54	0.86	23.34	0.97	23.34	0.96	23.34	0.96	19.50	0.80	18.88	0.76
Temperature (juvenile) (growing season) (C)	20.54	0.88	23.34	1.0	23.34	0.96	23.34	0.96	19.50	0.84	18.88	0.81
Water fluctuation category	A	0.30	A	0.30	A	0.30	A	0.30	A	0.30	A	0.30
Stream gradient (km/m)	2.55	1.0	1.86	1.0	0.937	1.0	0.822	1.0	1.75	1.0	8.97	0.5
Food component	0.39		0.75		0.55		0.79		0.58		0.69	
Cover Component	0.47		0.73		0.56		0.75		0.64		0.64	
Water Quality Component	0.93		0.96		0.96		0.96		0.72		0.81	
Reproduction Component	0.62		0.82		0.72		0.82		0.00		0.74	
Other component	1.0		1.0		1.0		1.0		1.0		0.5	
HSI	0.64		0.85		0.73		0.86		0		0.67	
HSS	0.63		0.33		0.39		0.44		0.20		0.04	
Abundance	5		7		5		8		0		0	
Biomass (g)	508.90		541.30		837.08		1341.54		0		0	
Estimated surface area (m^2)	1790.31		1567.93		1306.08		1781.89		1781.89		412.29	
Estimated volume (m^3)	719.70		558.18		356.56		727.01		892.73		94.00	
Biomass/surface area	0.28		0.35		0.64		0.75		0		0	
Biomass/volume	0.71		0.97		2.35		1.85		0		0	

Correlations	r value
HSI:Abundance:SA	0.748
HSI:abundance	0.74
HSI:biomass/surface area	0.65
HSI:biomass/volume	0.60

Figure N.1 Upstream View of Roosevelt Boulevard Dam

Figure N.2 Upstream View of Verree Road Dam

Figure O.1 Excavator in Process of Removing Bethayres Dam

Figure O.2 Former Site of Bethayres Dam after Removal Process

Figure O.3 PWD Contractor in Process of Removing Frankford Avenue Dam

Figure O.4 Former Site of Frankford Avenue Dam after Removal Process

Figure O.5 Huntingdon Pike Dam Prior to Removal Process

Figure O.6 Former Site of Huntingdon Pike Dam after Removal Process

Figure O.7 PWD Contractor in Process of Removing Rhawn Street Dam

Figure O.8 Former Site of Rhawn Street Dam after Removal Process

Figure O.9 Bill Weibrecht Arranging Boulders During Pennypack Creek Rock Ramp Construction

Figure O.10 Completed Pennypack Creek Rock Ramp Fishway

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