Oswego Castings
OSWEGO COUNTY

Oswego, NEW YORK

SITE MANAGEMENT PLAN

NYSDEC Site Number: 7-38-033

Prepared for:

New York State Department of Environmental Conservation Division of Environmental Remediation

625 Broadway, 12th Floor, Albany, NY 12233

Prepared by:

Arcadis CE, Inc. 855 Route 146, Suite 210 518.250.7300

Revisions to Final Approved Site Management Plan:

Revision No.	Date Submitted	Summary of Revision	NYSDEC Approval Date

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FEBRUARY 2016

CERTIFICATION STATEMENT

I ANDREW VITOLINS certify that I am currently a [NYS registered professional engineer or Qualified Environmental Professional as in defined in 6 NYCRR Part 375] and that this Site Management Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

____________________ [QEP]

2/17/16 ______________ DATE

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List of Acronyms

Arcadis	Arcadis CE, Inc.
CP	Commissioner Policy
DER	Division of Environmental Remediation
EC	Engineering Control
EWP	Excavation Work Plan
HASP	Health and Safety Plan
IC	Institutional Control
IRM	Interim Remedial Measure
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
NYCRR	New York Codes, Rules and Regulations
OU	Operable Unit
PCB	Polychlorinated Biphenyl
ppm	Parts per Million
PRR	Periodic Review Report
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
RP	Remedial Party
RSO	Remedial System Optimization
SCG	Standards, Criteria and Guidance
SCO	Soil Cleanup Objective
SMP	Soil Management Plan

ES EXECUTIVE SUMMARY

The following provides a brief summary of the controls implemented for the Site, as well as the inspections, monitoring, maintenance and reporting activities required by this Site Management Plan:

Site Identification: 7-38-033 375 Mitchell Street, Oswego, Oswego County, New York

Institutional Controls:	1. The property may be used for commercial or industrial use;
	2. Environmental Notice (2012)
	3. All ECs must be inspected at a frequency and in a manner defined in the SMP.
Engineering Controls:	1. Cover (or cap)
	2. Concrete Slab Cover
	3. Geotextile Cover
	4. Monitoring wells associated with monitoring the remedial action effectiveness

Inspections:	Frequency
1. Cover inspection	Annually
Monitoring:	
1. Groundwater Monitoring Wells MW-1, MW-2R, MW-3, MW-4, MW-5, MW-6, and MW-7	Every 5 quarters
Maintenance:	
1. Cover maintenance	As needed
Reporting:	
2. Periodic Review Report	Every 3 years

Further descriptions of the above requirements are provided in detail in the latter sections of this Site Management Plan.

1.0 INTRODUCTION

1.1 General

This Site Management Plan (SMP) is a required element of the remedial program for the Oswego Castings located in Oswego, New York (hereinafter referred to as the "Site"). See Figure 1. The Site is currently in the New York State Inactive Hazardous Waste Disposal Site Remedial Program Site No. 7-38-033, which is administered by New York State Department of Environmental Conservation (NYSDEC).

B&K Metals (Formerly known as Oberdorfer Foundries) entered into an Order on Consent in July 1993 (last amended in February 1997) with the NYSDEC to remediate the Site. A figure showing the site location and boundaries of this Site is provided in Figure 2. The boundaries of the Site are more fully described in the metes and bounds site description that is part of the Environmental Notice provided in Appendix D.

After completion of the remedial work, some contamination was left at this Site, which is hereafter referred to as "remaining contamination". Institutional and Engineering Controls (ICs and ECs) have been incorporated into the site remedy to control exposure to remaining contamination to ensure protection of public health and the environment. An Environmental Notice issued by the NYSDEC, and recorded with the Oswego County Clerk, requires compliance with this SMP and all ECs and ICs placed on the Site.

This SMP was prepared to manage remaining contamination at the Site until the Environmental Notice is extinguished in accordance with Environmental Conservation Law Article 71, Title 36. This plan has been approved by the NYSDEC, and compliance with this plan is required by the issuer of the Environmental Notice t and the issuer's successors and assigns. This SMP may only be revised with the approval of the NYSDEC.

It is important to note that:

- This SMP details the site-specific implementation procedures that are required by the Environmental Notice.
- Failure to comply with this SMP is also a violation of Environmental Conservation Law, New York Codes, Rules and Regulations (NYCRR) 6 NYCRR Part 375 and thereby subject to applicable penalties.

All reports associated with the Site can be viewed by contacting the NYSDEC or its successor agency managing environmental issues in New York State. A list of contacts for persons involved with the Site is provided in Appendix A of this SMP.

This SMP was prepared by Arcadis CE, Inc. (Arcadis), on behalf of the NYSDEC, in accordance with the requirements of the NYSDEC's Division of Environmental Remediation (DER)-10 ("Technical Guidance for Site Investigation and Remediation"), dated May 2010, and the guidelines provided by the NYSDEC. This SMP addresses the means for implementing the ICs and maintaining the ECs that are required by the Environmental Notice for the Site.

1.2 Revisions

Revisions to this plan will be proposed in writing to the NYSDEC's project manager. Revisions will be necessary upon, but not limited to, the following occurring: a change in media monitoring requirements, upgrades to or shut-down of a remedial system, post-remedial removal of contaminated sediment or soil, or other significant change to the site conditions. The NYSDEC will provide a notice of any approved changes to the SMP, and append these notices to the SMP that is retained in its files.

1.3 Notifications

Notifications will be submitted by the property owner to the NYSDEC, as needed, in accordance with NYSDEC's DER–10 for the following reasons:

- 60-day advance notice of any proposed changes in site use that are required under the terms of the Order on Consent, 6NYCRR Part 375 and/or Environmental Conservation Law.

- 7-day advance notice of any field activity associated with the remedial program.

- 15-day advance notice of any proposed ground-intrusive activity pursuant to the Excavation Work Plan (EWP).

- Notice within 48 hours of any damage or defect to the foundation, structures or EC that reduces or has the potential to reduce the effectiveness of an EC, and likewise, any action to be taken to mitigate the damage or defect.

- Verbal notice by noon of the following day of any emergency, such as a fire; flood; or earthquake that reduces or has the potential to reduce the effectiveness of ECs in place at the Site, with written confirmation within 7 days that includes a summary of actions taken, or to be taken, and the potential impact to the environment and the public.

- Follow-up status reports on actions taken to respond to any emergency event requiring ongoing responsive action submitted to the NYSDEC within 45 days describing and documenting actions taken to restore the effectiveness of the ECs.

Any change in the ownership of the Site or the responsibility for implementing this SMP will include the following notifications:

- At least 60 days prior to the change, the NYSDEC will be notified in writing of the proposed change. This will include a certification that the prospective purchaser/Remedial Party has been provided with a copy of the Order on Consent, and all approved work plans and reports, including this SMP.

- Within 15 days after the transfer of all or part of the Site, the new owner’s name, contact representative, and contact information will be confirmed in writing to the NYSDEC.

Table 1 on the following page includes contact information for the above notification. The information on this table will be updated as necessary to provide accurate contact information. A full listing of site-related contact information is provided in Appendix A.

Table 1: Notifications*

Name	**Contact Information**
Payson Long, P.E.	(518)-402-9813 payson.long@dec.ny.gov

* Note: Notifications are subject to change and will be updated as necessary.

2.0 SUMMARY OF PREVIOUS INVESTIGATIONS AND REMEDIAL ACTIONS

2.1 Site Location and Description

The Site is located in Oswego, Oswego County, New York and is identified as Tax Map ID Number 111.69-01-01 (see Figure 1). The Site is an approximately 23-acre area and is bounded by a nature preserve/Teal Marsh (NYSDEC-regulated wetland area) between the Site and Lake Ontario to the north, Mitchell Street with an auto-repair business and residential buildings to the south, Longs Beach Road and residential buildings to the east, and Oswego County Industrial Park Drive and commercial/industrial buildings to the west (see Figure 2 – Site Layout Map). The boundaries of the Site are more fully described in Appendix D –Environmental Notice. The owner(s) of the site parcel(s) at the time of issuance of this SMP is/are:

City of Oswego

2.2 Physical Setting

2.2.1 Land Use

The Site consists of the following: three former manufacturing buildings (main foundry building and two smaller outbuildings), as well as a saw mill constructed in a portion of the main building. The Site also includes a pond area as well as a wooded area. The Site is zoned industrial and is currently vacant.

The properties adjoining the Site and in the neighborhood surrounding the Site primarily include commercial properties. The properties immediately south of the Site include Mitchell Street with an auto-repair business and residential buildings properties; the properties immediately north of the Site include a nature preserve/Teal Marsh (NYSDEC-regulated wetland area) between the Site and Lake Ontario; the properties immediately east of the Site include Longs Beach Road and residential buildings; and the properties to the west of the Site include Oswego County Industrial Park Drive and commercial/industrial buildings.

2.2.2 Geology

The areas where buildings were constructed include surficial fill materials. Behind the buildings to the north, foundry wastes were disposed of behind the main plant building. This filling occurred since the construction of the main foundry building, as documented by aerial photographs of the Site. This area is shown as "Landfill Area" in Figure 2. Below these fill materials are native overburden soils, which are primarily unconsolidated glacial sediments or till.

2.2.3 Hydrogeology

The low permeability (6.2 x 10^{-6} centimeters per second) of these soils restricts the infiltration from the surface, resulting in the wetland areas, which surround the Site, some of which were likely filled by foundry waste in the landfill area. Groundwater flow is generally from south to north toward Lake Ontario.

During the original site investigation, groundwater in the native soil and the landfill was observed to vary from ground surface to 4 feet. During the construction phase of the Operational Unit No. 1, evidence that water had been in contact with the soil (mottling) was noted in the landfill at depths of 1 to 4 feet, but no groundwater was observed to a depth of 8 feet. It appears that the originally noted shallow groundwater in the fill material was the result of storm water soaking the yard area since storm water from the surrounding area is currently diverted away from the impacted area. The yard area and buildings are elevated above the lands to the north, east and west. Runoff from the land to the south is diverted away from the Site to the west. Only the storm water that falls in the yard area would be able to flow into the impacted soil.

2.3 Investigation and Remedial History

A Remedial Investigation (RI) was performed to characterize the nature and extent of contamination at the Site. The results of the RI are described in detail in the following reports:

- NYSDEC, 1997. Record of Decision, Oswego Castings Site, Oswego (C), Oswego County. Site Number 7-38-033. March, 1997.
- NYSDEC, 2000. Remedial Investigation Report for the Oswego Castings Inactive hazardous Waste Site, Operable Unit No. 2 – Yard/buildings. January, 2000.
- NYSDEC, 2000. Oswego Castings Site, Operable Unit No. 2 – Yards/Buildings, Proposed Remedial Action Plan. February, 2000.
- NYSDEC, 2000. Record of Decision, Oswego Castings Site Operable Unit No. 2 –Yard/Buildings, Oswego, Oswego County. Site Number 7-38-033. March, 2000.
- NYSDEC, 2002. Remediation Summary Report, Oswego Castings Site, Oswego (C), Oswego County. Site Number 7-38-033 (OU2). January, 2002.
- NYSDEC, 2012. Oswego Casting Site Sampling: DER Site Management September, 2012.
- Stearns and Wheler, LLC, 1995. Remedial Investigation. Oswego Castings, Oswego, NY. August 1994. Final Revision December 1995.

The following narrative provides a remedial history timeline and a brief summary of the available project records to document key investigative and remedial milestones for the Site. Full titles for each of the reports referenced below are provided in Section 8.0 - References.

Generally, the RI determined that polychlorinated biphenyls (PCBs) were present in site soils, sediment, surface water, and in the groundwater, particularly near the landfill area and down gradient of the former septic tank (Figure 2). Based on the RI, it was determined that the PCBs were likely migrating from the contaminated soil to the groundwater. Additionally, PCBs were detected in the drainage swale between the loading dock and the wetland as well as in the cooling water pond. Foundry wastes at the Site were also found to be contaminated with PCBs along with the sludge material within the former septic tank.

The Site was remediated in accordance with the NYSDEC-issued Records of Decision (RODs) dated March 1997 and March 2000, with the exception that a Deed Restriction was never filed. The NYSDEC attempted to get the Respondent to file a Deed Restriction with the Oswego County Clerk, but the Respondent never completed the process. Until such time as a Deed Restriction can be obtained, an Environmental Notice filed in 2012 provides notification of restrictions that apply to the Site.

The following is a summary of the Remedial Actions performed at the Site:

1. Interim remedial measures (IRMs) were conducted prior to the remedial actions determined by the March 2000 ROD with the goal of controlling a potential point source (Figure 2).
    a. The roof of the foundry building was connected to the cooling pond by a drain pipe. Large roof mounted blowers were noted, which could have transferred materials from inside the foundry to the roof and tests were conducted on a very fine particulate material observed on the roof. This material typically had PCB concentrations between 0.110 and 0.200 parts per million (ppm), which was anticipated to be a likely source of PCB to the cooling pond. The IRM provided for the roof to be cleaned.
    b. Contaminated materials from the west gate and loading dock were excavated and moved to the landfill area to be addressed during the final remedy.
2. Excavation of soil/fill exceeding applicable NYSDEC Standards, Criteria and Guidance (SCGs) in accordance with the March 1997 ROD was conducted at the Site and include:

a. Surface soils containing PCBs above 1 ppm. This action involved the removal of 12 inches of surface soil around the landfill area. Approximately 700 cubic yards of soil were removed.

b. Surface and subsurface waste containing PCBs above 10 ppm. This action involved the removal of approximately 2,000 cubic yards of core sands and foundry waste.

c. Sediment in the wetland and drainage swale containing PCBs above 1 ppm. This action involved the removal of approximately 1,000 cubic yards of contaminated sediments.

d. Approximately 400 cubic yards of material excavated as part of an IRM from the west gate and loading dock areas were included in the materials addressed by the remedy.

Materials containing PCB concentrations greater than 10 ppm, but less than 50 ppm, were disposed of as non-hazardous material at an off-site industrial waste landfill. This portion of material was estimated to be approximately 1,250 cubic yards. Materials containing PCBs at concentrations greater than or equal to 50 ppm were disposed of at a permitted hazardous waste landfill, with an estimated volume of approximately 3,600 cubic yards.

3. Construction and maintenance of a soil cover systems to prevent human exposure to remaining contaminated soil/fill remaining at the Site, including: consolidating foundry wastes with PCB concentrations less than 10 ppm in the landfill area and covering with 12 inches of soil and seeded (landfill), a 6-inch reinforced concrete pad over 8-inch crushed stone in the sawmill building area (yard area). Construction of a new pond (Figure 2) to allow for dewatering the cooling water pond. Backfilling the drained cooling water pond with consolidated soil and sediment with PCB concentrations less than 10 ppm, installing a geotextile fabric over the area and covering with 12 inches of gravel (cooling water pond).

4. Execution and recording of an Environmental Notice (in-lieu of a Deed Restriction) to restrict land use and prevent future exposure to any remaining contamination at the Site.
5. Conducting annual inspections to verify that the implemented cover system is in good order and verifying that the Environmental Notice is in place in addition to maintaining a long-term monitoring program for site groundwater (see Figure 3 for Monitoring Well locations).
6. Development and implementation of a SMP for long term management of remaining contamination as required by the Environmental Notice, which includes plans for: (1) ICs and ECs, (2) monitoring, (3) operation and maintenance and (4) reporting.

Remedial construction activities were completed at the Site in November 2001.

2.4 Remedial Action Objectives

The Remedial Action Objectives (RAOs) for the Site as listed in the ROD documents for the Site dated March 1997 and March 2000 are as follows:

Groundwater

RAOs for Environmental Protection

- Prevent, to the extent possible, migration of contaminants in the landfill to groundwater.
- Provide for attainment of SCGs for groundwater quality at the limits of the area of concern.
- Eliminate, to the extent practicable, the exposure of fish and wildlife to levels of PCBs above standards/guidance values.

Soil

RAOs for Public Health Protection

- Eliminate the potential for direct human or animal contact with the contaminated soils on site or sediments.

- Eliminate, to the extent practicable, the potential for direct human contact with PCB-contaminated soil and dust.

RAOs for Environmental Protection

- Reduce, control, or eliminate to the extent practicable the contamination present within the soils/waste on the Site and generation of leachate within the fill mass.

- Eliminate, to the extent practicable, the exposure of fish and wildlife to levels of PCBs above standards/guidance values.

Surface Water

RAOs for Environmental Protection

- Eliminate the threat to surface waters and Lake Ontario by eliminating any future contaminated surface run-off from the contaminated soils on the Site, and by reducing, controlling, or eliminating contaminated wetland sediment migration.

- Eliminate, to the extent practicable, the exposure of fish and wildlife to levels of PCBs above standards/guidance values.

Sediment

RAOs for Public Health Protection

- Eliminate the potential for direct human or animal contact with the contaminated soils on site or sediments.

RAOs for Environmental Protection

- Eliminate, to the extent practicable, the exposure of fish and wildlife to levels of PCBs above standards/guidance values.

2.5 Remaining Contamination

1. The cleanup levels prescribed by the RODs of 1 ppm PCBs for surface soil and 10 ppm subsurface soil allows for the Site to be used for commercial or industrial use.

The following subsections describe the known remaining contamination in the various environmental media at this Site.

2.5.1 Soil

The remedial actions were developed to excavate and/or consolidate materials impacted with PCBs that could be effectively achieved and develop a cover over areas where impacted materials may still be present. The materials below the buildings, below the concrete slab, and below the landfill cover are known to still be impacted by PCBs (Figure 2). However, there are not specific data available for the residual PCB-impacted soils beneath all of the cover areas, as much of the areas were not accessible during the RI. These areas will remain inaccessible to human and fish/wildlife as part of the remedy. Excavated areas are shown on Figure 4 (Figure from NYSDEC Periodic Review Report [PRR], 2011). The long-term monitoring and annual inspections have been established to monitor this remedy to verify continued effectiveness while the Environmental Notice has been established to maintain the remedy through changing property owners.

2.5.2 Sediment

Similar to the residual contamination associated with the soil, the sediment below the geotextile/stone cover in the former cooling water pond are known to still be impacted by PCBs (see Figure 4). The long-term monitoring and annual inspections have been established to monitor this remedy to verify continued effectiveness while the Environmental Notice has been established to maintain the remedy through changing property owners.

2.5.3 Groundwater

The groundwater contamination at the Site was determined to be the result of migrating contaminants from the soils. The soils that had the greatest PCB concentrations had been removed from the Site and remaining lesser-concentration contamination are consolidated. There is potential for residual contamination to appear in the groundwater, but anticipated to be low PCB concentration, if any, and also anticipated to continue to decrease in concentration over time.

2.5.4 Surface Water

The surface water at the pond will follow a similar result as the groundwater. With the major PCB sources now controlled at the Site, the surface water quality should be greatly improved with respect to PCB concentrations. While residual low-concentration PCBs may be possible from the residual concentrations around the Site, the PCB concentrations in the surface water should be a low concentration (if any detections at all) and should also be decreasing over the long term since the source PCBs are controlled.

2.5.5 Soil Vapor Intrusion

The 1997 ROD had indicated that volatile organic compounds were detected in the groundwater near the former septic tank. The septic tank has been removed and volatile organic compounds are not anticipated to present an environmental issue at this Site. The historical detection indicates that the chemicals were formerly present and may present a potential exposure issue if conditions at the Site change.

3.0 INSTITUTIONAL AND ENGINEERING CONTROL PLAN

3.1 General

Since remaining contamination exists at the Site, ICs and ECs are required to protect human health and the environment. This IC/EC Plan describes the procedures for the implementation and management of all IC/ECs at the Site. The IC/EC Plan is one component of the SMP and is subject to revision by the NYSDEC.

This plan provides:

- A description of all IC/ECs on the Site;
- The basic implementation and intended role of each IC/EC;
- A description of the key components of the ICs set forth in the Environmental Easement;
- A description of the controls to be evaluated during each required inspection and periodic review;
- A description of plans and procedures to be followed for implementation of IC/ECs, such as the implementation of the EWP for the proper handling of remaining contamination that may be disturbed during maintenance or redevelopment work on the Site; and
- Any other provisions necessary to identify or establish methods for implementing the IC/ECs required by the site remedy, as determined by the NYSDEC.

3.2 Institutional Controls

A series of ICs is required by the RODs to: (1) implement, maintain and monitor EC systems; (2) prevent future exposure to remaining contamination; and, (3) limit the use and development of the Site to commercial or industrial uses only. Adherence to these ICs on the Site is required by the Environmental Notice and will be implemented under this SMP. ICs identified in the Environmental Notice may not be discontinued without an amendment to or extinguishment of the Environmental Notice. The IC boundaries are shown in Appendix D. These ICs are:

- The property may be used for : commercial or industrial use;
- All ECs must be operated and maintained as specified in this SMP;
- All ECs must be inspected at a frequency and in a manner defined in the SMP.
- The use of groundwater underlying the property is prohibited without necessary water quality treatment as determined by the New York State Department of Health (NYSDOH) or the Oswego County Department of Health to render it safe for use as drinking water or for industrial purposes, and the user must first notify and obtain written approval to do so from the Department.
- Groundwater and other environmental or public health monitoring must be performed as defined in this SMP;
- Data and information pertinent to site management must be reported at the frequency and in a manner as defined in this SMP;
- All future activities that will disturb remaining contaminated material must be conducted in accordance with this SMP;
- Monitoring to assess the performance and effectiveness of the remedy must be performed as defined in this SMP;
- Operation, maintenance, monitoring, inspection, and reporting of any mechanical or physical component of the remedy shall be performed as defined in this SMP;
- Access to the Site must be provided to agents, employees or other representatives of the State of New York with reasonable prior notice to the property owner to assure compliance with the restrictions identified by the Environmental Notice.

3.3 Engineering Controls

3.3.1 Soil Cover

Exposure to remaining contamination in soil/fill at the Site is prevented by a cover system placed over the Site landfill. This cover system is comprised of a minimum of 12 inches of clean soil with vegetation. Figure 4 presents the location of the cover system and applicable demarcation layers. The EWP provided in Appendix B outlines the procedures required to be implemented in the event the cover system is breached, penetrated or temporarily removed, and any underlying remaining contamination is disturbed. Procedures for the inspection of this cover are provided in the Monitoring and Sampling Plan included in Section 4.0 of this SMP. Any work conducted pursuant to the EWP must also be conducted in accordance with the procedures defined in a Health and Safety Plan (HASP) and associated Community Air Monitoring Plan prepared for the Site and provided in Appendix G.

3.3.2 Concrete Slab Cover

Exposure to remaining contamination in soil/fill beneath the sawmill building area is minimized by a concrete cover. This concrete cover is comprised of a 6-inch thick reinforced concrete with an 8-inch thick crushed stone base. The EWP that appears in Appendix B outlines the procedures required to be implemented in the event the cover is breached, penetrated or temporarily removed, and any underlying remaining contamination is disturbed. Procedures for the inspection and maintenance of this cover are provided in the Monitoring Plan included in Section 3 of this SMP.

3.3.3 Geotextile Cover

Exposure to remaining contamination in at the cooling pond area is minimized by a cover system. This cover system is comprised of a layer of geotextile material covered by 12-inches of gravel. The EWP that appears in Appendix A outlines the procedures required to be implemented in the event the cover system is breached, penetrated or temporarily removed, and any underlying remaining contamination is disturbed. Procedures for the inspection and maintenance of this cover are provided in the Monitoring Plan included in Section 3 of this SMP.

3.3.4 Monitoring Wells Associated with Assessing Remedial Effectiveness

Groundwater will be monitored in accordance with NYSDEC requirement at the wells that have been established at the Site. Well construction logs are presented in the Field Sampling Plan (Appendix E). These sampling and analyses will support a dataset to assess any changes taking place with groundwater quality and also to determine if Monitored Natural Attenuation (in addition to the remedial action that has taken place at the surface) is causing the residual groundwater concentrations to be consistent and/or decrease at the Site.

3.3.5 Criteria for Completion of Remediation/Termination of Remedial Systems

Generally, remedial processes are considered completed when monitoring indicates that the remedy has achieved the remedial action objectives identified by the decision document. The framework for determining when remedial processes are complete is provided in Section 6.6 of NYSDEC DER-10.

3.3.5.1 – Soil Cover

The soil cover is a permanent control and the quality and integrity of the covered area will be inspected at defined, regular intervals in accordance with this SMP in perpetuity.

3.3.5.2 – Concrete Slab Cover

The concrete slab cover is a permanent control and the quality and integrity of this system will be inspected at defined, regular intervals in accordance with this SMP in perpetuity.

3.3.5.3 – Geotextile Cover

The geotextile cover in the cooling pond area is a permanent control and the quality and integrity of this system will be inspected at defined, regular intervals in accordance with this SMP in perpetuity.

3.3.5.4 - Monitoring Wells Associated with Assessing Remedial Effectiveness

Groundwater monitoring activities to assess natural attenuation will continue, as determined by the NYSDEC with consultation with NYSDOH, until residual groundwater concentrations are found to be consistently below ambient water quality standards, the site SCGs, or have become asymptotic at an acceptable level over an extended period. In the event that monitoring data indicates that monitoring may no longer be required, a proposal to discontinue the system will be submitted to NYSDEC Monitoring will continue until permission to discontinue is granted in writing by the NYSDEC. If groundwater contaminant levels become asymptotic at a level that is not acceptable to the NYSDEC, additional source removal, treatment and/or control measures will be evaluated.

4.0 MONITORING AND SAMPLING PLAN

4.1 General

This Monitoring and Sampling Plan describes the measures for evaluating the overall performance and effectiveness of the remedy. This Monitoring and Sampling Plan may only be revised with the approval of the NYSDEC. Details regarding the sampling procedures, data quality usability objectives, analytical methods, etc. for all samples collected as part of site management for the Site are included in the Quality Assurance Project Plan provided in Appendix F.

This Monitoring and Sampling Plan describes the methods to be used for:

- Sampling and analysis of all appropriate media (e.g., groundwater, indoor air, soil vapor, soils);
- Assessing compliance with applicable NYSDECSCGs, particularly groundwater standards and Part 375 Soil Cleanup Objectives for soil; and
- Evaluating site information periodically to confirm that the remedy continues to be effective in protecting public health and the environment;

To adequately address these issues, this Monitoring and Sampling Plan provides information on:

- Sampling locations, protocol and frequency;
- Information on all designed monitoring systems;
- Analytical sampling program requirements;
- Inspection and maintenance requirements for monitoring wells;
- Monitoring well decommissioning procedures; and

- Annual inspection and periodic certification.

Reporting requirements are provided in Section 7.0 of this SMP.

4.2 Site-wide Inspection

Site-wide inspections will be performed annually. Modification to the frequency or duration of the inspections will require approval from the NYSDEC. Site-wide inspections will also be performed after all severe weather conditions that may affect ECs or monitoring devices. During these inspections, an inspection form will be completed as provided in Appendix H – Site Management Forms. The form will compile sufficient information to assess the following:

- Compliance with all ICs, including site usage;
- An evaluation of the condition and continued effectiveness of ECs;
- General site conditions at the time of the inspection;
- The site management activities being conducted including, where appropriate, confirmation sampling and a health and safety inspection; and
- Confirm that site records are up to date.

Inspections of all remedial components installed at the Site will be conducted. A comprehensive site-wide inspection will be conducted and documented according to the SMP schedule, regardless of the frequency of the PRR. The inspections will determine and document the following:

- Whether ECs continue to perform as designed;
- If these controls continue to be protective of human health and the environment;
- Compliance with requirements of this SMP and the Environmental Easement;
- Achievement of remedial performance criteria; and

- If site records are complete and up to date; and

Reporting requirements are outlined in Section 7.0 of this plan.

Inspections will also be performed in the event of an emergency. If an emergency, such as a natural disaster or an unforeseen failure of any of the ECs occurs that reduces or has the potential to reduce the effectiveness of ECs in place at the Site, verbal notice to the NYSDEC must be given by noon of the following day. In addition, an inspection of the Site will be conducted within 5 days of the event to verify the effectiveness of the IC/ECs implemented at the Site by a qualified environmental professional, as determined by the NYSDEC. Written confirmation must be provided to the NYSDEC within 7 days of the event that includes a summary of actions taken, or to be taken, and the potential impact to the environment and the public.

4.3 Post-Remediation Media Monitoring and Sampling

4.3.1 Groundwater Sampling

Groundwater monitoring will be performed every 5 quarters to assess the performance of the remedy. Modification to the frequency or sampling requirements will require approval from the NYSDEC.

The network of monitoring wells has been installed to monitor upgradient, on-site and downgradient groundwater conditions at the Site. The network of on-site wells has been designed based on the following criteria:

The well placement was designed to assess the groundwater conditions around the buildings as well as at property boundaries upgradient and downgradient in an effort to understand groundwater quality and if the remedial measures thus far have controlled the sources of PCB contaminants.

Table 2 summarizes the wells identification number, as well as the purpose, location, depths, diameter and screened intervals of the wells. As part of the groundwater monitoring, 1 upgradient wells, 3 on-site wells and 3 downgradient wells are sampled to evaluate the effectiveness of the remedial system.

Table 2 – Monitoring Well Construction Details

Monitoring Well ID	Well Location	Coordinates (longitude/ latitude)	Well Diameter (inches)	Elevation (above mean sea level)			
				Casing	Surface	Screen Top	Screen Bottom
MW-1	on-site	43.4734° N, -76.4755° W	4	313.29	311.29	307.29	295.29
MW-2R	on-site	43.4735° N, -76.4752° W	2	313.11	311.11	307.11	295.11
MW-3	downgradient	43.4747° N, -76.4739° W	4	311.72	309.72	305.72	293.72
MW-4	on-site	43.4741° N, -76.4759° W	4	312.45	310.45	306.45	294.45
MW-5	downgradient	43.4748° N, -76.4773° W	2	312.70	308.00		
MW-6	upgradient	43.4739° N, -76.4731° W	2	331.82	325.00		
MW-7	downgradient	43.4754° N, -76.4758° W	2	314.11	309.00		

Monitoring well construction logs are included in Appendix H of this document.

If biofouling or silt accumulation occurs in the on-site and/or off-site monitoring wells, the wells will be physically agitated/surged and redeveloped. Additionally, monitoring wells will be properly decommissioned and replaced, if an event renders the wells unusable.

Repairs and/or replacement of wells in the monitoring well network will be performed based on assessments of structural integrity and overall performance.

The NYSDEC will be notified prior to any repair or decommissioning of any monitoring well for the purpose of replacement, and the repair or decommissioning and replacement process will be documented in the subsequent PRR. Well decommissioning without replacement will be done only with the prior approval of the NYSDEC. Well abandonment will be performed in accordance with NYSDEC's guidance entitled "CP-43: Groundwater Monitoring Well Decommissioning Procedures." Monitoring wells that are decommissioned because they have been rendered unusable will be replaced in kind in the nearest available location, unless otherwise approved by the NYSDEC.

The sampling frequency may only be modified with the approval of the NYSDEC. This SMP will be modified to reflect changes in sampling plans approved by the NYSDEC.

Deliverables for the groundwater monitoring program are specified in Section 7.0 – Reporting Requirements.

4.3.2 Monitoring and Sampling Protocol

All sampling activities will be recorded in a field book and associated sampling log as provided in Appendices E and H. Other observations (e.g., groundwater monitoring well integrity, etc.) will be noted on the sampling log. The sampling log will serve as the inspection form for the monitoring network. Additional detail regarding monitoring and sampling protocols are provided in the site-specific Field Activities Plan provided as Appendix E of this document.

5.0 OPERATION AND MAINTENANCE PLAN

5.1 General

The site remedy does not rely on any mechanical systems, such as groundwater treatment systems, sub-slab depressurization systems or air sparge/soil vapor extraction systems to protect public health and the environment. Therefore, the operation and maintenance of such components is not included in this SMP.

6.0 PERIODIC ASSESSMENTS/EVALUATIONS

6.1 Climate Change Vulnerability Assessment

Increases in both the severity and frequency of storms/weather events, an increase in sea level elevations along with accompanying flooding impacts, shifting precipitation patterns and wide temperature fluctuation, resulting from global climactic change and instability, have the potential to significantly impact the performance, effectiveness and protectiveness of a given site and associated remedial systems. Vulnerability assessments provide information so that the Site and associated remedial systems are prepared for the impacts of the increasing frequency and intensity of severe storms/weather events and associated flooding.

This section provides a summary of vulnerability assessments that will be conducted for the Site during periodic assessments, and briefly summarizes the vulnerability of the Site and/or ECs to severe storms/weather events and associated flooding.

The nearest waterbody to the Site, other than Lake Ontario (to the north), is Wine Creek (approximately 0.5 mile south; south of Mitchell Street). The flooding risk is generally low since the flow is controlled by high road grades, small culverts, and swamps (Federal Emergency Management Agency 2013).

The Site is not on a direct border with Lake Ontario, so any lake ice is not anticipated to be an issue. Other potential vulnerabilities may be the significant snowfall that Oswego endures during the winter due to lake effect snowfall events. This may introduce snow and ice to the Site which may impact the conditions. However, the inspection program that is in place will be able to identify if any significant impacts have occurred and arrange for repairs if necessary.

6.2 Green Remediation Evaluation

NYSDEC’s DER-31 Green Remediation requires that green remediation concepts and techniques be considered during all stages of the remedial program including site management, with the goal of improving the sustainability of the cleanup and summarizing the net environmental benefit of any implemented green technology. This section of the SMP provides a summary of any green remediation evaluations to be completed for the Site during site management, and as reported in the PRR.

Waste generation associated with purge water at this Site has been planned and developed to minimize any wastes generated. Low-flow purging is the procedure followed for this process and minimizes the purge water volumes generated during sampling. Additionally, the purge water is discharged back to the land surface further minimizing water materials generated from the process.

Following the remediation was performed at the cooling pond, a new pond was constructed to maintain the pond ecosystem that had been present on the Site for so many years. This restoration of the pond preserved and maintained the landscape at the Site.

6.2.1 Timing of Green Remediation Evaluations

For major remedial system components, green remediation evaluations and corresponding modifications will be undertaken as part of a formal Remedial System Optimization (RSO), or at any time that the Project Manager feels appropriate, e.g. during significant maintenance events or in conjunction with storm recovery activities.

Modifications resulting from green remediation evaluations will be routinely implemented and scheduled to occur during planned/routine operation and maintenance activities. Reporting of these modifications will be presented in the PRR.

7.0. REPORTING REQUIREMENTS

7.1 Site Management Reports

All site management inspection, maintenance and monitoring events will be recorded on the appropriate site management forms provided in Appendix H. These forms are subject to NYSDEC revision.

All applicable inspection forms and other records, including media sampling data and system maintenance reports, generated for the Site during the reporting period will be provided in electronic format to the NYSDEC in accordance with the requirements of Table 3 and summarized in the PRR.

Table 3: Schedule of Interim Monitoring/Inspection Reports

Task/Report	Reporting Frequency*
Cover Inspections (Landfill and Yard area); including one overall Site inspection	Annual
Groundwater Monitoring	Every 5 quarters
Periodic Review Report	Every three years, or as otherwise determined by the Department

* The frequency of events will be conducted as specified until otherwise approved by the NYSDEC.

All interim monitoring/inspections reports will include, at a minimum:

- Date of event or reporting period;
- Name, company, and position of person(s) conducting monitoring/inspection activities;
- Description of the activities performed;

- Where appropriate, color photographs or sketches showing the approximate location of any problems or incidents noted (included either on the checklist/form or on an attached sheet);

- Type of samples collected (e.g., sub-slab vapor, indoor air, outdoor air, etc);

- Copies of all field forms completed (e.g., well sampling logs, chain-of-custody documentation, etc.);

- Sampling results in comparison to appropriate standards/criteria;

- A figure illustrating sample type and sampling locations;

- Copies of all laboratory data sheets and the required laboratory data deliverables required for all points sampled (to be submitted electronically in the NYSDEC-identified format);

- Any observations, conclusions, or recommendations; and

- A determination as to whether contaminant conditions have changed since the last reporting event.

Routine maintenance event reporting forms will include, at a minimum:

- Date of event;

- Name, company, and position of person(s) conducting maintenance activities;

- Description of maintenance activities performed;

- Any modifications to the system;

- Where appropriate, color photographs or sketches showing the approximate location of any problems or incidents noted (included either on the checklist/form or on an attached sheet); and,

- Other documentation such as copies of invoices for maintenance work, receipts for replacement equipment, etc., (attached to the checklist/form).

Non-routine maintenance event reporting forms will include, at a minimum:

- Date of event;

- Name, company, and position of person(s) conducting non-routine maintenance/repair activities;

- Description of non-routine activities performed;

- Where appropriate, color photographs or sketches showing the approximate location of any problems or incidents (included either on the form or on an attached sheet); and
- Other documentation such as copies of invoices for repair work, receipts for replacement equipment, etc. (attached to the checklist/form).

Data will be reported in digital format as determined by the NYSDEC. Currently, data is to be supplied electronically and submitted to the NYSDEC EQuIS^{TM} database in accordance with the requirements found at this link http://www.dec.ny.gov/chemical/62440.html.

7.2 Periodic Review Report

The PRR shall be submitted every 3 years to the Department or at another frequency as may be required by the Department. In the event that the Site is subdivided into separate parcels with different ownership, a single PRR will be prepared that addresses the Site described in Appendix C -Environmental Easement. The report will be prepared in accordance with NYSDEC's DER-10 and submitted within 30 days of the end of each certification period. Media sampling results will also be incorporated into the PRR. The report will include:

- Identification, assessment and certification of all ECs/ICs required by the remedy for the Site.
- Results of the required annual site inspections and severe condition inspections, if applicable.
- All applicable site management forms and other records generated for the Site during the reporting period in the NYSDEC-approved electronic format, if not previously submitted.
- A summary of any discharge monitoring data and/or information generated during the reporting period, with comments and conclusions.
- Data summary tables and graphical representations of contaminants of concern by media (groundwater, soil vapor, etc.), which include a listing of all compounds analyzed, along with the applicable standards, with all exceedances

highlighted. These will include a presentation of past data as part of an evaluation of contaminant concentration trends.

- Results of all analyses, copies of all laboratory data sheets, and the required laboratory data deliverables for all samples collected during the reporting period will be submitted in digital format as determined by the NYSDEC. Currently, data is supplied electronically and submitted to the NYSDEC EQuIS^{TM} database in accordance with the requirements found at this link: http://www.dec.ny.gov/chemical/62440.html.

- A site evaluation, which includes the following:
    - The compliance of the remedy with the requirements of the site-specific RODs;
    - The operation and the effectiveness of all treatment units, etc., including identification of any needed repairs or modifications;
    - Any new conclusions or observations regarding site contamination based on inspections or data generated by the Monitoring and Sampling Plan for the media being monitored;
    - Recommendations regarding any necessary changes to the remedy and/or Monitoring and Sampling Plan; and
    - Trends in contaminant levels in the affected media will be evaluated to determine if the remedy continues to be effective in achieving remedial goals as specified by the Decision Document.
    - The overall performance and effectiveness of the remedy.

7.2.1 Certification of Institutional and Engineering Controls

Following the last inspection of the reporting period, a qualified environmental professional will prepare, and include in the PRR, the following certification as per the requirements of NYSDEC DER-10:

"For each institutional or engineering control identified for the site, I certify that all of the following statements are true:

- *The inspection of the site to confirm the effectiveness of the institutional and engineering controls required by the remedial program was performed under my direction;*

- *The institutional control and/or engineering control employed at this site is unchanged from the date the control was put in place, or last approved by the Department;*

- *Nothing has occurred that would impair the ability of the control to protect the public health and environment;*

- *Nothing has occurred that would constitute a violation or failure to comply with any site management plan for this control;*

- *Access to the site will continue to be provided to the Department to evaluate the remedy, including access to evaluate the continued maintenance of this control;*

- *If a financial assurance mechanism is required under the oversight document for the site, the mechanism remains valid and sufficient for the intended purpose under the document;*

- *Use of the site is compliant with the environmental easement;*

- *The engineering control systems are performing as designed and are effective;*

- *To the best of my knowledge and belief, the work and conclusions described in this certification are in accordance with the requirements of the site remedial program and generally accepted engineering practices; and*

- *The information presented in this report is accurate and complete.*

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, [name], of [business address], am certifying as [Owner/Remedial Party or Owner's/Remedial Party's Designated Site Representative] for the site."

If the remedy requires only an institutional control, include the following:

At the end of each certifying period, as determined by the NYSDEC, the following certification will be provided to the Department:

"For each institutional identified for the site, I certify that all of the following statements are true:

- *The institutional control employed at this site is unchanged from the date the control was put in place, or last approved by the Department;*
- *Nothing has occurred that would impair the ability of the control to protect the public health and environment;*
- *Nothing has occurred that would constitute a violation or failure to comply with any site management plan for this control;*
- *Access to the site will continue to be provided to the Department to evaluate the remedy, including access to evaluate the continued maintenance of this control;*
- *If a financial assurance mechanism is required under the oversight document for the site, the mechanism remains valid and sufficient for the intended purpose under the document;*
- *Use of the site is compliant with the environmental easement.*
- *The information presented in this report is accurate and complete.*

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, [name], of [business address], am certifying as [Owner or Owner's Designated Site Representative] for the site."

The signed certification will be included in the PRR.

The PRR will be submitted, in electronic format, to the NYSDEC Central Office, Regional Office in which the Site is located and the NYSDOH Bureau of Environmental Exposure Investigation. The PRR may need to be submitted in hard-copy format, as requested by the NYSDEC project manager.

7.3 Corrective Measures Work Plan

If any component of the remedy is found to have failed, or if the periodic certification cannot be provided due to the failure of an IC or EC, a Corrective Measures Work Plan will be submitted to the NYSDEC for approval. This plan will explain the failure and provide the details and schedule for performing work necessary to correct the failure. Unless an emergency condition exists, no work will be performed pursuant to the Corrective Measures Work Plan until it has been approved by the NYSDEC.

7.4 Remedial Site Optimization Report

In the event that an RSO is to be performed (see Section 6.3, upon completion of an RSO, an RSO report must be submitted to the Department for approval. A general outline for the RSO report is provided in Appendix I. The RSO report will document the research/ investigation and data gathering that was conducted, evaluate the results and facts obtained, present a revised conceptual site model and present recommendations. RSO recommendations are to be implemented upon approval from the NYSDEC. Additional work plans, design documents, HASPs etc., may still be required to implement the recommendations, based upon the actions that need to be taken. A final engineering report and update to the SMP may also be required.

The RSO report will be submitted, in electronic format, to the NYSDEC Central Office, Regional Office in which the Site is located, Site Control and the NYSDOH Bureau of Environmental Exposure Investigation.

8.0 REFERENCES

6NYCRR Part 375, Environmental Remediation Programs. December 14, 2006.

Federal Emergency Management Agency. 2013. Flood Insurance Study for Oswego County. Volumes 1 and 2. June 18.

NYSDEC DER-10 – "Technical Guidance for Site Investigation and Remediation".

NYSDEC, 1997. Record of Decision, Oswego Castings Site, Oswego (C), Oswego County. Site Number 7-38-033. March, 1997.

NYSDEC, 1998. Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1. June 1998 (April 2000 addendum).

NYSDEC, 2000. Remedial Investigation Report for the Oswego Castings Inactive hazardous Waste Site, Operable Unit No. 2 – Yard/buildings. January, 2000.

NYSDEC, 2000. Oswego Castings Site, Operable Unit No. 2 – Yards/Buildings, Proposed Remedial Action Plan. February, 2000.

NYSDEC, 2000. Record of Decision, Oswego Castings Site Operable Unit No. 2 – Yard/Buildings, Oswego, Oswego County. Site Number 7-38-033. March, 2000.

NYSDEC, 2002. Remediation Summary Report, Oswego Castings Site, Oswego (C), Oswego County. Site Number 7-38-033 (OU2). January, 2002.

NYSDEC, 2011. Periodic Review Report. Oswego Castings, Site 7-38-033. State Superfund, New York State Department of Environmental Conservation. April.

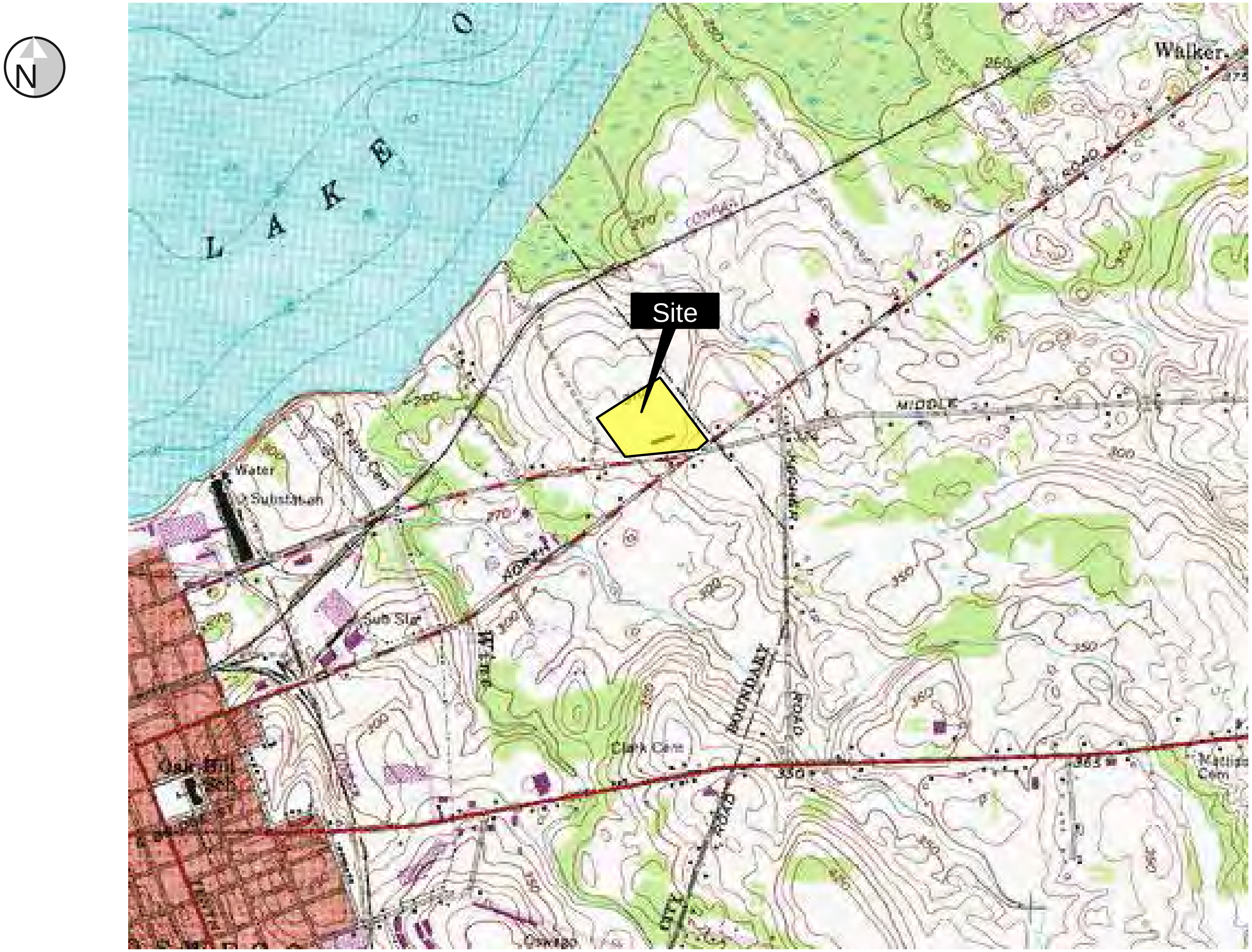
NYSDEC, 2012. Oswego Casting Site Sampling: DER Site Management September, 2012.

Stearns and Wheler, LLC, 1995. Remedial Investigation. Oswego Castings, Oswego, NY. August 1994. Final Revision December 1995.

Figure 1
Site Location

Oswego Castings Site

Oswego, New York



Source: USGS 7.5-minute Series Topographic Quadrangle, Oswego East, 1984.

0 150 300 600 900 1,200 Feet

N

Legend

⊕ Monitoring Well	▨ IRM Area (1997 ROD)
▭ Approximate Site Boundary	▨ IRM Area (2000 ROD)
▭ OU-1	
▭ OU-2	

Note: Remedial area boundaries are approximate.

New York State Department of Environmental Conservation
Site Number 738033
Oswego Castings, Oswego, New York

SITE MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2

G:\GISMOD\00266404.0000\SITEMAP.mxd
G:\PROJECT\00266404.0000\SMP\Figure 2 - Site Map.pdf

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- ● Monitoring Well
- ☐ Approximate Site Boundary

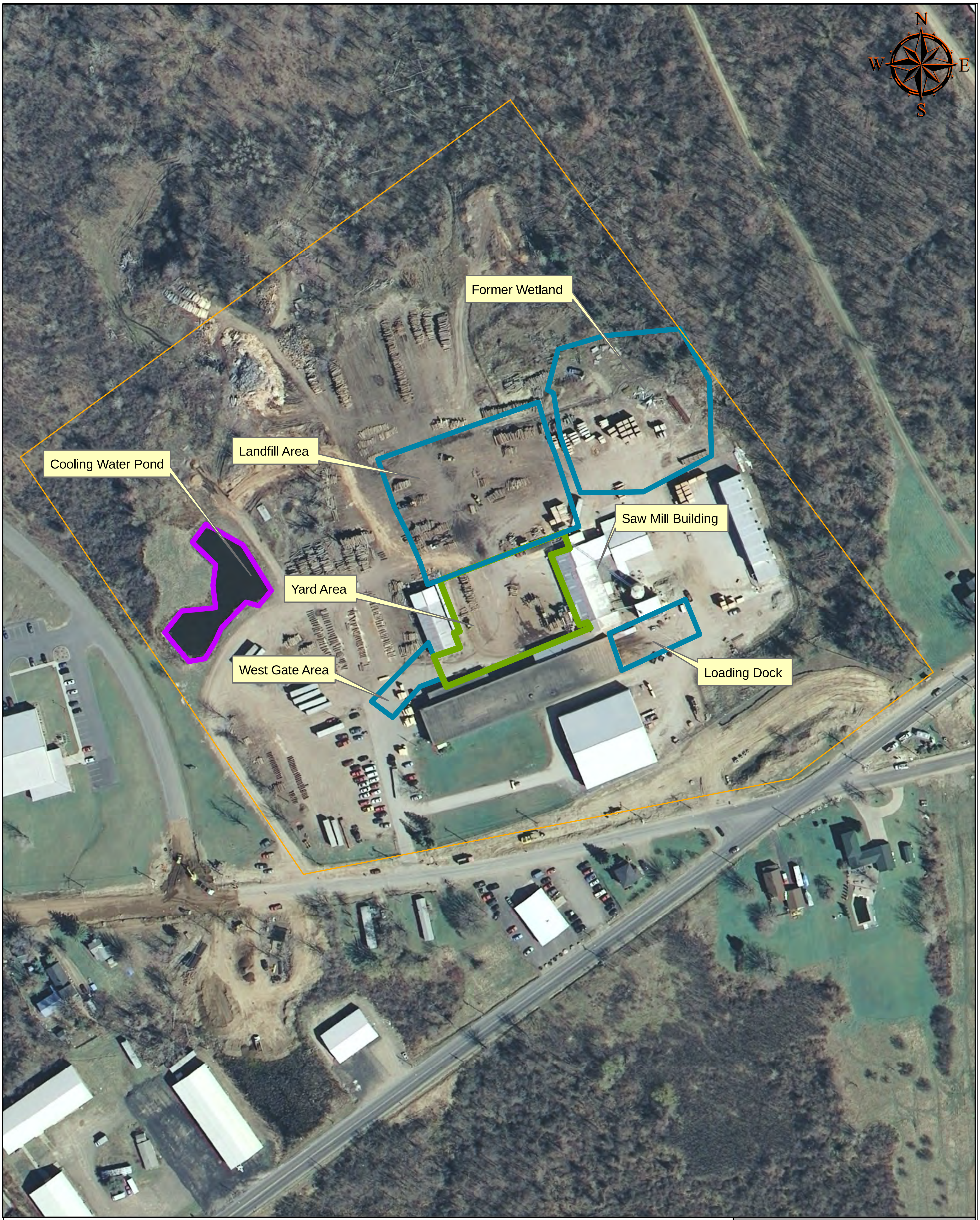
New York State Department of Environmental Conservation
Site Number 738033
Oswego Castings, Oswego, New York

MONITORING WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

G:\GISMOD\00266404.0000\WELLS.mxd
G:\PROJECT\00266404.0000\SMP\Figure 3 - Wells.pdf



March 4,2009

Figure 4

Oswego Casting Site

Site Number 7-38-033

Site Inspection conducted June 24, 2008

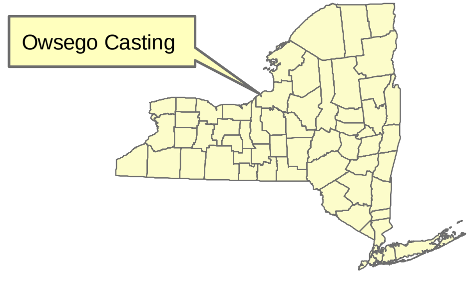
37 Mitchell Street
Owsego, NY 13126

0 75 150 300 450 600
Feet

C:\Documents and Settings\pdlong\My Documents\GIS Projects\Oswego Casting.mxd

Legend

▢	Excavation Work Completed for Operable Unit 1
▢	Concrete Pad Area Completed for Operable Unit 2
▢	Cooling Water Pond Excavated During Operable Unit 2
▢	Site Boundary



APPENDIX A – LIST OF SITE CONTACTS

Name	**Phone/Email Address**
City of Oswego - Owner	---(315)-342-8136 support@oswegony.org
Arcadis CE, Inc. – NYSDEC Consultant	(518)-250-7300
Andrew Vitolins, P.G.	(518)-250-7359 andy.vitolins@arcadis.com
Payson Long, P.E. – NYSDEC Project Manager	(518)-402-9813 pdlong@gw.dec.state.ny.us

APPENDIX B – EXCAVATION WORK PLAN (EWP)

This plan represents a procedure for any activity that would disturb the landfill cover or the concrete yard cover at the Site and any other area of the Site, where contamination may be present. Any work will be required to follow the procedures outlined below. In summary, NYSDEC will be notified of the work and detailed work plans, including waste disposal management, will be required for submittal. At minimum all work plans, HASPs, Community Air Monitoring Plans, and any other applicable document related to the proposed work will need to, at minimum, meet the requirements of NYSDEC.

B-1 NOTIFICATION

At least 15 days prior to the start of any activity that is anticipated to encounter remaining contamination, the site owner or their representative will notify the NYSDEC. Table B-1 includes contact information for the above notification. The information on this table will be updated as necessary to provide accurate contact information. A full listing of site-related contact information is provided in Appendix A.

Table B-1: Notifications*

Payson Long, P.E.	(518)-402-9813 payson.long@dec.ny.gov

* Note: Notifications are subject to change and will be updated as necessary.

This notification will include:

- A detailed description of the work to be performed, including the location and areal extent of excavation, plans/drawings for site re-grading, intrusive elements or utilities to be installed below the soil cover, estimated volumes of contaminated soil to be excavated and any work that may impact an engineering control;
- A summary of environmental conditions anticipated to be encountered in the work areas, including the nature and concentration levels of contaminants of

concern, potential presence of grossly contaminated media, and plans for any pre-construction sampling;

- A schedule for the work, detailing the start and completion of all intrusive work;
- A summary of the applicable components of this EWP;
- A statement that the work will be performed in compliance with this EWP and 29 Code of Federal Regulations 1910.120;
- A copy of the contractor’s health and safety plan (HASP), in electronic format, if it differs from the HASP provided in Appendix G of this SMP;
- Identification of disposal facilities for potential waste streams; and
- Identification of sources of any anticipated backfill, along with all required chemical testing results.

B-2 SOIL SCREENING METHODS

Visual, olfactory and instrument-based (e.g. photoionization detector) soil screening will be performed by a qualified environmental professional during all excavations into known or potentially contaminated material (remaining contamination). Soil screening will be performed when invasive work is done and will include all excavation and invasive work performed during development, such as excavations for foundations and utility work, after issuance of the COC.

Soils will be segregated based on previous environmental data and screening results into material that requires off-site disposal and material that requires testing to determine if the material can be reused on-site as soil beneath a cover or if the material can be used as cover soil. Further discussion of off-site disposal of materials and on-site reuse is provided in Sections B-6 and B-7 of this Appendix.

B-3 SOIL STAGING METHODS

Soil stockpiles will be continuously encircled with a berm and/or silt fence. Hay bales will be used as needed near catch basins, surface waters and other discharge points.

Stockpiles will be kept covered at all times with appropriately anchored tarps. Stockpiles will be routinely inspected and damaged tarp covers will be promptly replaced.

Stockpiles will be inspected at a minimum once each week and after every storm event. Results of inspections will be recorded in a logbook and maintained at the site and available for inspection by the NYSDEC.

B-4 MATERIALS EXCAVATION AND LOAD-OUT

A qualified environmental professional or person under their supervision will oversee all invasive work and the excavation and load-out of all excavated material.

The owner of the property and remedial party (if applicable) and its contractors are responsible for safe execution of all invasive and other work performed under this Plan.

The presence of utilities and easements on the site will be investigated by the qualified environmental professional. It will be determined whether a risk or impediment to the planned work under this SMP is posed by utilities or easements on the site.

Loaded vehicles leaving the site will be appropriately lined, tarped, securely covered, manifested, and placarded in accordance with appropriate Federal, State, local, and NYSDOT requirements (and all other applicable transportation requirements).

A truck wash will be operated on-site, as appropriate. The qualified environmental professional will be responsible for ensuring that all outbound trucks will be washed at the truck wash before leaving the site until the activities performed under this section are complete Truck wash waters will be collected and disposed of off-site in an appropriate manner.

Locations where vehicles enter or exit the site shall be inspected daily for evidence of off-site soil tracking.

The qualified environmental professional will be responsible for ensuring that all egress points for truck and equipment transport from the site are clean of dirt and other materials derived from the site during intrusive excavation activities. Cleaning of the adjacent streets will be performed as needed to maintain a clean condition with respect to site-derived materials.

B-5 MATERIALS TRANSPORT OFF-SITE

All transport of materials will be performed by licensed haulers in accordance with appropriate local, State, and Federal regulations, including 6 NYCRR Part 364. Haulers will be appropriately licensed and trucks properly placarded.

Material transported by trucks exiting the site will be secured with tight-fitting covers. Loose-fitting canvas-type truck covers will be prohibited. If loads contain wet material capable of producing free liquid, truck liners will be used.

All trucks loaded with site materials will exit the vicinity of the site using only these approved truck routes. This is the most appropriate route and takes into account: (a) limiting transport through residential areas and past sensitive sites; (b) use of city mapped truck routes; (c) prohibiting off-site queuing of trucks entering the facility; (d) limiting total distance to major highways; (e) promoting safety in access to highways; and (f) overall safety in transport; [(g) community input [where necessary]

Trucks will be prohibited from stopping and idling in the neighborhood outside the project site.

Egress points for truck and equipment transport from the site will be kept clean of dirt and other materials during site remediation and development.

Queuing of trucks will be performed on-site in order to minimize off-site disturbance. Off-site queuing will be prohibited.

B-6 MATERIALS DISPOSAL OFF-SITE

All material excavated and removed from the site will be treated as contaminated and regulated material and will be transported and disposed in accordance with all local, State (including 6NYCRR Part 360) and Federal regulations. If disposal of material from this site is proposed for unregulated off-site disposal (i.e. clean soil removed for development purposes), a formal request with an associated plan will be made to the NYSDEC. Unregulated off-site management of materials from this site will not occur without formal NYSDEC approval.

Off-site disposal locations for excavated soils will be identified in the pre-excavation notification. This will include estimated quantities and a breakdown by class of disposal facility if appropriate, i.e. hazardous waste disposal facility, solid waste landfill, petroleum treatment facility, construction and demolition recycling facility, etc. Actual disposal quantities and associated documentation will be reported to the NYSDEC in the Periodic Review Report. This documentation will include: waste profiles, test results, facility acceptance letters, manifests, bills of lading and facility receipts.

Non-hazardous historic fill and contaminated soils taken off-site will be handled, at minimum, as a Municipal Solid Waste per 6NYCRR Part 360-1.2. Material that does not meet Unrestricted Soil Cleanup Objectives (SCOs) is prohibited from being taken to a New York State recycling facility (6NYCRR Part 360-16 Registration Facility).

B-7 MATERIALS REUSE ON-SITE

‘Reuse on-site’ means reuse on-site of material that originates at the Site and which does not leave the Site during the excavation. The detailed work plans for the specific activities taking place should include the following topics for approval from NYSDEC:

- Procedure for determining if reuse is appropriate:
    - Sampling (methods and analytical)
    - Chemical limits for on-site reuse
        - Table of chemical limits for reuse
    - Stockpile segregation scheme for on-site reuse
        - Size of stockpiles, location (include figure)
    - Chemical criteria for on-site reuse of material, as presented in the detailed work plans, must be approved by NYSDEC.

The qualified environmental professional will ensure that procedures defined for materials reuse in this SMP are followed and that unacceptable material does not remain on-site. Contaminated on-site material, including historic fill and contaminated soil, that is acceptable for reuse on-site will be placed below the demarcation layer or impervious surface, and will not be reused within a cover soil layer, within landscaping berms, or as backfill for subsurface utility lines.

Any demolition material proposed for reuse on-site will be sampled for asbestos and the results will be reported to the NYSDEC for acceptance. Concrete crushing or processing on-site will not be performed without prior NYSDEC approval. Organic matter (wood, roots, stumps, etc.) or other solid waste derived from clearing and grubbing of the site will not be reused on-site.

B-8 FLUIDS MANAGEMENT

All liquids to be removed from the site, including but not limited to, excavation dewatering, decontamination waters and groundwater monitoring well purge and development waters, will be handled, transported and disposed in accordance with applicable local, State, and Federal regulations. Dewatering, purge and development fluids will not be recharged back to the land surface or subsurface of the site, and will be managed off-site, unless prior approval is obtained from NYSDEC.

Discharge of water generated during large-scale construction activities to surface waters (i.e. a local pond, stream or river) will be performed under a State Pollutant Discharge Elimination System permit.

B-9 COVER SYSTEM RESTORATION

After the completion of soil removal and any other invasive activities the cover system will be restored in a manner that complies with the Record of Decision. The existing cover system is comprised of a minimum of 12 or 24 inches of clean soil, asphalt pavement, concrete covered sidewalks and concrete building, etc.. The demarcation layer, consisting of orange snow fencing material, white geotextile or equivalent material, etc. will be replaced to provide a visual reference to the top of the remaining contamination zone, the zone that requires adherence to special conditions for disturbance of remaining contaminated soils defined in this SMP. If the type of cover system changes from that which exists prior to the excavation (i.e., a soil cover is replaced by asphalt), this will constitute a modification of the cover element of the remedy and the upper surface of the remaining contamination. A figure showing the modified surface will be included in the subsequent Periodic Review Report and in an updated SMP.

B-10 BACKFILL FROM OFF-SITE SOURCES

The detailed work plans for the excavation activities must include the procedures planned for the import, handling and placement of backfill material from off-site. The requirements for backfill used at the site should be consistent with the backfill requirements provided in DER-10. At minimum, the following topics should be covered:

- Source area approval process
  - Sources of backfill material
    - Past use of Site
    - Source area background check
    - DOT Certification
  - Chemical sampling
    - Analytes
    - Frequency

    - Imported Soil Chemical Quality Standards
        - Applicability of protection of groundwater SCOs
        - Applicability of protection of ecological resources SCOs
        - Stockpile procedures for imported backfill material
    - Size of stockpiles, cover, etc.
- Procedure for determining if reuse is appropriate
    - Sampling (methods and analytical)
- Stockpile procedures for imported backfill material
    - Size of stockpiles, cover, etc.

All materials proposed for import onto the site will be approved by the qualified environmental professional and will be in compliance with provisions in this SMP prior to receipt at the site. A Request to Import/Reuse Fill or Soil form, which can be found at http://www.dec.ny.gov/regulations/67386.html, will be prepared and submitted to the NYSDEC project manager allowing a minimum of 5 business days for review.

Material from industrial sites, spill sites, or other environmental remediation sites or potentially contaminated sites will not be imported to the site.

All imported soils will meet the backfill and cover soil quality standards established in 6NYCRR 375-6.7(d). Based on an evaluation of the land use, protection of groundwater and protection of ecological resources criteria, the resulting soil quality standards must be presented. Soils that meet 'exempt' fill requirements under 6 NYCRR Part 360, but do not meet backfill or cover soil objectives for this site, will not be imported onto the site without prior approval by NYSDEC. Solid waste will not be imported onto the site.

Trucks entering the site with imported soils will be securely covered with tight fitting covers. Imported soils will be stockpiled separately from excavated materials and covered to prevent dust releases.

B-11 STORMWATER POLLUTION PREVENTION

For large excavations, but less than 1 acre, procedures for stormwater pollution prevention should be specified in the EWP. For construction projects exceeding 1 acre, this is required. A summary of the Stormwater Pollution Prevention Plan that conforms to the requirements of the NYSDEC Division of Water guidelines and NYS regulations should be included here. The plan itself may be included as an Appendix to the EWP.

Barriers and hay bale checks will be installed and inspected once a week and after every storm event. Results of inspections will be recorded in a logbook and maintained at the site and available for inspection by the NYSDEC. All necessary repairs shall be made immediately.

Accumulated sediments will be removed as required to keep the barrier and hay bale check functional.

All undercutting or erosion of the silt fence toe anchor shall be repaired immediately with appropriate backfill materials.

Manufacturer's recommendations will be followed for replacing silt fencing damaged due to weathering.

Erosion and sediment control measures identified in the SMP shall be observed to ensure that they are operating correctly. Where discharge locations or points are accessible, they shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters.

Silt fencing or hay bales will be installed around the entire perimeter of the construction area.

B-12 EXCAVATION CONTINGENCY PLAN

If underground tanks or other previously unidentified contaminant sources are found during post-remedial subsurface excavations or development related construction, excavation activities will be suspended until sufficient equipment is mobilized to address the condition.

Sampling will be performed on product, sediment and surrounding soils, etc. as necessary to determine the nature of the material and proper disposal method. Chemical analysis will be performed for a full list of analytes (target analyte list metals; target compound list volatiles and semi-volatiles, target compound list pesticides and PCBs), unless the site history and previous sampling results provide a sufficient justification to limit the list of analytes. In this case, a reduced list of analytes will be proposed to the NYSDEC for approval prior to sampling.

Identification of unknown or unexpected contaminated media identified by screening during invasive site work will be promptly communicated by phone to NYSDEC’s Project Manager. Reportable quantities of petroleum product will also be reported to the NYSDEC spills hotline. These findings will be also included in the Periodic Review Report.

B-13 OTHER NUISANCES

The following items may be necessary depending on the type of wastes present, the location of the Site and other site-specific concerns. These plans are generally not required for submission to the NYSDEC.

A plan for rodent control will be developed and utilized by the contractor prior to and during site clearing and site grubbing, and during all remedial work.

A plan will be developed and utilized by the contractor for all remedial work to ensure compliance with local noise control ordinances.

APPENDIX C
RESPONSIBILITIES of
OWNER and REMEDIAL PARTY

Responsibilities

The responsibilities for implementing the Site Management Plan ("SMP") for the Oswego Castings site (the "site"), number 7-38-033, are divided between the site owner(s) and a Remedial Party, as defined below. The owner(s) is/are currently listed as:
City of Oswego (the "owner").

Solely for the purposes of this document and based upon the facts related to a particular site and the remedial program being carried out, the term Remedial Party ("RP") refers to any of the following: certificate of completion holder, volunteer, applicant, responsible party, and, in the event the New York State Department of Environmental Conservation ("NYSDEC") is carrying out remediation or site management, the NYSDEC and/or an agent acting on its behalf. The RP is:

Arcadis CE, Inc. as an Agent to the NYSDEC
855 Route 146, Suite 210
Clifton Park, NY 12065

Nothing on this page shall supersede the provisions of an Environmental Easement, Consent Order, Consent Decree, agreement, or other legally binding document that affects rights and obligations relating to the site.

Site Owner's Responsibilities:

1) The owner shall follow the provisions of the SMP as they relate to future construction and excavation at the site.

2) In accordance with a periodic time frame determined by the NYSDEC, the owner shall periodically certify, in writing, that all Institutional Controls set forth in a(n) Environmental Notice remain in place and continue to be complied with. The owner shall provide a written certification to the RP, upon the RP's request, in order to allow the RP to include the certification in the site's Periodic Review Report (PRR) certification to the NYSDEC.

3) In the event the site is delisted, the owner remains bound by the Environmental Notice and shall submit, upon request by the NYSDEC, a written certification that the Environmental Notice is still in place and has been complied with.

4) The owner shall grant access to the site to the RP and the NYSDEC and its agents for the purposes of performing activities required under the SMP and assuring compliance with the SMP.

5) The owner is responsible for assuring the security of the remedial components located on its property to the best of its ability. In the event that damage to the remedial components or vandalism is evident, the owner shall notify the site's RP and the NYSDEC in accordance with the timeframes indicated in Section 1.3-Notifications.

6) In the event some action or inaction by the owner adversely impacts the site, the owner must notify the site's RP and the NYSDEC in accordance with the time frame indicated in Section 1.3- Notifications and (ii) coordinate the performance of necessary corrective actions with the RP.

7) The owner must notify the RP and the NYSDEC of any change in ownership of the site property (identifying the tax map numbers in any correspondence) and provide contact information for the new owner of the site property. 6 NYCRR Part contains notification requirements applicable to any construction or activity changes and changes in ownership. Among the notification requirements is the following: Sixty days prior written notification must be made to the NYSDEC. Notification is to be submitted to the NYSDEC Division of Environmental Remediation's Site Control Section. Notification requirements for a change in use are detailed in Section 2.4 of the SMP. A 60-Day Advance Notification Form and Instructions are found at http://www.dec.ny.gov/chemical/76250.html.

8) In accordance with the tenant notification law, within 15 days of receipt, the owner must supply a copy of any vapor intrusion data, that is produced with respect to structures and that exceeds NYSDOH or Occupational Safety and Health Administration guidelines on the site, whether produced by the NYSDEC, RP, or owner, to the tenants on the property. The owner must otherwise comply with the tenant and occupant notification provisions of Environmental Conservation Law Article 27, Title 24.

Remedial Party Responsibilities

1) The RP must follow the SMP provisions regarding any construction and/or excavation it undertakes at the site.

2) The RP shall report to the NYSDEC all activities required for remediation, operation, maintenance, monitoring, and reporting. Such reporting includes, but is not limited to, periodic review reports and certifications, electronic data deliverables, corrective action work plans and reports, and updated SMPs.

3) Before accessing the site property to undertake a specific activity, the RP shall provide the owner advance notification that shall include an explanation of the work expected to be completed. The RP shall provide to (i) the owner, upon the owner's request, (ii) the NYSDEC, and (iii) other entities, if required by the SMP, a copy of any data generated during the site visit and/or any final report produced.

4) If the NYSDEC determines that an update of the SMP is necessary, the RP shall update the SMP and obtain final approval from the NYSDEC. Within 5 business days after NYSDEC approval, the RP shall submit a copy of the approved SMP to the owner(s).

5) The RP shall notify the NYSDEC and the owner of any changes in RP ownership and/or control and of any changes in the party/entity responsible for the operation, maintenance, and monitoring of and reporting with respect to any remedial system (Engineering Controls). The RP shall provide contact information for the new party/entity. Such activity constitutes a Change of Use pursuant to 375-1.11(d) and requires 60-days prior notice to the NYSDEC. A 60-Day Advance Notification Form and Instructions are found at http://www.dec.ny.gov/chemical/76250.html .

6) The RP shall notify the NYSDEC of any damage to or modification of the systems as required under Section 1.3- Notifications of the SMP.

7) The RP is responsible for the proper maintenance of any installed vapor intrusion mitigation systems associated with the site, as required in Section 5 of the SMP.

8) The RP is responsible for the proper monitoring and maintenance of any installed drinking water treatment system associated with the site, as required in Section 5.

9) Prior to a change in use that impacts the remedial system or requirements and/or responsibilities for implementing the SMP, the RP shall submit to the NYSDEC for approval an amended SMP.

10) Any change in use, change in ownership, change in site classification (*e.g.*, delisting), reduction or expansion of remediation, and other significant changes related to the site may result in a change in responsibilities and, therefore, necessitate an update to the SMP and/or updated legal documents. The RP shall contact the Department to discuss the need to update such documents.

Change in RP ownership and/or control and/or site ownership does not affect the RP's obligations with respect to the site unless a legally binding document executed by the NYSDEC releases the RP of its obligations.

Future site owners and RPs and their successors and assigns are required to carry out the activities set forth above.

APPENDIX D – ENVIRONMENTAL NOTICE

Oswego Castings
Site No. 738033
Mitchell Street, City of Oswego
Oswego County, NY
Tax Map: 111.69-01-01.000

ENVIRONMENTAL NOTICE

THIS ENVIRONMENTAL NOTICE is made the 16th day of May 2012, by the New York State Department of Environmental Conservation (Department), having an office for the transaction of business at 625 Broadway, Albany, New York 12233.

WHEREAS, a parcel of real property identified as Oswego Castings (Site 738033), located on 375 Mitchell Street in the City of Oswego, County of Oswego, State of New York, which is part of lands assessed to Great Lakes Veneer Corp., known and designated on the tax map of the Oswego County Clerk's Office as tax map parcel numbers: Section 111.69, Block 1 Lot 01 and being more particularly described in Appendix "A", attached to this noticed and made a part hereof, and hereinafter referred to as " the Property" is the subject of a Remedial Program performed by the Department as part of the Department's State Superfund Program; and

WHEREAS, the Department approved a cleanup to address contamination disposed at the Property and such cleanup was conditioned upon certain limitations.

NOW, THEREFORE, the Department provides notice that:

FIRST, the Property subject to this Environmental Notice is as shown on a map attached to this Notice as Appendix "B" and made a part hereof.

SECOND, unless prior written approval by the Department or, if the Department shall no longer exist, any New York State agency or agencies subsequently created to protect the environment of the Sate and the health of the State's citizens, hereinafter referred to as "the Relevant Agency," is first obtained, where contamination remains at the Property subject to the provisions of the Operation and Maintenance (O&M Plan), there shall be no disturbance or excavation of the Property which threatens the integrity of the engineering controls or which results or may result in a significantly increased threat of harm or damage at any site as a result of exposure to soils. A violation of this provision is a violation of 6 NYCRR 375-1.11(b)(2).

THIRD, no person shall disturb, remove, or otherwise interfere with the installation, use, operations, and maintenance of engineering controls required for the Remedy, including but not limited to those engineering controls described in the O&M Plan and listed below, unless in each instance they first obtain a written waiver of such prohibition from the Department or Relevant Agency.

FOURTH, the remedy was designed to be protective for the following uses: Commercial as described in 6 NYCRR Part 375-1.8(g)(2)(iii) and Industrial as described in 6 NYCRR Part 375-1.8(g)(2)(iv). Therefore, any use for purposes other than Commercial and Industrial without the express written waiver of such prohibition by the Relevant Agency may result in a significantly increased threat of harm or damage at any site.

FIFTH, no person shall use the groundwater underlying the Property without treatment rendering it safe for drinking water or industrial purposes, as appropriate, unless the user first obtains permission to do so from the Department or Relevant Agency. Use of the groundwater without appropriate treatment may result in a significantly increased threat of harm or damage at any site.

SIXTH, it is a violation of 6 NYCRR 375-1.11(b) to use the Property in a manner inconsistent with this environmental notice.

IN WITNESS WHEREOF, the undersigned, acting by and though the Department of Environmental Conservation as Designee of the Commissioner, has executed this instrument the day written below.

By: ____________________
Robert W. Schick, P.E,
Acting Director
Division of Remediation

STATE OF NEW YORK)
) ss:
COUNTY OF)

On the 16th day of May, in the year 2012, before me, the undersigned, personally appeared Robert Schick, personally known to me or proved to me on the basis of satisfactory evidence to be the individual whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his capacity as Designee of the Commissioner of the State of New York Department of Environmental Conservation, and that by his signature on the instrument, the individual, or the person upon behalf of which individual acted, executed the instrument.

____
Notary Public – State of New York

David J. Chiusano
Notary Public, State of New York
No. 01CH5032146
Qualified in Schenectady County
Commission Expires August 22, 2014

APPENDIX A
METES AND BOUNDS DESCRIPTION

ALL THAT CERTAIN PLOT, tract or parcel of land situate in Lot 35 of the 18th Township of Scriba's Patent in the second ward of the City of Oswego, County of Oswego, and State of New York, being more particularly bounded as follows:

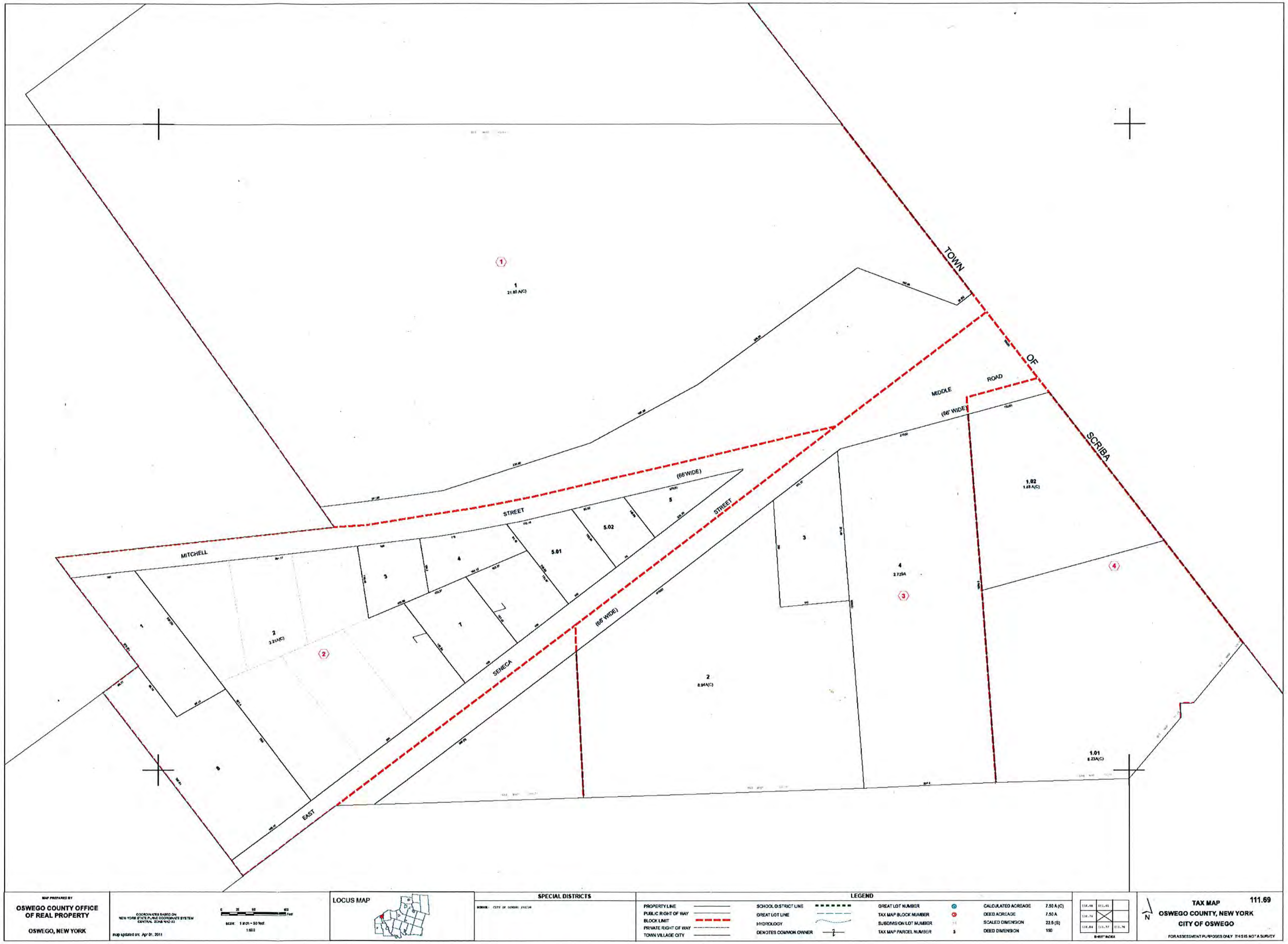
BEGINNING at a point in the centerline of E. Seneca Street at the intersection of said centerline with an Easterly Corporation Line of the City of Oswego; running thence the following courses and distances:

1) Along the centerline of E. Seneca Street, South 58°-20' West a distance of 282.0 feet to a point in the centerline of Mitchell Street, thence
2) Along the same, South 28°-13' West a distance of 551.82 feet along the centerline of Mitchell Street to an angle point, thence
3) Along the same, South 88°- 48' West a distance of 250.0 feet along the centerline of Mitchell street to a point, thence
4) Along the same, North 32°- 0' West a distance of 777.0 feet to a point, thence
5) Along the same, North 58°- 0' East a distance of 1000.0 feet to a point in an easterly Corporation Line of the City of Oswego, thence
6) Along the same, South 32°- 0' East a distance of 1133.0 feet along an Easterly Corporation Line of the City of Oswego to a point in the centerline of Seneca Street and the point of beginning.

Containing 23.2389 acres of land more or less inclusive of the highway.

APPENDIX B
MAP

APPENDIX “B” TAX MAP
Oswego Castings, Site No. 738033



APPENDIX E – FIELD SAMPLING PLAN

ARCADIS

WELL DEVELOPMENT/ PURGING LOG

WELL NUMBER: ____________________

DATE: ____________________________________

PROJECT NAME: ____________________________________

PROJECT NUMBER: ____________________________________

SAMPLERS: ____________________________________

A: Total Casing and Screen Length: ________________

B: Casing Internal Diameter: ________________

C: Water Level Below Top of Casing: ________________

D: Volume of Water in Casing: ________________

Well I.D.	**Vol. Gal./ft.**
1"	**0.04**
2"	**0.17**
3"	**0.38**
4"	**0.66**
5"	**1.04**
6"	**1.50**
8"	**2.60**

$$v = 0.0408\,(B)^2 \times (A-C) = D$$

$v = 0.0408\,(\qquad)^2 \times (\qquad - \qquad) =$ ______________ gal.

PARAMETER	ACCUMULATED VOLUME PURGED												
Time													
Gallons													
Depth to Water													
Temperature (^{o}C)													
pH													
Redox (mV)													
Conductivity (mohm/cm													
Turbidity (ntu)													
Disolved Oxygen (mg/l)													
TDS													
Salinity													

Notes: ____________________________________

ARCADIS

GROUNDWATER MONITORING WELL INSPECTION

SITE/PROJECT NAME: ______________________ PROJECT NUMBER: ______________________

DATE OF INSPECTION: ______________________ INSPECTOR: ______________________

WELL DESIGNATION: ____

WELL LOCATION: ____

Outward Appearance

Flushmount Diameter	______ inches	N/A [ ]		
Approximate Stickup Height	______ feet	N/A [ ]		
Integrity of Protective Casing	Describe: ____			
Protective Casing Material	Steel [ ]	Stainless Steel [ ]	Other ______________________	
Protective Casing Width or Dia.	______ inches			
Weep Hole in Protective Casing	Yes [ ]	No [ ]		
Surface Seal/Apron Material	Cement [ ]	Bentonite [ ]	Not apparent [ ]	Other ________
Integrity of Surface Seal/Apron	Describe: ____			
Surface Drainage	Away from Wellhead [ ]	Toward Wellhead [ ]		
Bollards Present?	Yes [ ]	No [ ]	Describe:	____________________________
Well ID. Visible?	Yes [ ]	No [ ]	Describe:	____________________________
Lock Present and Functional?	Yes [ ]	No [ ]	Describe:	____________________________
Photograph Taken? Photo #	Yes [ ]	No [ ]	Describe:	____________________________

Inner Appearance

Integrity of Well Casing	Describe: ____			
Integrity of Cap Seal	Describe: ____			
Surface Water in Casing?	Yes [ ]	No [ ]	Describe:	____________________________
Well Casing Diameter	______ inches			
Well Casing Material	PVC [ ]	Steel [ ]	Stainless Steel [ ]	
Inner Cap	Threaded [ ]	Slip [ ]	Expansion Plug [ ]	None [ ]
Reference/Measuring Point	Groove [ ]	Indelible Mark [ ]	None [ ]	
Evidence of Double Casing?	Yes [ ]	No [ ]	Describe:	____________________________

Downhole

Odor	Yes [ ]	No [ ]	Describe:	____________________________
PID Reading	______ ppm			
Depth to Water (to top of casing)	______ feet (nearest 0.01)	Depth to LNAPL	_____ feet (nearest 0.01)	N/A [ ]
Total Well Depth (to top of casing)	______ feet (nearest 0.1)			
Sediment (Hard/Soft Bottom)	Describe: ____			

Additional Comments:

____

____

____

____

____

____

OSWEGO CASTINGS SITE

Landfill and Concrete Cap Operation and Maintenance Checklist

Inspected by: ______________________________

Date: ____________ Time: ______________

Weather Conditions: ______________________________

LANDFILL COVER SYSTEM

Erosion	______	YES	______	NO
Cap Settlement	______	YES	______	NO
Ponded Water or Wet Areas	______	YES	______	NO
Burrowing Rodents	______	YES	______	NO
Brush or Other Woody Vegetation	______	YES	______	NO

Comments: ______________________________

____

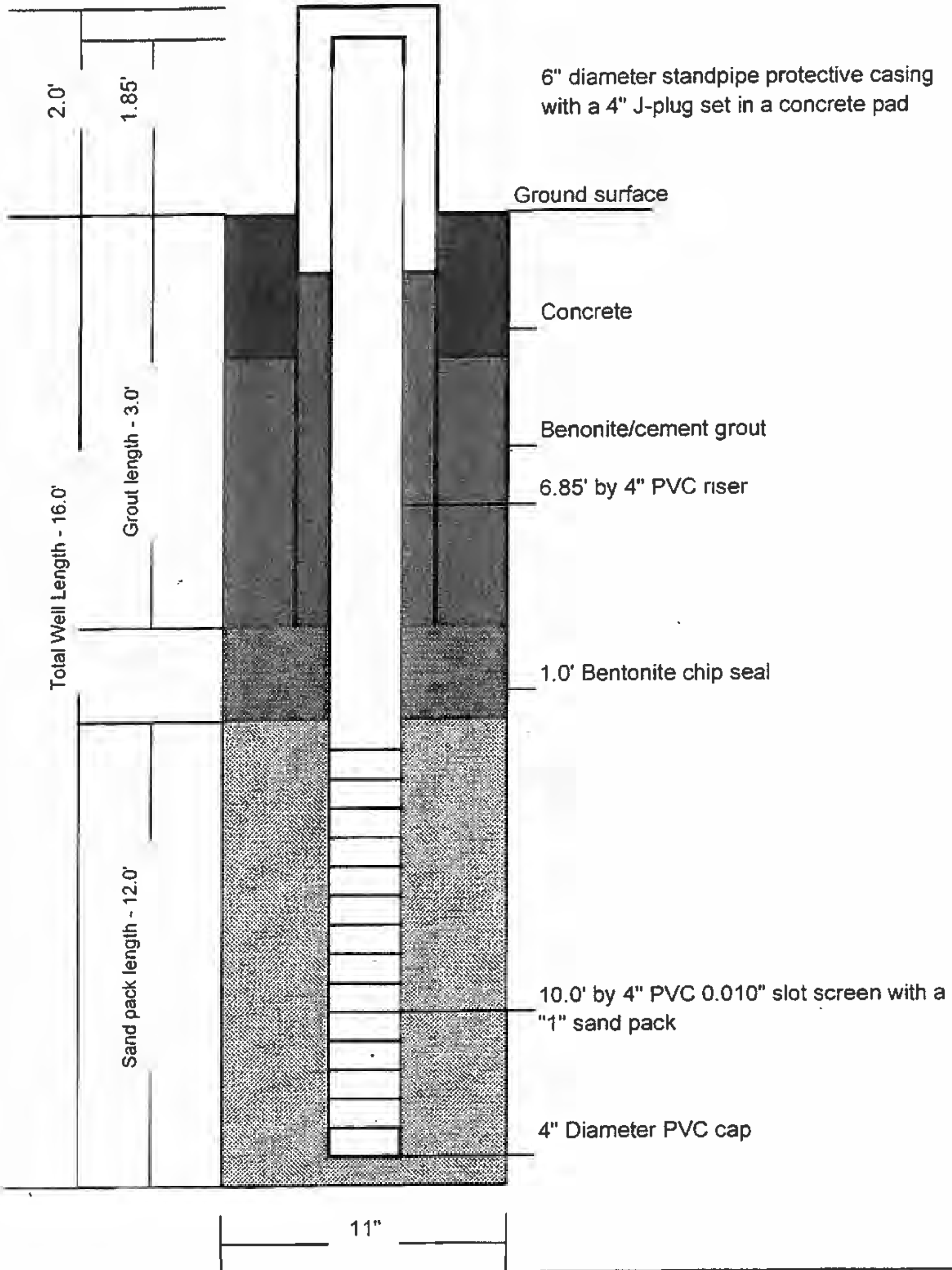
CONCRETE COVER

Cracked Concrete	______	YES	______	NO
Damaged Concrete	______	YES	______	NO
Concrete Settlement	______	YES	______	NO
Ponded Water or Wet Areas	______	YES	______	NO
Presence of Vegetation	______	YES	______	NO

Comments: ______________________________

____

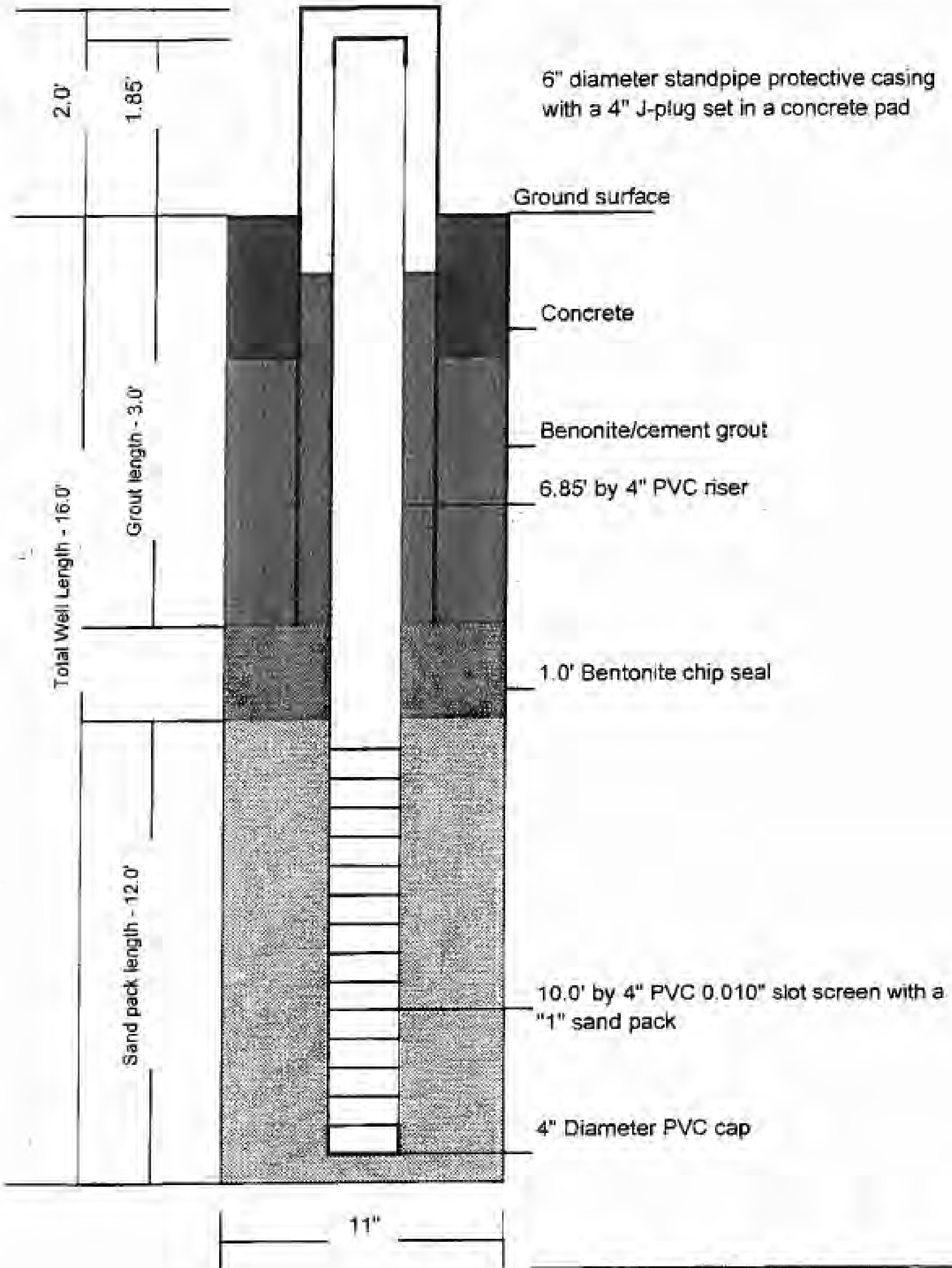
INSPECTOR'S SIGNATURE DATE ____________



PARRATT-WOLFF INC.

MONITORING WELL MW-1
OSWEGO CASTINGS
OSWEGO, NEW YORK

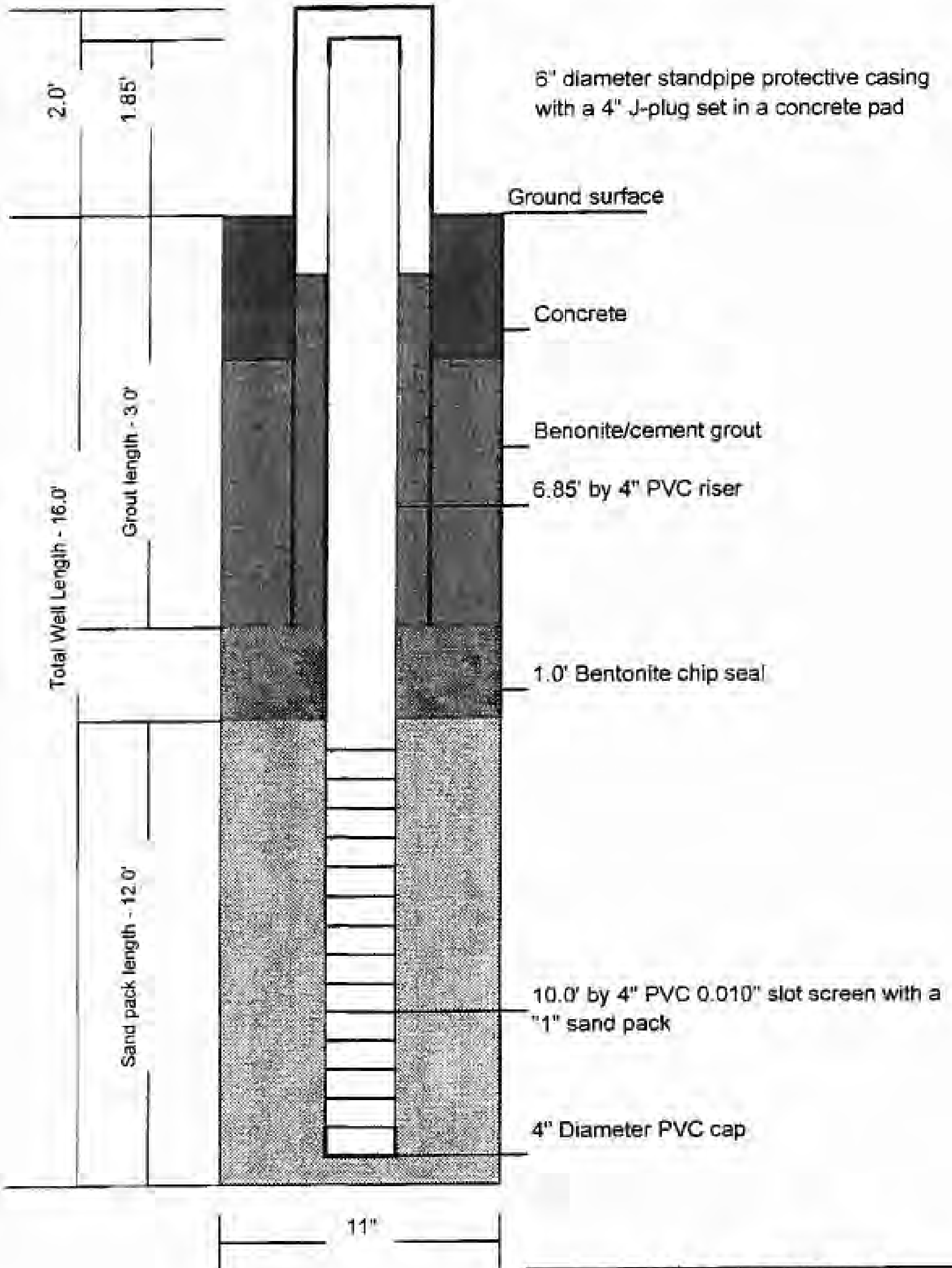
NOT TO SCALE AUGUST 2001



PARRATT-WOLFF INC.

MONITORING WELL MW-2
OSWEGO CASTINGS
OSWEGO, NEW YORK

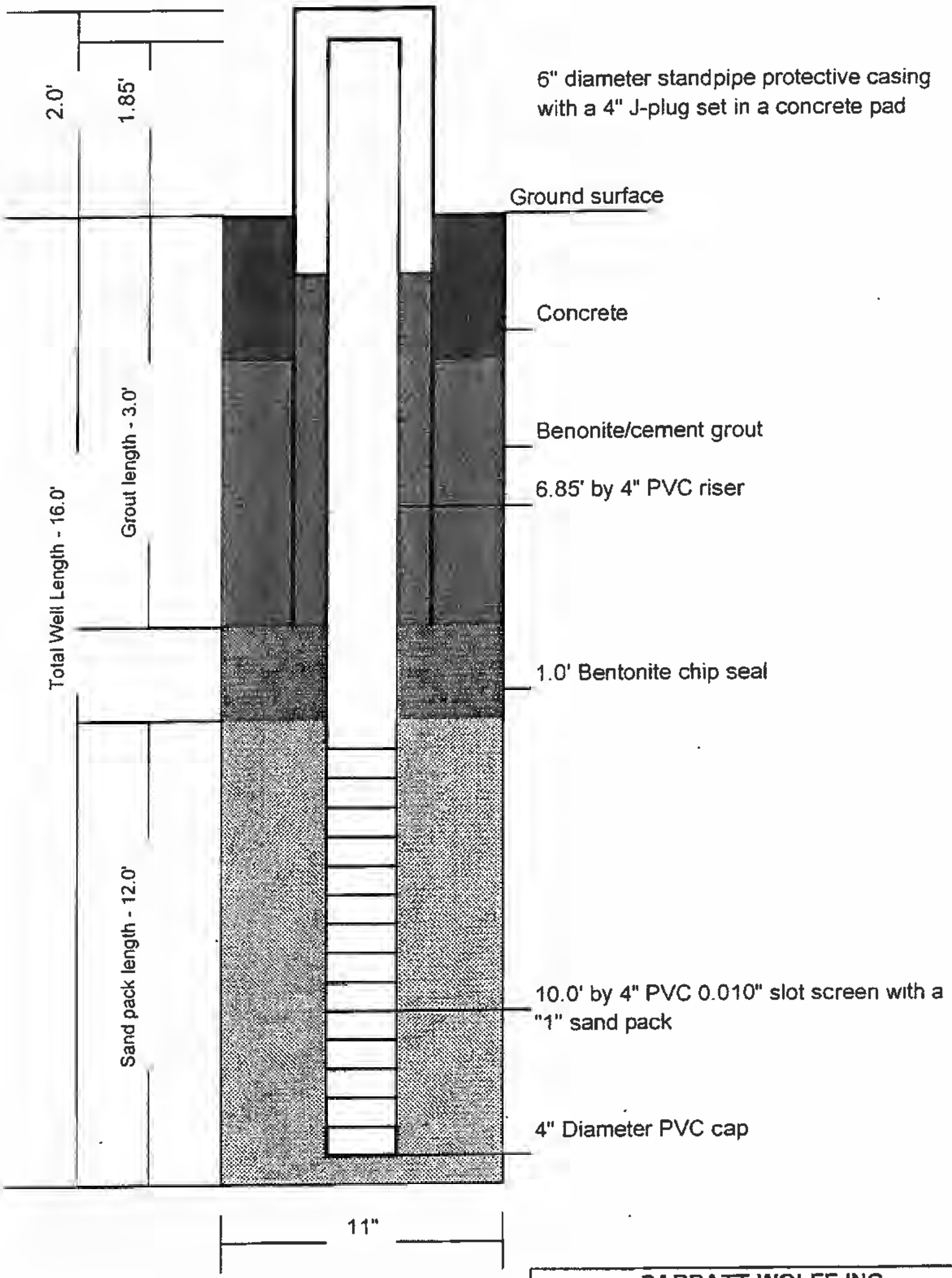
NOT TO SCALE AUGUST 2001



PARRATT-WOLFF INC.

MONITORING WELL MW-3
OSWEGO CASTINGS
OSWEGO, NEW YORK

NOT TO SCALE AUGUST 2001



PARRATT-WOLFF INC.

MONITORING WELL MW-4
OSWEGO CASTINGS
OSWEGO, NEW YORK

NOT TO SCALE AUGUST 2001

APPENDIX F – QUALITY ASSURANCE PROJECT PLAN

New York State Department of Environmental Conservation

Site #7-38-033

Oswego Castings Site Specific Quality Assurance Project Plan

February 2016

,

Oswego Castings Site Specific Quality Assurance Project Plan

Site #7-38-033

Prepared for:

New York State Department of
Environmental Conservation

Prepared by:

Arcadis CE, Inc.
855 Route 146
Suite 210
Clifton Park
New York 12065
Tel 518 250 7300
Fax 518 250 7301

Our Ref.:

00266404.0000

Date:

February 2016

CONTENTS

APPENDICES

Acronyms Used in the Report

ASP	Analytical Services Protocol
CRQLs	Contract Required Quantitation Limits
DCA	Dichloroethane
DCE	Dichloroethene
FSP	Field Sampling Plan
GW	Groundwater
gpm	gallons per minute
HASP	Site Specific Health and Safety Plan
IDL	Instrument Detection Limit
MDL	Minimum Detection Limit
MS	Matrix spikes
MSD	Matrix spike duplicate
NBS	National Bureau of Standards
NYSDEC	New York State Department of Environmental Conservation
OSWER	Office of Solid Waste and Emergency Response
PARCCS	Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity
PCBs	Polychlorinated Biphenyl's
PCE	Perchloroethene (Tetrachloroethene)
RCRA	Resource Conservation and Recovery Act
PID	Photoionization Detector
PPE	Personal protective equipment
RFI	RCRA Facility Investigation
RPD	Relative percent difference
SCG	Standards, Criteria, and Guidance Values
SMP	Site Management Plan
SOPs	Standard Operating Procedures
SVOCs	Semi-volatile organic compounds
SWMU	Solid Waste Management Unit
TAGM	Technical and Administrative Guidance Memorandum
TCA	Trichloroethane
TCE	Trichloroethene
VC	Vinyl chloride
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds

QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
EPA	United States Environmental Protection Agency

1 PURPOSE AND OBJECTIVES

1.1 Purpose

This Site Specific Quality Assurance Project Plan (QAPP) has been prepared as an appendix to the Oswego Castings Site Management Plan (SMP) developed for the New York State Department of Environmental Conservation (NYSDEC). The purpose of this document is to provide quality assurance/ quality control (QA/QC) methods, procedures, and protocols for the collection, analysis, and evaluation of data collected during site activities.

1.2 QAPP Objectives

The objective of this Site Specific QAPP is to support that data collected during site activities are of suitable quality and quantity to meet the project objectives. To meet this objective, the following topics are presented and discussed in this QAPP.

- Project organization and responsibilities
- Data quality objectives
- Analytical method requirements
- Data validation requirements
- Preventative maintenance
- Quality assurance procedures
- Corrective actions

This QAPP has been prepared to address laboratory analysis of samples and data evaluation of the laboratory sample results. In addition, this QAPP addresses components that influence these processes and provides a plan to support that decisions being made from the analytical data are valid, accurate, and defensible in support of subsequent recommendations.

2 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Project Organization

The project consultant will provide oversight, coordination, health and safety, field support, and evaluation of analytical data. The project consultant will also be responsible for evaluation of analytical test results, which will be submitted to NYSDEC.

2.2 Analytical Laboratories

Analytical laboratories have been selected in accordance with the NYSDEC Standby Contract procurement procedures.

Each laboratory has their own provisions for performing internal QA/QC review of the data prior to transmittal to the project consultant. In addition, the project consultant may be required to contract a data validation service to review the methods and protocols performed by the laboratory to validate the analytical results. A Data Usability Summary Report (DUSR) is not required for this project. If a DUSR is required for future work, a summary of the data validation results will be provided by the data validation service (Section 7.2.2).

3 DATA MEASUREMENT AND QA/QC OBJECTIVES

This section defines the QA/QC objectives for environmental sampling and analysis, including the data quality objectives (DQOs) for measurement data and the criteria for measuring performance within these objectives. Data collected during the project may include both field measurements and analytical samples. This Section discusses the various types of data anticipated and provides QA/QC objectives for data collected during the project.

3.1 Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the quality of the data to support decisions, and are developed to address specific procedures for collecting, analyzing, and evaluating results to meet overall project objectives. DQOs are developed and implemented to ensure that the quality of the data is such that the data is legally and scientifically defensible and is applicable for its anticipated use. DQOs developed for each specific site, measurement, and media assume project objectives, data objectives, and data collection methods.

Site-specific DQOs have been developed based on the factors presented above, and are presented below. These include the specific DQOs for each planned data collection task, which identifies the particular sampling protocols, analysis methods, and laboratory deliverables to be provided for each data type anticipated.

3.1.1 DQOs for Groundwater

Groundwater will be sampled and analyzed to evaluate the nature and extent of groundwater contamination at the site. Field instrumentation will be used during sampling activities to support the collection of representative samples. As such, data from the field instrumentation must be of sufficient quality to measure groundwater conditions prior to sampling. Analytical data will be used to identify the location of any groundwater contamination, to aid in evaluating contaminant source locations, and to assess if any standards, criteria, and guidance values (SCGs) have been exceeded. To meet these objectives, the data from the groundwater samples must be of known quality. Therefore, USEPA SW-846 analytical methodologies with NYSDEC ASP Category B deliverables have been selected for all groundwater analyses. These deliverables are characterized by rigorous QA/QC protocols and documentation, which historically have provided high quality data able to meet the DQOs for this media. Site-specific groundwater sample analyses are summarized in the SMP. Groundwater samples will be critical samples for the evaluation of potential risks to human health and the environment.

3.2 Field Measurement Quality Assurance Objective

Tasks requiring field measurements may include field screening of samples, evaluating the progress of monitoring well development, monitoring well sample collection, collection of soil conductivity data, in-situ measurements, surveying sampling locations, and field analysis of samples using test kits. To support the accuracy and quality of the data provided by field measurements, section 4 provides DQOs for recording field measurements during site investigations, including the following:

- Water Quality Parameters

The DQOs developed for each method will ensure that the data is appropriate and reliable for the extent they will be used in the investigation. A summary of field measurement methods, documentation, DQOs, and QA/QC protocols is provided in section 4.

3.3 Laboratory Quality Assurance Objectives

Laboratory generated data are used to accurately identify and quantify hazardous substances, while the field generated data are used in conjunction with the laboratory data for further investigation of contamination at the site. Both laboratory and field internal QC programs include steps to confirm the data are reliable for the extent they will be used in the investigation. In general, laboratory QC programs are more rigorous than field QC programs.

The scope and description of QC samples and QC methods are well detailed in the applicable USEPA methodologies for the particular analyses. The methodologies for organic and inorganic analyses describe the type of QC samples and required QC methods, and the required frequency of analysis. QC limits have been established for standards, blanks, duplicates, matrix spikes, and surrogates, and are contained in the methodologies.

Laboratory QC data will be reviewed by the project consultant's personnel. The NYSDEC may request a subcontracted third-party data validation service to assess the validity of the data and determine if the DQOs have been met. This objective will be met by implementing the following:

- *Evaluation of Laboratory Method Performance* – QC criteria for method performance will be reviewed and assessed for target analyses. Analysis methods will be performed based on documented procedures by certified laboratories.
- *Sample Matrix Effects* – QC samples will be collected and analyzed to determine measurement bias due to the sample matrix. If criteria are not met, matrix interferences will be confirmed by reanalysis or inspection of laboratory control samples to verify laboratory method performance is in control.
- *Planning and Management* – Laboratories will perform preventive maintenance and routine calibration of equipment. A managed program of internal and external QC checks will be followed to ensure data quality.
- *Corrective Actions* – If QC issues are detected during QA audits or QC checks, corrective actions will be taken to stop work and modify procedures to ensure data quality.

4 FIELD INVESTIGATION PROCEDURES

A summary of objectives, equipment, and procedures for the following field activities is provided in this section:

- Field quality control samples
  - Trip blanks
  - Field blanks
  - Matrix spike/matrix spike duplicates
  - Field duplicates
- Field measurements
  - Water level measurements
  - Water quality parameters
- Sample equipment decontamination
- Groundwater sampling
- Storage and disposal of investigation derived waste
- Field documentation
- Sample handling

4.1 Field Quality Control Samples

Quality control procedures will be employed to ensure that sampling, transportation and laboratory activities do not bias sample analytical quality. Trip blanks, field blanks, duplicate samples, matrix spike samples and matrix spike duplicates will provide a quantitative basis for validating the analytical data.

4.1.1 Trip Blanks

The trip blanks will be prepared by the laboratory by filling 40 ml vials with a Teflon-lined septum with deionized, analyte-free water. The trip blank will accompany the day's sample containers at all times. One trip blank will be returned to the laboratory with each cooler containing aqueous samples for volatile organic compound (VOC) analysis. The trip blank will be analyzed for VOCs to detect possible contamination during shipment. Trip blanks will remain in the shipping cooler from the time of packing, in the laboratory, to arrival back at the laboratory.

4.1.2 Field Blanks

A field blank consists of an empty set of laboratory-cleaned sample containers. At the field location, deionized, analyte-free water is passed through decontaminated sampling equipment and placed in the empty set of sample containers for analysis of the same parameters as the samples collected with the sampling equipment. One field blank will be collected per every 20 environmental samples sent to the analytical laboratory, per media.

4.1.3 Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample pairs are analyzed by the laboratory to provide a quantitative measure of the laboratory's precision and accuracy. When performing USEPA SW-846 volatile organic or organic extractable analysis with NYSDEC Category B deliverables, the laboratory must be supplied with triple sample volume for each Sample Delivery Group (SDG) in order to perform MS/MSD analyses. Blanks do not require separate matrix spike or duplicate analyses regardless of their matrix.

The limits on an SDG are:

- Each Case for field samples, or
- Each 20 field samples within a Case, or
- Each fourteen calendar day period during which field samples in a Case are received (said period beginning with receipt of the first sample in the SDG), whichever comes first.

Field personnel will specify samples for MS/MSD analysis. Extra volume is not required for aqueous samples for inorganic analysis. Non-aqueous samples (soils) do not require that any extra volume of sample be submitted to the laboratory for MS/MSD samples.

4.1.4 Field Duplicates

For each sample matrix, a field duplicate sample will be collected for the analytical laboratory at a rate of one sample per 20 environmental samples, per media. The duplicate sample is collected at the same location as the environmental sample. The field duplicate sample is identified using the sample designation system described in Section 4.6.1. The identity of the field duplicate is not revealed to the laboratory. The analytical results of the environmental sample will be compared to the field duplicate sample, to evaluate field sampling precision.

4.2 Field Measurements

Tasks requiring recording of field measurements include monitoring well sample collection, and field analysis of samples using test kits. A summary of field measurements is provided below. Specific procedures for inspection and calibration of the related field equipment are provided in Section 5.

4.2.1 Water Level Measurements

4.2.1.1 Measurement Objectives

Water levels in monitoring wells will be measured and used in conjunction with horizontal and vertical ground survey data to determine horizontal and vertical components of groundwater flow. Water level measurements will also be used to determine the volume of standing water in monitoring wells for development and purging activities. These measurements made during the initial site activities will be utilized to provide a baseline of groundwater elevations and flow at the site prior to subsequent activities.

4.2.1.2 Measurement Equipment

The following equipment will be used for the measurement of water levels:

- Electronic water level indicator and/or interface probe;
- Field logbook and pen;
- Photoionization Detector;
- Deionized Water; and
- Low Phosphate Detergent.

4.2.1.3 Measurement Procedure

The first time water levels are measured at sites where VOCs are the contaminant of concern, at each monitoring well, the expansion cap will be removed and the head space and breathing zone's air quality will be monitored with a PID. This step may be omitted in subsequent rounds of water level measurements in those monitoring wells that yielded no detectable amounts of vapors or gases from prior sampling rounds. If air quality readings in the breathing space around the well exceed action levels set in the site-specific health and safety plan (HASP), appropriate measures will be taken as listed in the HASP.

The battery of the electric water level indicator will be checked by pushing the battery check button, and waiting for the audible signal to sound or the instrument light to come on. The water level indicator will be decontaminated before collecting a measurement in each monitoring well by using an alconox wash and deionized water rinse. The instrument will then be turned on and the probe will be slowly lowered into the monitoring well, until the audible signal is heard or the instrument light goes on, indicating that the sensor in the probe has made contact with the water surface in the monitoring well.

In the presence of NAPL, an interface probe, which can indicate and differentiate between the contact surfaces of NAPL and water, will be used in the place of an electric water level indicator. The probe is checked, decontaminated, and used in the same manner as an electric water level indicator. When the sensor probe makes contact with the NAPL or water surfaces in a monitoring well, an audible signal will be heard. To distinguish between NAPL and water surfaces, a different audible signal is used for each medium (i.e., constant signal for NAPL, intermittent signal for water).

The depth to water will be recorded to the nearest one-hundredth of a foot, from the top of the measuring mark on the monitoring well riser. The date, time, monitoring well number, and depth to water will be recorded in the field book.

4.2.2 Water Quality Parameters

Water quality parameters, including pH, conductivity, dissolved oxygen, temperature, and turbidity are often measured during monitoring well development and groundwater and surface water sampling tasks. The parameters are typically measured using a multi-parameter water quality instrument equipped with a flow-through cell (e.g., Horiba U-52 or equivalent). A Standard Operating Procedure (SOP) for measuring water quality parameters is provided in the Low-flow Groundwater Sampling SOP presented in Appendix A.

At a minimum, the multi-parameter water quality instrument will measure the following field parameters:

- Temperature;
- Conductivity;
- Dissolved oxygen (DO);
- pH;
- Turbidity; and
- Salinity.

4.2.2.1 Instrument Operation

A thermistor is used by the instrument to measure temperature. The thermistor also measures the change in electrical resistance accompanying changes in temperature. The instrument uses the temperature data in conductivity temperature conversions, DO temperature compensation, and pH temperature compensation. The unit of measurement for temperature is ºC (Celsius). The conductivity of water is determined by measuring the resistance of ion flow in between charged plates because conductivity is inversely proportional to resistance. The instrument reports conductivity as mS/cm (milli Siemen / centimeter). The instrument uses the membrane-electrode method for Dissolved Oxygen (DO). A reduction reaction in the cathode is caused by oxygen diffusing through the membrane of the sensor to create a current. This current is proportional to the concentration of oxygen dissolved in water. DO is reported as mg DO/L.

The instrument uses a glass-electrode method to determine pH. The known pH of a reference solution is determined by using two electrodes, a glass electrode and a reference electrode, and measuring the voltage (difference in potential) generated between the two electrodes. The difference in pH between solutions inside and outside the thin glass membrane creates electromotive force in proportion to this difference in pH. The reporting unit is the standard unit of pH (for example, 7.00 pH units). The instrument measures turbidity using the light-transmission scattering method. The unit for turbidity is NTU (Nephelometric Turbidity Unit).

4.2.2.2 Water Quality Measurement Procedures

The Horiba U-52 utilizes a water flow-through cell during groundwater sampling, or can be used without the cell for measuring surface water parameters. Field personnel will follow all procedures outlined for calibration and operation of the Horiba U-52 or equivalent instrument when collecting field parameter measurements. Specific procedures for operation and calibration of the multi-parameter water quality instrument are provided in Appendix B.

4.3 Sampling Equipment Decontamination

Cross contamination of samples from any source is to be avoided. All sampling equipment must be clean and free from the residue of any previous samples. All non-dedicated sampling equipment must be cleaned initially and prior to being re-used. The following is the procedure for decontamination and does not apply to heavy equipment or drilling equipment, with the exception of split spoons or equivalent samplers. All heavy equipment and drilling equipment will be steam cleaned in a predesignated location prior to use and between locations.

4.3.1 Equipment and Supplies

The following equipment may be needed to decontaminate equipment and tools used to collect water samples:

1. Tap water for initial cleaning and rinsing of equipment;
2. Distilled water for final rinsing of equipment after tap water or solvent rinse;
3. Non-phosphate detergent (e.g., Alconox™) for cleaning equipment;
4. Dishwashing detergent to remove oily or organic residue;
5. Personnel protective equipment (PPE) - including disposable gloves (Nitrile preferred), first aid kit, and waterproof outerwear (if necessary);
6. Re-sealable buckets approved for waste collection;
7. Squirt bottles for water;
8. Brushes for cleaning equipment; and
9. Field notebooks, pens and pencils.

4.3.2 Decontamination Guidelines

1. Non-dedicated soil and water sampling and processing equipment should be decontaminated between sampling intervals and between locations;
2. All instruments that come into contact with the sample water must be cleaned in the same manner as the sampling device;
3. Liquids collected into the chemical waste container must be discarded in an appropriate waste stream;
4. Staff performing decontamination procedures are required to wear appropriate PPE, gloves (e.g., Nitrile) and eye protection;
5. Care should be taken during cleaning to prevent cleaning solution contact with clothing. If circumstances dictate that contact will occur (e.g., high wind), waterproof outer clothing (e.g., foul weather gear or rain gear) and face shields must be worn; and
6. The project work plan may designate collection of equipment rinse samples to document effectiveness of cleaning.

4.3.3. Decontamination Procedure

The following procedures will be followed for decontamination:

1. Disassemble item(s) (if necessary);
2. Rinse each item with tap water;

3. Thoroughly scrub the item with a brush and soapy water, using non-phosphate detergent such as Alconox™ for non-oily residue, or a detergent for items with oily or other sticky organic residue;
4. During the scrubbing process, be sure to bleed Alconox™ solution or equivalent through small passageways/nozzles/vents, etc.;
5. Rinse the item with tap water to remove all residual soap. Be sure to bleed tap water through small passageways/nozzles/vents, etc.;
6. Rinse the item with de-ionized water. Be sure to bleed de-ionized water through small passageways/nozzles/vents, etc.;
7. Rinse the item with organic solvent (e.g., hexane or equivalent) if deemed necessary. Be sure to bleed organic solvent through small passageways/nozzles/vents, etc.;
8. Rinse the item with de-ionized or analyte-free water and allow to air dry. Be sure to bleed de-ionized or analyte-free water through small passageways, nozzles, vents, etc.;
9. Re-assemble item(s) (if necessary); and
10. Wrap the item(s) in aluminum foil or plastic bag to protect it until it is used.

Equipment used for sampling water from monitoring wells such as pneumatic bladder pumps will be decontaminated by thoroughly washing all internal and external surfaces with soapy water and rinsing with deionized water prior to use. All tubing must be dedicated to individual monitoring wells (i.e., tubing cannot be reused). Field instrumentation will be cleaned per manufacturer's instructions (Appendix B). Probes, such as those used in pH and conductivity meters, and thermometers will be rinsed prior to and after each use with deionized water.

4.4 Groundwater Sampling

4.4.1 Sampling Objectives

Groundwater samples will be collected to evaluate the nature and extent of contaminants at concentrations greater than NYSDEC Class GA standards in groundwater. Specific sampling objectives are outlined in the SMP.

4.4.2 Sampling Equipment

The following equipment may be required for groundwater sampling:

- Electric water level indicator and/or interface probe;
- Peristaltic pump;
- Polyethylene or Teflon®-lined polyethylene tubing;
- Silicone tubing;
- Temperature, pH, dissolved oxygen, ORP, specific conductivity, and turbidity meters;
- Photoionization detector;
- Field logbook and field data sheets;

- Laboratory prepared sample containers;
- Polyethylene tubing;
- Decontamination equipment; and
- Disposable nitrile gloves.

4.4.3 Sampling Procedures (Permanent Monitoring Wells)

Groundwater sampling will typically be conducted in accordance with the USEPA Low-Flow Sampling Protocol (USEPA, 2010). Alternative methods, such as the collection of groundwater samples with passive diffusion bags or following purging of three well volumes, may be used based on sample requirements and site conditions and in consultation with NYSDEC. Specific sampling procedures are provided in the low-flow groundwater sampling and passive diffusion bag GAPs provided in Appendix A. General low-flow sampling procedures using a peristaltic pump are summarized below.

Refer to section 4.2.1.3. regarding well head space measurement. The PID will be calibrated before the start of each sampling event.

Clean, new polyethylene or Teflon®-lined polyethylene tubing will be lowered into the water column to a maximum depth of two feet above the bottom of the monitoring well. The polyethylene tubing will be connected to a piece of silicone tubing that is inserted into the mechanical rollers of a peristaltic pump. By using the process of mechanical peristalsis, the peristaltic pump draws groundwater through the tubing to the surface, so that a sample can be collected. The well will be purged at a rate suitable to minimize drawdown. Field parameters, consisting of pH, specific conductance, temperature, dissolved oxygen, ORP, and turbidity will be measured in each sample collected from a monitoring point through the use of individual meters. Both the pH and the specific conductivity meters will be calibrated for water temperature before each sampling event.

The volume of water removed from each monitoring well will be dependent upon the amount of time required for stabilization of the field parameters. In general, the well will be considered stabilized for sample collection when field parameters have stabilized for three consecutive readings as follows:

pH:	+/- 0.1 standard units
Specific Conductance:	+/- 3%
Oxidation-Reduction Potential:	+/- 10 millivolts
Dissolved Oxygen	+/- 10%
Turbidity	+/- 10%

When the field parameters have stabilized, the volume of water purged will be recorded, and the monitoring point will be sampled in the same manner as was used to purge the well. Once a groundwater sample is collected from the well, the polyethylene tubing will be disposed of as ordinary solid waste.

After recording field measurements, the analytical parameters and order of sample collection for groundwater samples will be:

1. TCL VOCs;

2. TCL SVOCs; and

3. Other Parameters (TAL Metals, Pesticides, PCBs, etc.).

The sample bottles will be pre-preserved by the laboratory. The sample bottles will be immediately placed in a cooler held at 4°C. Disposable nitrile gloves will be worn by the sampling personnel and changed between sampling points. Data to be recorded in the field logbook will include purging and sampling methods, depth to water, volume of water removed during purging, pH, temperature, ORP, dissolved oxygen, turbidity, and specific conductivity values, and PID readings.

Groundwater that is purged from monitoring wells will be discharged to the ground surface within 50 feet of each monitoring well location in accordance with the NYSDEC Proposed Technical and Administrative Guidance Memorandum (TAGM) - Disposal of contaminated groundwater generated during Site Investigations, if the following criteria are met:

1. There is a defined site which is the source of the groundwater contamination;
2. There is no free product observed such as DNAPLs or LNAPLs;
3. The infiltrating groundwater is being returned to the same water bearing zone from which it is being purged; and
4. Prior approval has been granted by the NYSDEC project manager.

If there is no recharge surface (i.e., grass, uncovered soil, etc.) located within 50 feet of a well, then the purge water will be containerized and disposed of off-site. Purge water requiring off-site disposal will be handled in accordance with Section 4.5.

4.5 Storage and Disposal of Investigation Derived Waste

Investigation derived wastes (IDW) will be handled in accordance with the NYSDEC Final TAGM for the Disposal of Drill Cuttings. Purged water requiring off-site disposal will be containerized in UN-approved, 55-gallon steel drums. If disposable personal protective equipment (PPE) and decontamination fluids are generated, attempts will be made to wash surface contamination off so that PPE (i.e., gloves and other disposable items) may be disposed of as ordinary solid waste. If contamination is suspected, these materials will be collected and containerized in UN-approved, 55-gallon steel drums (separately from contaminated soil and groundwater) and disposed of off-site.

Containerized materials will be labeled and staged at a location designated by the NYSDEC. The project consultant will maintain a log of the containers and their contents. The contents will be evaluated upon receipt of analytical results from the field investigations. Containerized IDW will be transported by a licensed waste hauler and disposed of at an approved facility in accordance with applicable regulations.

4.6 Field Documentation

Documentation of an investigative team's field activities often provides the basis for technical site evaluations and other such related written reports. All records and notes generated in the field will be considered controlled evidentiary documents and may be subject to scrutiny in litigation.

Personnel designated as being responsible for documenting field activities must be aware that all notes may provide the basis for preparing responses for legal interrogatories. Field documentation must provide sufficient information and data to enable reconstruction of field activities. Numerically serialized field logbooks provide the basic means for documenting field activities. The following information must be provided on the inside front cover of each field logbook:

- Project Name (Site Name);
- Site Location;
- Site Manager; and
- Date of Issue.

Control and maintenance of field logbooks is the responsibility of the Field Team Leader.

4.6.1 Sample Designation

A sample numbering system will be used to identify each sample. This system will provide a tracking procedure to allow retrieval of information about a particular sample, and will assure that each sample is uniquely numbered. The sample identification will consist of at least three components as described below. Identification numbers for soil boring samples will also have a fourth component.

Project Identification: The first component consists of a two- or three-letter designation, which identifies the project site.

- Sample type: The second component, which identifies the sample type, will consist of a two-letter code as follows:
    - MW - Monitoring Well (Groundwater Sample)
- Sample Location: The third component identifies the sample location using a two-digit number.
- Sample Identification: The fourth component will only be used for soil boring samples to indicate the vertical interval from which the sample was collected.
- Quality Assurance/Quality Control Samples: The samples will be labeled with the following suffixes:
    - FB - Field Blank
    - MS - Matrix Spike
    - MSD - Matrix Spike Duplicate
    - TB - Trip Blank

Duplicate samples will be numbered uniquely as if they were samples. A record of identification for duplicate samples will be maintained.

An example of identification numbers are given below:

- XX-MW-03-MSD: Monitoring well groundwater sample, monitoring well sample location 3, matrix spike duplicate.

4.6.2 Documentation of Field Activities

Field logbook entries must be legibly written and provide an unbiased, concise, detailed picture of all field activities. Use of preformatted data reporting forms must be identifiable and referenced to field notebook entries.

Step-by-step instructions and procedures for documenting field activities are provided below and in following sub-sections. Instruction and procedures relating to the format and technique in which field logbook entries are made are as follows:

- Leave the first two pages blank. They will provide space for a table of contents to be added when the field logbook is complete;
- The first written page for each day identifies the date, time, site name, location, personnel and their responsibilities, other non-personnel and observed weather conditions. Additionally, during the course of site activities, deviations from the SMP must also be documented;
- All photos taken must be traceable to field logbook entries. It is recommended to reference photo locations on the site sketch or map;
- All entries must be made in ink. Waterproof ink is recommended;
- All entries must be accompanied by the appropriate military time (such as 1530 instead of 3:30);
- Errors must be lined through and initialed. No erroneous notes are to be made illegible;
- The person documenting must sign and date each page as it is completed;
- Isolated logbook entries made by a team member other than the team member designated responsible for field documentation, must be signed and dated by the person making the entry; and
- Additions, clarifications, or corrections made after completion of field activities must be dated and signed.

4.6.3 General Site Information

General site characteristics must be recorded. Information may include:

- Type of access into facility (locked gates, etc.);
- Anything that is unexpected on-site (e.g., appearance of drums that have not been previously recorded);
- Information obtained from interview with access or responsible party personnel (if applicable), or other interested party contact on-site;
- Names of any community contacts on-site; and
- A site map or sketch may be provided. It can be sketched into the logbook or attached to the book.

4.6.4 Sample Activities

A chronological record of each sampling activity must be kept that includes:

- Explanation of sampling at the location identified in the sampling plan (e.g., discolored soil, stressed vegetation);
- Exact sample location, using permanent recognizable landmarks and reproducible measurements;
- Sample matrix;
- Sample descriptions, i.e., color, texture, odor (e.g., soil type) and any other important distinguishing features; and
- Decontamination procedures, if used.

As part of chain-of-custody procedures, recorded on-site sampling information must include sample number, date, time, sampling personnel, sample type, designation of sample as a grab or composite, and any preservative used. Sample locations should be referenced by sample number on the site sketch or map. The offer and/or act of providing sample splits to a thirty party (e.g., the responsible party representative; state, county, or municipal, environmental and/or health agency, etc.) must be documented.

4.6.5 Sample Dispatch Information

When sampling is complete, all sample documentation such as chain-of-custody forms shall be copied and copies placed in the project files. A notation of numbers of coolers shipped, carrier and time delivered to pick-up point should be made in a field notebook.

4.7 Sample Handling

The analytical laboratory will provide the sample containers necessary for all groundwater samples. Container closures for all samples will be screw-on type and made of inert materials. Sample containers will be cleaned and prepared by the laboratory prior to being sent to the site. Trip blanks will be used to check for false positives due to laboratory cleaning procedures or cross contamination during sample shipment.

All samples collected will be identified with a sample label. A label will be attached to each bottle and each sample will be identified with a unique sample number.

Immediately following sample collection, each sample container will be marked with the following information:

- Sample Code;
- Project Number;
- Date/Time;
- Sample Type;
- Requested Analysis;
- Preservative, if used; and
- Sampler's Initials.

The sample code will indicate the site location, media sampled, and the sample station.

After all sample identification information has been recorded, each sample label will be covered with waterproof clear plastic tape to preserve its integrity. All samples will be recorded and tracked under strict chain-of-custody protocols. In the field, each sample will be checked for proper labeling. The samples will then be packed into coolers with ice and shipped to the laboratory, if applicable. A chain-of-custody form will be completed for each cooler. The form will be signed and dated by the person who collected the samples, the person the samples were relinquished to for transport to the laboratory, and the laboratory sample controller/custodian who receives the samples.

4.7.1 Chain-of-Custody Record

A chain-of-custody record is a printed form that accompanies a sample or group of samples as custody is transferred from person to person. A sample chain-of-custody form is included in Appendix C. It documents custody transfer from person to person and sample information recorded on bottle labels. A chain-of-custody record is a controlled document.

As soon as practicable after sample collection, preferably after decontamination, the following information must be entered on the chain-of-custody form. All information is to be recorded in black ink:

- Project consultant project number that uniquely identifies the project site;
- Project name. Enter site name;
- Samplers. Sign the name(s) of the sampler(s);
- Station number;
- Date. Enter a six-digit number, indicating the year, month, and day of sample collection (YYMMDD); for example, 051125;
- Time. Enter a four-digit number indicating the military time of collection; for example, 1354;
- Composite or grab. Indicate the type of sample;
- Station location. Describe the location where the sample was collected;
- Number of containers. For each sample number, enter the number of sample bottles that are contained in the shipment; and
- Remarks. Enter any appropriate remarks.

4.7.2 Transferring to Common Carrier

Instructions for transferring custody of samples to a common carrier are as follows:

1. Sign, date, and enter time under "Relinquished by" entry;
2. Enter name of carrier (e.g., UPS, Federal Express) under "Received by";
3. Enter bill-of-lading of Federal Express airbill number under "Remarks";
4. Place the original of the chain-of-custody form in the appropriate sample shipping package. Retain a copy with field records;
5. Sign and date the custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field;
6. Wrap the seal across filament tape that has been wrapped around the package at least twice
7. Fold the custody seal over on itself so that it sticks together; and
8. Complete other carrier-required shipping papers.

Common carriers will usually not accept responsibility for handling chain-of-custody forms; this necessitates packing the record in the sample package.

4.7.3 Transferring Custody Directly to a Courier

To transfer custody of samples from the sampler directly to a carrier, proceed as above, except eliminate the shipper's signature.

5 CALIBRATION PROCEDURES

Instruments must be properly calibrated to produce technically valid data. Documented calibration and calibration check results verify that the instruments used for measurement are in proper working order and the data produced is reliable. The calibration requirements described or referenced in this section are necessary to support the data quality objectives for this project. When calibration requirements are met, the data will support the focused investigation decisions dealing with the nature and extent of contamination and safety concerns.

5.1 Calibration Procedures for Field Equipment

The manufacturer specifications for operation and maintenance procedures for the field equipment to be used during these tasks are provided in Appendix B. General calibration procedures and requirements include the following:

- All instruments will be calibrated at least once a month;
- All instruments will have the calibrations checked at a minimum at the start of each day before measurements are made;
- The calibration and calibration checks will indicate that the sensitivity of the instrument (practical detection limit) is adequate to meet project needs and that the instrument is accurate over the working range; and
- All calibration information will be recorded in the field log book. This includes date and time, technician signature, calibration procedure, calibration results, calibration problems, recalibration and maintenance, and instrument serial numbers.

All calibration standards will be of National Bureau of Standards (NBS) quality and their sources listed and documented so that standards are traceable. In addition, only technicians trained in the use of the field instruments will operate them. If the instrument readings are incorrect at the time of the initial calibration, the instrument will either be calibrated by the technician or returned to the manufacturer for calibration. If the instrument readings are incorrect after a continuing calibration check, the preceding sample results will be reviewed for validity, and reanalyzed if necessary.

5.2 Laboratory Calibration Procedures

All samples analyzed according to the USEPA SW-846 analytical methodologies shall follow the procedures described in the applicable Statement of Work (SOW). The calibration procedures and frequency are specifically described for each analysis contained in the SOW. All calibration results shall be recorded and kept on file, and will be reviewed and evaluated by the data validator as part of analytical data validation procedures.

Instrument calibration will be checked with a reference standard prior to the analysis of any sample. The standards used for calibrations will be traceable to the NBS, and each calibration will be recorded in the laboratory notebook for the particular analysis. Any printouts, chromatograms, etc., generated for the calibration will be kept on file.

6 ANALYTICAL PROCEDURES

All groundwater samples collected for laboratory analysis will be analyzed by a NYSDEC ASP-certified laboratory for various analytes, including VOCs and PCBs, using USEPA SW-846 analytical methodologies accompanied by NYSDEC ASP Category B deliverables. The SMP summarizes the analytical procedures and methods that will be utilized for the site.

The analytical methods listed in each work assignment are sufficient to support the DQOs for each project. In particular, the detection limits of these methods are adequate to support the DQOs. The general SW-846 methods and procedures used for the analysis of VOCs (Method 8260C), and PCBs (Method 8082) are summarized as follows:

- All instruments will have the calibrations checked at a minimum at the start of each day before measurements are made;
- The calibration and calibration checks will indicate that the sensitivity of the instrument (practical detection limit) is adequate to meet project needs and that the instrument is accurate over the working range; and
- All calibration information will be recorded in the laboratory log book. This includes date and time, technician signature, calibration procedure, calibration results, calibration problems, recalibration and maintenance, and instrument serial numbers.

7 DATA REDUCTION, VALIDATION, AND REPORTING

The purpose of this section is to ensure that the large amounts of data produced by the laboratory are presented in a clear and useable format. In addition, data quality and technical validity must be verified prior to data use. The samples collected at the site will be analyzed according to USEPA SW-846 analytical methodologies, in which data reduction and reporting schemes are well developed and clearly defined. The employment of this method ensures comparability with other similarly analyzed environmental samples. Reduction, validation and reporting specifications for these analyses are detailed below.

7.1 Data Reduction

Data reduction is the process by which raw analytical data generated from the analytical instrument systems is converted into useable concentrations. The raw data, which takes the form of area counts or instrument responses, is processed by the laboratory and converted into concentrations expressed in terms of milligrams per kilogram (mg/kg), milligrams per liter (mg/L), micrograms per kilogram (ug/kg), micrograms per liter (ug/L), parts per million (ppm), parts per billion (ppb), or micrograms per cubic meter (ug/m3). These concentrations are the standard method for expressing the level of contamination present in environmental samples.

The process used to convert the instrument output into useable concentrations is clearly defined in the USEPA SW-846 methodologies. The resulting concentrations are comparable to other environmental samples in general and will be comparable to data previously collected for each site.

7.2 Data Validation

Data validation identifies invalid data and qualifies the usability of the remaining data. The output of data validation is qualitative or quantitative statements of data quality. Once the quality of individual measurements is known, a compilation of all data points into a cohesive statement can be made. The confidence associated with a statement incorporates both the confidence in individual measurements as well as in the decision.

Although rigorous validation of the data generated by the laboratory may be performed by a third party data validation subcontractor, the laboratory will be responsible for reviewing data to determine if any analytical problems exist. Specifically, the laboratory will develop a case narrative describing how closely the data meet the DQOs presented in this QAPP.

7.2.1 Data Review

The data review process shall consist of a contractual review that shall include an evaluation of the analysis and specific requirements of the published method in addition to the laboratory SOP. Data qualification shall be performed following the intent of the National Functional Guidelines in conjunction with the data validator’s professional judgment, where applicable, since there are no formal validation guidelines written for this analysis.

Data will be declared invalid whenever documented evidence exists demonstrating that an sample was not collected under representative conditions, such as an air sampling canister leaking to ambient pressure during shipment.

The laboratory will provide a data reporting package. One copy of the ASP Category B data packages will be delivered to a third party data validation subcontractor for data assessment. If required by NYSDEC, the data packages will include the case narrative, sampling analysis, and summary forms.

Data validation will be performed using guidance from the following documents:

- USEPA Region 2 Evaluation of Metals Data for the Contract Laboratory Program (SOP# HW2 Rev. 13);
- USEPA Region 2 Validating Semi-volatile Organic Compounds by SW-846 Method 8270 (SOP# HW22 Rev. 4);
- USEPA Region 2 Validating Volatile Organic Compounds by SW-846 Method 8260B (SOP# HW24 Rev. 2);
- USEPA Region 2 Validating Polychlorinated Biphenyls by SW-846 Method 8082 (SOP# HW23B Rev. 1); and
- USEPA Region 2 Validating Volatile Organic Analysis of Ambient Air in canister by Method TO-15 (SOP# HW31 Rev. 4).

The QA/QC Task Leader will coordinate the validation of the data set based on information from the field team and information supplied from the laboratory on the analysis. The Validator shall review the submitted data package to determine compliance with those portions of this QAPP and site documents that pertain to the production of laboratory data. Compliance is defined by the following criteria:

1. The data package is complete;
2. The data has been produced and reported in a manner consistent with the data requirements of the QAPP and the laboratory subcontract;
3. All protocol required QA/QC criteria have been met;
4. All instrument tune and calibration requirements have been met for the time frame during which the analyses were completed;
5. All protocol required initial and continuing calibration data is present and documented;
6. All data reporting forms are complete for all samples submitted. This will include all sample dilution/concentration factors and all pre-measurement sample cleanup procedures; and
7. All problems encountered during the analytical process have been reported in the case narrative along with any and all actions taken by the laboratory to correct these problems

The data validation task requires that the Data Validator conduct a detailed comparison of the reported data with the raw data submitted as part of the supporting documentation package.

Data are never declared invalid solely because they are unlikely to occur in nature, but may be flagged as suspect and be subjected to further review until the cause for the apparent anomaly is determined. The results from all QA/QC checks are evaluated to determine if the DQOs for each measurement are being met. Evidence of overwhelming measurement bias, external influences on the representativeness of the data, or lack of reproducibility of the measurement data may be cause for the data to be judged invalid.

7.2.2 Data Usability Summary Report (DUSR)

If a DUSR is required by the NYSDEC for future work, the Data Validator shall submit a DUSR covering the results of the data review process. This report shall include the following:

- A general assessment of the data package;
- Detailed descriptions of any and all deviations from the required protocols. (These descriptions must include references to the portions of the protocols involved in the alleged deviations);
- Any and all failures in the Validator's attempt to reconcile the reported data with the raw data from which it was derived. (Again, specific references must be included). Telephone logs should be included in the validation report;
- A detailed assessment by the Validator of the degree to which the data has been comprised by any deviations from protocol, QA/QC breakdowns, lack of analytical control, etc., that occurred during the analytical process;
- The report shall include, as an attachment, a copy of the laboratory's case narrative including the NYSDEC required sample and analysis summary sheets; and
- The report shall include an overall appraisal of the data package.

The validation report shall include a chart presented in a spreadsheet format, consisting of site name, sample numbers, data submitted to laboratory, year of analytical protocol used, matrix, fractions analyzed, e.g., volatiles, semi-volatiles, metals, cyanide, PCBs. Space should be provided for a reference to the NYSDEC ASP when non-compliance is involved and a column for an explanation of such violation.

7.3 Reconciliation with Data Quality Objectives

Calculations and determinations for data precision, accuracy and completeness will be performed in accordance with the procedures presented in Section 7.4 upon the receipt of the validated analytical data. Results will be compared to the project specifications discussed in the work assignment and site documents. If the results do not meet the project specifications, the data will be flagged as questionable and the cause of the failure (i.e., analytical methods, equipment failure, or sampling error) will be evaluated. The Project Manager and Quality Assurance Officer (QAO) will be responsible for decisions regarding use of questionable data. Potential outcomes of this evaluation will include limitations on the use of the data, rejection of the data, and/or re-sampling. Any limitations on the use of the data will be detailed in site reports. Corrective action procedures are discussed further in Section 10.

7.4 Data Reporting

The laboratory will report TCL and TAL data consistent with ASP reporting requirements. The QA reporting will include the following accuracy and precision protocols as performed on the appropriate QA samples.

If any of the data quality measures indicate performance outside the desired objective, the data associated with that result are not considered useless. The burden is on the project team to determine the extent to which a quality issue affects the related data, and ultimately how the issue impacts the fitness for use of the data.

Most often a single isolated incident in which the performance objective is not met does not automatically render the data useless, but rather slightly reduces the confidence that the measurement is reliable, and indicates that increased quality control measures are needed. Any potential limitations of the data set will be identified and communicated. The project team will present all known or potential limitations on the data in the final report.

Data quality is measured by how well the data meet the QA/QC goals for the project. QC elements include precision, accuracy, representativeness, completeness, comparability, and sensitivity:

- Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed conditions. Assessing precision measures the random error component of the data collection process. Precision is determined by measuring the agreement among individual measurements of the same property, under similar conditions. The degree of agreement, expressed as the RPD, is calculated using the formula below.

$$\mathrm{RPD} = \frac{(V_1 - V_2)}{\frac{(V_1 + V_2)}{2}} \times 100$$

where: V1 = value 1

V2 = value 2

Analytical precision is assessed by analyzing MS/MSD pairs and laboratory duplicate samples. Field precision is assessed by measurement of field duplicate samples. The objective for precision is to equal or exceed the precision demonstrated for similar samples and should be with the established control limits for the methods. Precision control limits and QC RPD limits are noted within the laboratory SOP.

- Accuracy is the degree of agreement of a measurement with an accepted reference or true value. Accuracy measures the bias or systematic error of the entire data collection process. Sources of these errors include the sampling process, field and laboratory contamination, sample preservation and handling, sample matrix interferences, sample preparation methods, and calibration and analytical procedures. To determine accuracy, a reference material of known concentration is analyzed or a sample which has been spiked with a known concentration is reanalyzed. Accuracy is expressed as a percent recovery and is calculated using the following formula:

- Completeness is calculated as follows:

$$\%\ \text{Completeness} = 100 \times \frac{V}{n}$$

where: V = number of measurements judged valid

n = total number of measurements

The objective is to generate a sufficient database with which to make informed decisions. To help meet the completeness objective, every effort must be made to avoid sample loss through accidents or inadvertence. The completeness goal for this project is 100%.

- Comparability expresses the confidence with which one data set can be compared to another; and
- Sensitivity is the capability of a method or instrument to discriminate between small differences in analyte concentration.

8 PREVENTATIVE MAINTENANCE

The purpose of the preventative maintenance program is to ensure that the sampling, field testing, and analytical equipment perform properly thereby avoiding erroneous results, and minimizing equipment downtime. The preventative maintenance program also provides for the documentation of all maintenance to be used as evidence of instrument maintenance and for scheduling of future maintenance. This section describes the equipment maintenance program for field instruments and those responsible for implementation of the program at the Site. The specific field equipment maintenance procedures are given in the manufacturer specifications and operating manuals provided in Appendix B. The laboratory preventative maintenance program is the responsibility of the laboratory and only the minimum requirements are mentioned here.

8.1 Responsibilities

Responsibilities of key project personnel are described below:

Personnel	**Responsibilities**
Field Team Leader	• Keeping all maintenance records. • Development and implementation of maintenance program.
Equipment Manager	• Maintaining storage of equipment within the equipment inventory. • Carrying out all maintenance according to schedule. Informing field team members of specific maintenance requirements. • Keeping records of all maintenance performed under his care. Sending out equipment for service/repair. Maintaining adequate supply of spare parts.
Field Personnel	• Maintenance of all equipment located on-site on a regular basis and after each use. Keeping supply of spare parts on-hand.

8.2 Preventative Maintenance Program

The preventative maintenance program consists of three parts, normal upkeep, service and repair, and formal recordkeeping. Normal upkeep consists of daily procedures that include cleaning, lubrication and checking the batteries of the equipment. The following is a partial list of normal upkeep procedures and a partial list of important spare parts:

- Normal upkeep for environmental monitoring equipment performed daily or after each use:
  - Cleaning;
  - Lubrication of moving parts;

  - Check/charge battery;
  - Inspect for damage;
  - Check for operation problems and
  - Inspect all hoses and lines.

- Partial list of important spare parts for environmental monitoring instruments frequently used:

  - Fuses;
  - Mini Rae-UV lamp; and
  - Spare battery.

The normal upkeep is performed daily after each use and includes inspecting for damage, signs of problems, and charging the batteries if necessary. Specific equipment upkeep procedures are described in the manufacturer specifications and operation manuals for each instrument provided in the Generic Field Activities Plan.

Minor service and repair will be performed by the Equipment Manager who is experienced in the service and repair of field instruments. Equipment in need of major or more complex repair and service will be sent to the manufacturer.

All maintenance, servicing and repair of equipment shall be recorded and kept on file. Field personnel shall record maintenance and instrument problems in the field instrument log books. These will ultimately be kept on file by the Field Team Leader. The Equipment Manager shall keep a record of all equipment released to the field and a record of all maintenance and service on file.

8.3 Laboratory Instrument Maintenance

Preventative maintenance procedures will be clearly defined and written for each measurement system. Maintenance activity, preventative or repair, will be documented on standard forms, which are maintained in log books. Written procedures will include maintenance schedules, problem identification procedures, space for describing problems and repair notes, and failure analysis protocols. Service contracts and regularly scheduled in-house maintenance will be included, along with a list of critical spare parts. Laboratory instrument maintenance and calibration and corrective action procedures are incorporated in the laboratory SOPs.

8.4 Rental Equipment

Rental equipment will be obtained only from known, reputable rental suppliers. The equipment will require a pre-receipt to verify accuracy, maintenance and upkeep of the equipment.

9 QUALITY ASSURANCE PROCEDURES

In order to monitor the quality of the analytical data generated for each work assignment, an appropriate number of QC methods will be employed for all field and laboratory measurement systems. The employment of QC methods permits the validation of the analytical methodology utilized and provides a measure of the suitability of the methodology to meet the DQOs prior to the beginning of measurement or analysis. Once the measurement and analysis has begun, the employment of QC methods permits the monitoring of the system output for quality. The QC results presented with the environmental sample data, allows the data to be assessed for quality, and a determination made on how well the data has met the DQOs.

Laboratory generated data is used to accurately identify and quantify hazardous substances, while the field generated data is used in conjunction with the laboratory data for further investigation of contamination at the site. Both laboratory and field internal QC programs include steps to assure the data are reliable for the extent they will be used in the focused investigation. In general, laboratory QC programs are more rigorous than field QC programs.

9.1 Field Quality Control

The intended data uses have been identified and the DQOs established for all field measurement activities in Sections 3 and 5 of this QAPP. Section 3 contains SOPs, which describe the use and calibration of field instruments. QC methods will be used to demonstrate that the instruments are capable of producing reliable data. The QC checks employed for field instruments are as follows:

QC METHOD	PURPOSE	FREQUENCY
Calibration Check Sample	• Documents proper working order of instrument.	Daily
Background Sample	• Measures instrument accuracy and sensitivity.	Daily
Duplicate Sample	• Measures instrument precision.	5%
Trip Blanks	• Measures potential contamination from sample transport, the environment and/or shipping.	Minimum of one per cooler of aqueous volatile samples.

Field Blanks	• Measures potential contamination due to poor sampling device decontamination procedures.	One per every 20 environmental samples per media.

The calibration check samples will be analyzed daily and duplicate samples will be analyzed at a minimum frequency of five percent. The calibration check verifies that the instrument is capable of accurately identifying and quantifying contaminants of concern. The duplicates provide a quantitative measurement of the precision of the instrument. Background samples are similar to blanks and provide information regarding instrument reliability. The information is recorded in field logbooks. The field technician uses the results from these QC methods to monitor the instrument at the time of the analysis. If QC results indicate a problem with the instrument, corrective action will be taken and, if necessary, the samples will be reanalyzed. Because field measurements are generally easy to repeat, measurements should be repeated as necessary so the data are as complete as possible. The QC results are used as an indication of data quality and reliability when the data are being reviewed.

9.2 Laboratory Quality Control

The scope and description of QC samples and QC methods are well detailed in the applicable USEPA SW-846 methodologies for the particular analysis. The methodologies for organic and inorganic analyses describe the type of QC samples and required QC methods, and the required frequency of analysis. QC limits have been established for standards, blanks, duplicates, matrix spikes, and surrogates, and are contained in the methodologies. QC data will be reviewed by the project consultant’s personnel to assess the validity of the data and determine if the DQOs have been met.

10 CORRECTIVE ACTIONS

10.1 Non-conformance Reports

Corrective action will be undertaken when a non-conforming condition is identified. A non-conforming condition occurs when QA objectives for precision, accuracy, completeness, representativeness or comparability are not met, or when procedural practices or other conditions are not acceptable.

A non-conformance report will be prepared by the site QAO, approved by the Project Officer, and issued to the Project Manager and other appropriate parties. The non-conformance report will describe the unacceptable condition and the nature of corrective measures recommended and will include a discussion of specific data involved, the impact to data quality, and ultimate data usability. A schedule for compliance will also be provided.

10.2 Corrective Actions

The non-conformance report will be transmitted to a responsible officer of the ASP laboratory, the NYSDEC, the Project Officer and the Project Manager. The non-conformance report will specify, in writing, the corrective action recommended including measures to prevent a recurrence of the original deficiency. Appropriate documentation of corrective action will also be prepared. The site QAO will monitor implementation of the corrective action, and provide written record as to whether the original problem has been resolved.

10.3 Stop Work Orders

A Stop-Work Order may be issued, upon authorization, by the site QAO, if corrective action does not adequately address a problem or if no resolution can be reached. To issue a Stop-Work Order, written authorization is required from the Project Manager and the NYSDEC Representative. If disagreement occurs among these individuals, it will be brought before successively higher levels of management until the issue is resolved.

10.3.1 Stop Work Order Documentation

The conditions and need for a Stop-Work Order will be documented in sufficient detail to permit evaluation of the deficiency and determination of proper corrective action. Pertinent communications will be attached to the Stop-Work Order and referenced in the appropriate spaces. Such communications include discussions, correspondences, or telephone conversations that pertain to evaluation of the problem and potential solutions, and implementation of the preferred solution.

10.3.2 Resumption of Work

In order for work to resume following a Stop-Work Order, the Project Manager and the NYSDEC Representative must rescind it in writing.

10.4 Course and Action to Prevent Recurrence

The site QAO is responsible for tracking non-conforming conditions, evaluating the effectiveness of corrective measures, and assuring that the necessary steps have been taken to prevent recurrence of the original problem.

10.5 Field Changes

The Project Manager is responsible for all site activities. In this capacity the Project Manager will at times be required to modify site programs in response to changing site conditions. At such times the responsible Field Team Leader will notify the Project Manager of the anticipated change, and obtain the approval of the Project Manager and implement the necessary changes. The Project Manager will notify in writing the site QAO, the Project Officer, and the NYSDEC Representative. A copy of the notification will be attached to the file copy of the affected document. If an unapproved action has been taken during a period of deviation, the action will be evaluated to determine the significance of any departure from established procedures.

11 QUALITY ASSURANCE REPORTS

Field staff will promptly report any difficulties to the Project Manager. The laboratory will provide a written description on any quality assurance, problems to the project consultant with submission of the analytical data packages.

Following any quality assurance audits, the site QAO will submit a Quality Assurance report to the Project Manager describing the performance of the quality assurance program. Problems or issues that arise independent of audits, may be identified to project management at any time.

12 REFERENCES

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USEPA, 1989, Soil Sampling Quality Assurance User’s Guide, Second Edition, EPA 600/8-89/046.

USEPA, 1992, Region II Evaluation of Metals Data for the Contract Laboratory Program, SOP ID: HW-2, Revision 11, 3/90.

USEPA, 1997, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), EPA 402-R-97-016, Revision 1.

USEPA, 1999, Contract Laboratory Statement of Work for Organic Analysis, Multi Media, Multi-Concentration OLMO4.2.

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USEPA, 2000, Guidance for the Data Quality Objectives Process, EPA QA/G-4, August 2000.

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USEPA, 2005, Contract Laboratory Program Statement of Work for Inorganic Analysis Multi-Media, Multi-Concentration ILMO6.X, Draft.

USEPA, 2010, Region II Low Stress (Low-Flow) Purging and Sampling Procedure for Collecting Ground Water Samples from Monitoring Wells, Final.

.

APPENDIX A

Standard Operating Procedure for Low Stress (Low Flow) Groundwater Sampling

GENERALLY ACCEPTABLE PROCEDURE

FOR

LOW STRESS (LOW FLOW) GROUNDWATER SAMPLING

PURPOSE/APPLICATION

This low flow groundwater purging and sampling procedure presents a standard method for collecting groundwater samples that are representative of the formation from which they are being withdrawn. By using low flow rates for purging and sampling to minimize drawdown within the well, three primary benefits gained. First, using a low flow rate during sampling promotes laminar flow, which minimizes the disturbance of sediment at the bottom of a well or fine particles in the well's filter pack. Groundwater samples are therefore less turbid, which reduces sampling time and generally eliminates the need to filter. Second, the amount of groundwater purged from the sampling well is significantly reduced, minimizing investigation derived waste. Third, low flow purging and sampling reduces aeration and therefore helps to preserves the natural chemical characteristics of the groundwater sample. Low flow sampling may be used to collect groundwater samples for analysis of contaminants of concern, as well as geo-chemical and biological parameters.

This guideline is for information purposes and should not take precedence over the requirements of project specific plans. This is especially true for federal project sites, which are governed by regionally directed United States Environmental Protection Agency (USEPA) low flow groundwater sampling protocols.

EQUIPMENT

Low flow groundwater sampling requires traditional groundwater sampling equipment with the addition of the following:

Multi-parameter water quality monitoring system (e.g. Horiba U-22 or equivalent) equipped with a flow through cell.
An adjustable rate, positive displacement, groundwater pump (e.g., centrifugal, submersible, or bladder pumps) constructed of stainless steel or Teflon capable of achieving low flow pumping rates (i.e., 100 to 500 ml/min).
Polyethylene tubing or equivalent.
Flow measurement device (e.g., a graduated container and stop watch).
A water level probe or oil/water interface probe.

PRE-SAMPLING PROCEDURES

The pre-sampling procedures for low flow groundwater sampling and purging are as follows:

1. To minimize the risk of cross-contamination, if possible, begin with the monitoring well that is known or believed to have the lowest contaminant concentrations.

2. Position a sheet of polyethylene over the monitoring well for placement of all sampling equipment.

3. Where applicable, measure the concentration of volatile organic compounds (VOCs) in the well's headspace with a photoionization detector (PID) and record the concentration in the field log book.

4. Measure and record the depth to water and if applicable, the depth to light non-aqueous phase liquid (LNAPL).

SAMPLING PROCEDURES

The procedures for collecting groundwater samples using low flow are as follows:

1. **Pump Installation:** Install the pump by slowly lowering the pump assembly and tubing into the well. The pump should be set to the appropriate depth with the intake being a minimum of two-feet above the bottom of the well to prevent disturbing and re-suspending any sediment at the bottom of the well.

2. **Water Level Measurement:** Measure the depth to groundwater from the top of the well casing using a water level probe. Leave the probe in the well for subsequent water level measurements.

3. **Purging:** Begin purging the well at a rate of 200 to 500 milliliters per minute (ml/min) and measure the water level. If excessive drawdown is observed in the well (i.e. greater that 0.3 feet), reduce the flow rate until the water level stabilizes. When the water level has stabilized, subsequent measurements should be made on five minute intervals. The flow rate, as well as flow rate adjustments should be recorded on a field purge log.

4. **Field Parameter Monitoring:** Field parameters (pH, conductivity, reduction/oxidation potential, DO, and turbidity) should be recorded every five minutes with water level measurements. The well is considered stable and ready to be sampled once the field parameters are stable over three consecutive readings (USEPA Region 2, 1998). The following criteria identify stabilized field parameters:
   - ± 0.1 for pH
   - ± 3.0 percent for conductivity
   - ± 10.0 mv for redox potential
   - ± 10.0 percent for DO and turbidity

   The pump should **not** be removed or shut off between purging and sampling.

5. **Sample Collection:** If necessary, reduce the flow rate to 100 to 250 ml/min to reduce turbulence while filling sample containers during sample collection. Where wells are purged at a flow rate less than 100 ml/min, maintain the same flow rate during sample collection. Disconnect the inflow line from the flow through cell and collect the groundwater sample. All sample containers should be filled directly from the tubing. Allow water to flow from the tubing gently down the inside of the containers to minimize turbulence during sample collection. Groundwater samples should be collected in order of importance, according to the project requirements.

6. **Pump Removal:** Once sampling is complete, slowly remove the pump assembly and tubing from the well. If the tubing is dedicated to the well, disconnect the tubing from the pump, re-insert the tubing into the well, and secure the tubing so it is easily accessible.

7. **Secure Well:** Secure the top of the well casing with a locking cap or expansion plug and close the well. In the case of a stick-up protective well cover, , lock the outer casing.

DECOMTAMINATION

All dedicated or "single use" groundwater sampling equipment should be disposed in accordance with all applicable local and federal regulations. The decontamination procedures for non-dedicated low flow groundwater sampling equipment are as follows:

1. **Pre-rinse:** Operate the pump and flush equipment thoroughly with deionized or distilled water for approximately five minutes.

2. **Wash:** Operate the pump and flush equipment thoroughly with Alconox or other non-phosphate detergent solution for approximately five minutes.

3. **Rinse:** Operate the pump and flush equipment thoroughly with deionized or distilled water for approximately five minutes or until all of the detergent has been removed from the equipment.

FIELD SAMPLING FORM

See attached.

REFERENCES

United States Environmental Protection Agency (USEPA) Region II, 1998, Ground Water Sampling Procedure, Low Stress (low flow) Purging and Sampling, GW Sampling SOP, March 16th.

POTENTIAL PROBLEMS/TROUBLESHOOTING

Insufficient yield, cascading, field parameters failing to stabilize, and aerating the groundwater sample are potential problems when trying to use low flow protocols to collect representative groundwater samples.

Insufficient Yield/Cascading

A low yielding well that cannot sustain a low flow purge rate may eventually go dry. The sampler should take care not to dewater the well below the top of the well screen to prevent cascading of the sand pack. Therefore, pumping a well dry should be avoided in all situations. If a well should go dry, the groundwater sample should be collected as soon as there is sufficient recharge to collect the sample. If the well has not recharged sufficiently within 48 hours, the well should not be sampled.

A low yielding well that consistently demonstrates that it cannot sustain a low flow purge rate of 250 ml/min or less should not be sampled using low flow protocols. Groundwater samples collected from low yielding wells are often representative of the stagnant groundwater within the well and the surrounding sand pack, and not representative of the geologic formation. In addition, these samples are typically very turbid, which can skew the analytical results of groundwater samples being analyzed for organic compounds and metals.

Key Field Parameters Fail to Stabilize

If any key parameters fail to stabilize within four hours of purging, then the following alternatives should be considered:

1. Continue purging until stabilization.
2. Stop purging, do not collect a sample, and document the activity.
3. Stop purging, collect a sample, and document the activity.
4. Stop purging, secure the well, and resume purging the following day.

The key parameter for samples being analyzed for VOCs is dissolved oxygen (DO). The key parameter for all other analytical samples is turbidity. Typically DO and turbidity take the longest to stabilize.

Non-stabilizing turbidity measurements may be avoided by periodically removing sediments that may be trapped in the flow through cell during purging. Trapped sediments may cause artificial fluctuations in turbidity measurements. Additionally, the sampler should visually compare the turbidity of the groundwater in the Cell with the groundwater entering the Cell. If the groundwater entering the Cell is clearer, disconnect the inflow line, drain the turbid groundwater from the Cell, and reconnect the inflow line. Turbidity readings should more accurately reflect true groundwater conditions.

Fluctuations in DO measurements may be caused by air bubbles that form in the flow through cell or sample tubing. Ensure that the inflow tubing is sealed tightly to the flow through cell to prevent the intrusion of air. It may be necessary to drain the flow through cell to remove all air bubbles that may interfere with accurate DO readings.

Aerating the Sample

To prevent inadvertently aerating the groundwater sample, the flow rate should be set so that pump suction and positive groundwater flow through the sample tubing is maintained. The sampler should minimize the length and diameter of the sample tubing. It is recommended that either one-quarter or three-eights-inch inner diameter tubing are used.

Where centrifugal pumps are being used to collect a groundwater sample from a deep well, preventing aeration and sustaining a low flow rate becomes problematic. These issues can be minimized if an impeller is removed from the pump. This allows the pump to run at a lower flow rate and reduces the potential for aerating the groundwater sample. There is also concern that the centrifugal pump will heat the groundwater sample, however, the increases in temperature rarely increases more than two degrees Celsius during sampling.

APPENDIX B

Equipment Manuals

Multi Water Quality Checker
U-50 Series

Instruction Manual

CODE:GZ0000144342C

Preface

This manual describes the operation of the Multi Water Quality Checker, U-50 Series.
Be sure to read this manual before using the product to ensure proper and safe operation of the instrument. Also safely store the manual so it is readily available whenever necessary.

Product specifications and appearance, as well as the contents of this manual are subject to change without notice.

■ Warranty and Responsibility

HORIBA warrants that the Product shall be free from defects in material and workmanship and agrees to repair or replace free of charge, at HORIBA’s option, any malfunctioned or damaged Product attributable to HORIBA’s responsibility for a period of one (1) year from the delivery unless otherwise agreed with a written agreement. In any one of the following cases, none of the warranties set forth herein shall be extended;

- Any malfunction or damage attributable to improper operation
- Any malfunction attributable to repair or modification by any person not authorized by HORIBA
- Any malfunction or damage attributable to the use in an environment not specified in this manual
- Any malfunction or damage attributable to violation of the instructions in this manual or operations in the manner not specified in this manual
- Any malfunction or damage attributable to any cause or causes beyond the reasonable control of HORIBA such as natural disasters
- Any deterioration in appearance attributable to corrosion, rust, and so on
- Replacement of consumables

HORIBA SHALL NOT BE LIABLE FOR ANY DAMAGES RESULTING FROM ANY MALFUNCTIONS OF THE PRODUCT, ANY ERASURE OF DATA, OR ANY OTHER USES OF THE PRODUCT.

■ Trademarks

Generally, company names and brand names are either registered trademarks or trademarks of the respective companies.

April, 2009

Conformable Directive

This equipment conforms to the following directives and standards:

Directives: the EMC Directive 2004/108/EC

Standards: [the EMC Directive]
EN61326-1:2006 Class B, Portable test and measurement equipment

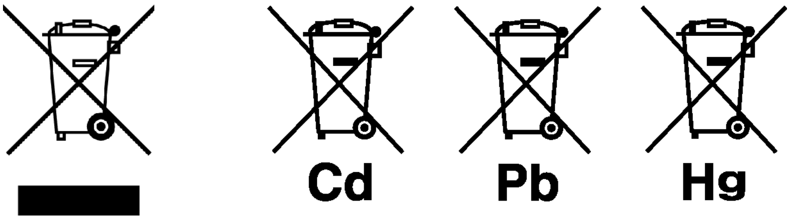
Information on Disposal of Electrical and Electronic Equipment and Disposal of Batteries and Accumulators

The crossed out wheeled bin symbol with underbar shown on the product or accompanying documents indicates the product requires appropriate treatment, collection and recycle for waste electrical and electronic equipment (WEEE) under the Directive 2002/96/EC, and/or waste batteries and accumulators under the Directive 2006/66/EC in the European Union.

The symbol might be put with one of the chemical symbols below. In this case, it satisfies the requirements of the Directive 2006/66/EC for the object chemical.

This product should not be disposed of as unsorted household waste.
Your correct disposal of WEEE, waste batteries and accumulators will contribute to reducing wasteful consumption of natural resources, and protecting human health and the environment from potential negative effects caused by hazardous substance in products.

Contact your supplier for information on applicable disposal methods.



FCC Rules

Any changes or modifications not expressly approved by the party responsible for compliance shall void the user's authority to operate the equipment.

WARNING

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

For your safety

Warning messages are described in the following manner. Read the messages and follow the instructions carefully.

● Meaning of warning messages

⚠ DANGER	This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
⚠ WARNING	This indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. Without safety alert indication of hazardous situation which, if not avoided, could result in property damage.

● Symbols

❗	Description of what should be done, or what should be followed
🛇	Description of what should never be done, or what is prohibited

■ Safety Precautions

This section provides precautions to enable you to use the product safely and correctly and to prevent injury and damage. The terms of DANGER, WARNING, and CAUTION indicate the degree of imminency and hazardous situation. Read the precautions carefully as it contains important safety messages.

⚠	**WARNING**
🚫	Do not disassemble or modify the meter. May cause overheating or fire, resulting in accidents.

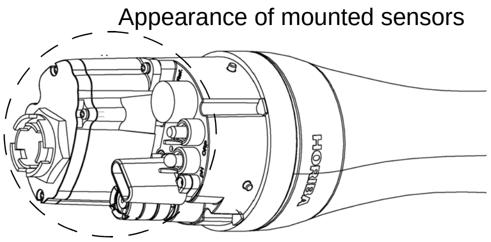
⚠	**CAUTION**
❗	The pH and ORP sensors are made of glass. Handle them carefully to avoid breakage.
❗	Do not ingest the DO, pH or ORP standard solutions. If it comes into contact with the eyes, rinse thoroughly with water. If swallowed, consult a physician.
🚫	Keep away from water when using USB communication. Improper use may result in fire or damage.

Points of concern

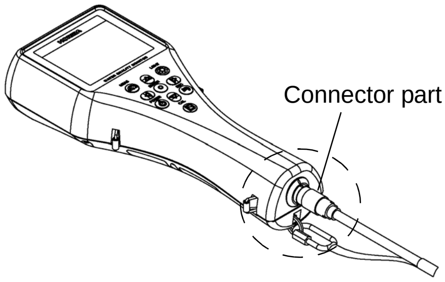
Use of the equipment in a manner not specified by the manufacturer may impair the protection provided by the equipment. It may also reduce equipment performance.

Sensor probe

- Do not immerse the sensor probe in seawater or other samples with high salinity. Doing so may erode metallic parts. After use, promptly wash the sensor probe thoroughly in water.
- Do not immerse the sensor probe in alcohol, organic solvent, strong acid, strong alkaline, and other similar solutions.
- Do not subject to strong shocks.
- Do not perform measurement in environments of magnetic fields. Measurement errors may result.
- The sensor probe is no longer waterproof when the sensors are not mounted.

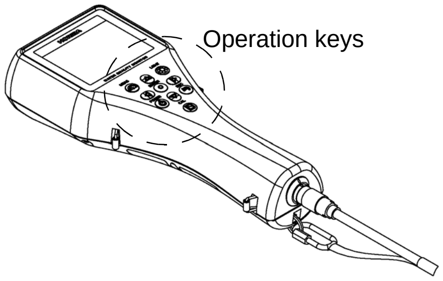


- Does not support measurement of samples containing fluorine.
- To disconnect the sensor cable or interface cable, pull them out with holding the connector part. Do not pull the cable part; it may cause breakage.



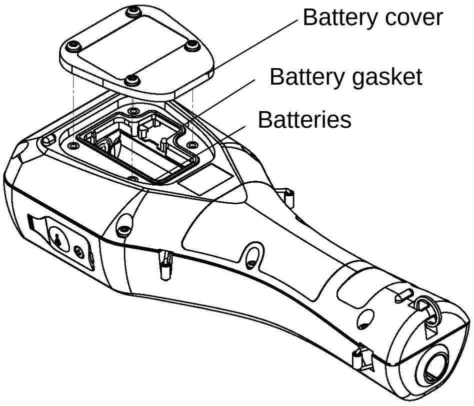
Control unit

- Do not subject to strong shocks.
- The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.



- The control unit is no longer waterproof when the USB cable is connected.
- When operating the control unit only, protect the connector with the connector cap provided.

- Remove the batteries when not using the control unit for an extended period of time. Battery fluid leakage may cause equipment failure.
- Do not wipe the control unit with organic solvents or powder polish. The surface may deteriorate or its printing may disappear. If the display becomes dirty, wipe the dirt off with a soft cloth soaked in neutral detergent.
- Do not turn the power OFF or disconnect the cable during calibration or setting. Memory data may be erased.
- To perform measurement, connect the sensor probe cable before turning the power ON.
- Do not remove the battery gasket or twist it.
- When opening the battery case, make sure that no foreign matter is attached to the battery gasket.
- Do not use any unspecified batteries; it may cause breakage.



Measurement

- Do not pull the cable when lowering the sensor probe into the sample during measurement. Lower the sensor probe into the sample on a chain or string.
- Before lowering the sensor probe into the sample, do not connect the hook on the unit to a human body.
- The correct values are not displayed if the sensor is not mounted when the measurement display is activated.
- Perform DO measurement with no air bubbles in the internal solution.
- Do not reuse a membrane cap of DO sensor.
- Use the spanner for DO sensor provided to attach or remove the DO sensor.
- Avoid both U-53 and U-53G turbidity measurement in air, since the rubber wiper will quickly become damaged.
- Avoid turbidity measurement in direct sunlight, since the readout may be affected.

Calibration

During atmosphere calibration for the DO electrode with DO salinity compensation set to automatic, values are compensated based on electrical conductivity, but calibration is performed normally.

Location of use and storage

- Storage temperature: –10°C to 60°C
- Relative humidity: Under 80% and free from condensation

Store the meter in locations void of dust, strong vibrations, direct sunlight, corrosive gases, near air conditioners or windy areas.

Disposal of the product

When disposing of the product, follow the related laws and/or regulations of your country for disposal of the product.

Description in this manual

Note

This interprets the necessary points for correct operation and notifies the important points for handling the unit.

Reference

This indicates where to refer for information.

Tip

This indicates reference information.

Contents

1 About this Unit

The U-50 Series Multi Water Quality Checker features an integrated control unit and sensors. It is capable of making a maximum of eleven simultaneous measurements for various parameters, and is perfect for use in the field. The U-50 Series is designed with on-site ease-of-use in mind, provides a wide variety of functions, and can be used for water quality measurements and inspections of river water, groundwater, and waste water.

2 Device Information

2.1 Measurement parameters

Parameters	Model				
	U-51	U-52	U-52G	U-53	U-53G
pH (pH)	✓	✓	✓	✓	✓
pH (mV)	✓	✓	✓	✓	✓
Oxidation reduction potential (ORP)	✓	✓	✓	✓	✓
Dissolved oxygen (DO)	✓	✓	✓	✓	✓
Electrical conductivity (COND)	✓	✓	✓	✓	✓
Salinity (SAL) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Total dissolved solids (TDS) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Seawater specific gravity (SG) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Water temperature (TEMP)	✓	✓	✓	✓	✓
Turbidity (TURB) [LED transmission/front 30° scattering method]	–	✓	✓	–	–
Turbidity (TURB) [tungsten lamp 90° transmission/scattering method] with wiper	–	–	–	✓	✓
Water depth (DEP)	–	–	✓	✓	✓
GPS	–	–	✓	–	✓

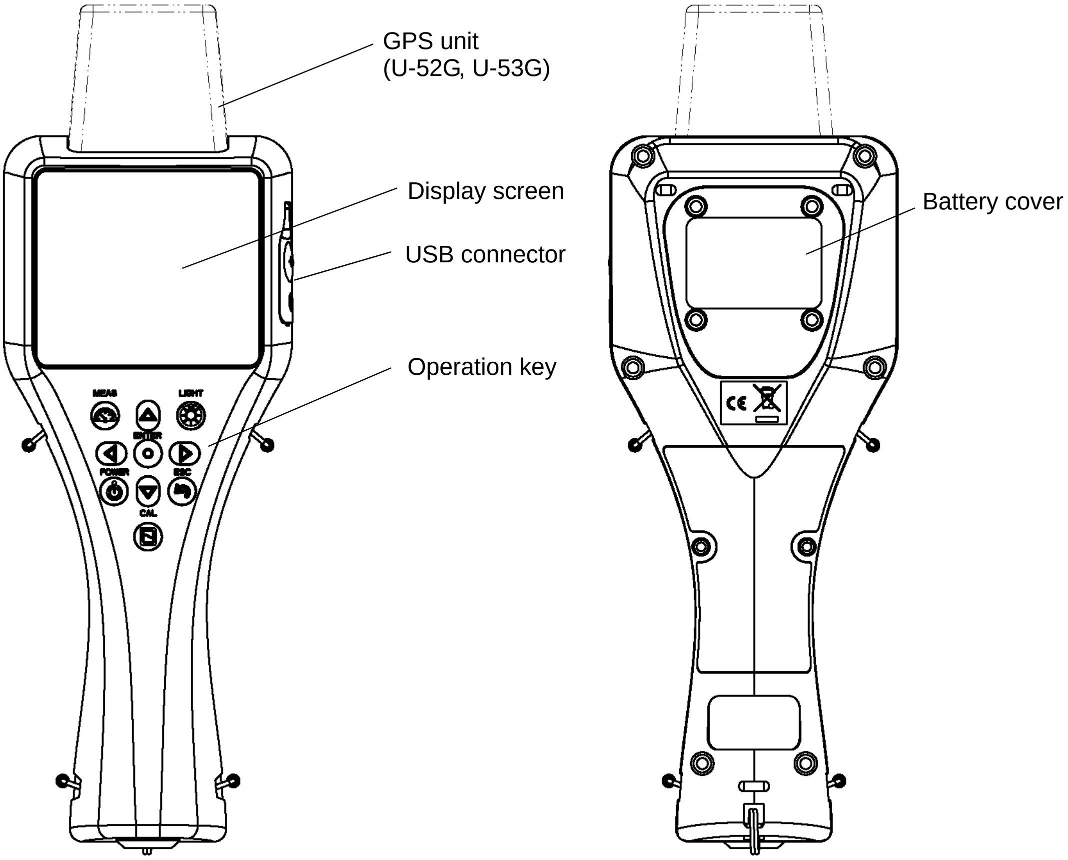
"✓" indicates a measurable parameter.

2.2 Packing list

Parts Name	Quantity	Note
Control unit	1	
Sensor probe	1	
pH sensor (#7112)	1	
ORP sensor (#7313)	1	
Reference electrode (#7210)	1	
DO sensor (#7543)	1	
Turbidity sensor (#7800)	1	With U-52/U-52G only. Attached to the sensor probe.
Turbidity sensor (#7801)	1	With U-53/U-53G only. Attached to the sensor probe.
pH 4 standard solution (#100-4)	1	500 mL
pH reference internal solution (#330)	1	250 mL
DO sensor internal solution set (#306)	1	Internal solution (50 mL), Sandpaper (#8000, #600), Syringe
DO Membrane spare parts set	1	
Spanner for DO sensor	1	
Cleaning brush	1	
calibration cup	1	transparent calibration cup, black calibration cup
Back pack	1	
Strap	1	
Alkaline batteries	4	LR14
Silicon grease	1	
Instruction manual	1	

2.3 Parts name and functions

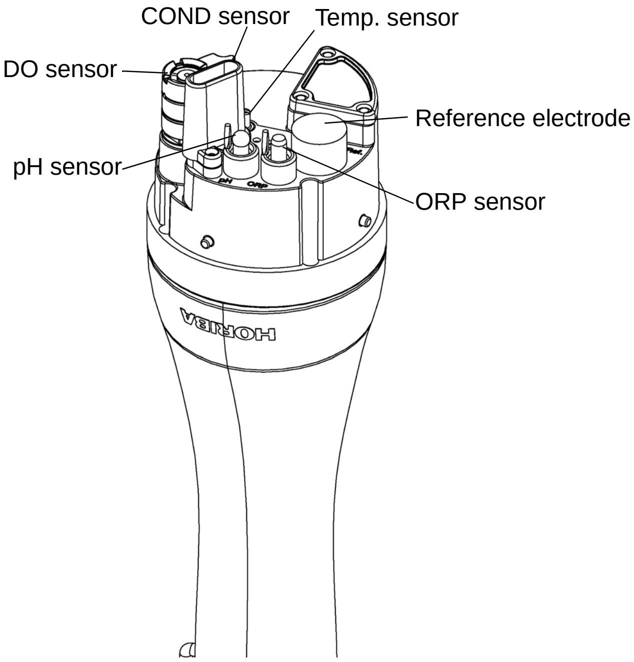
● Display



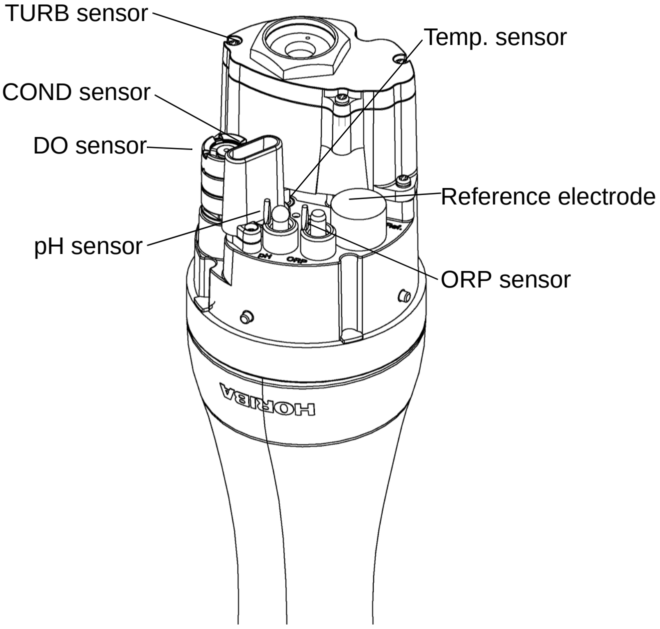
Front view

Back view

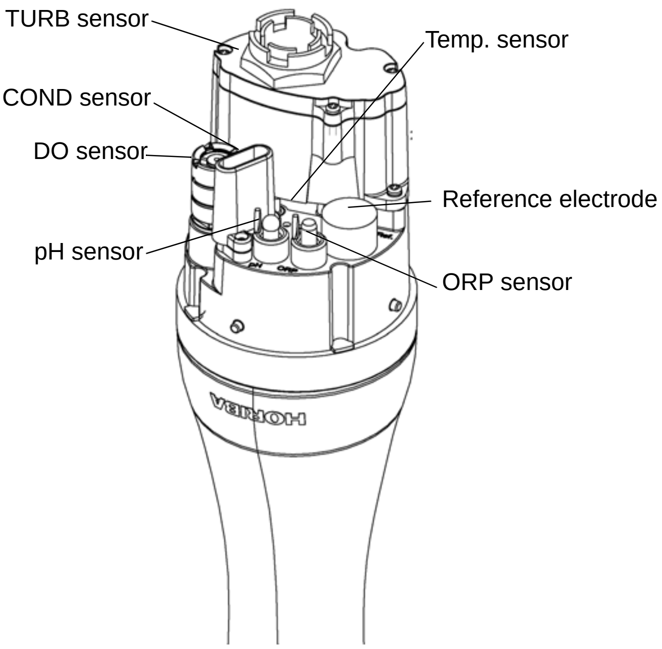
● Sensor probe (U-51)



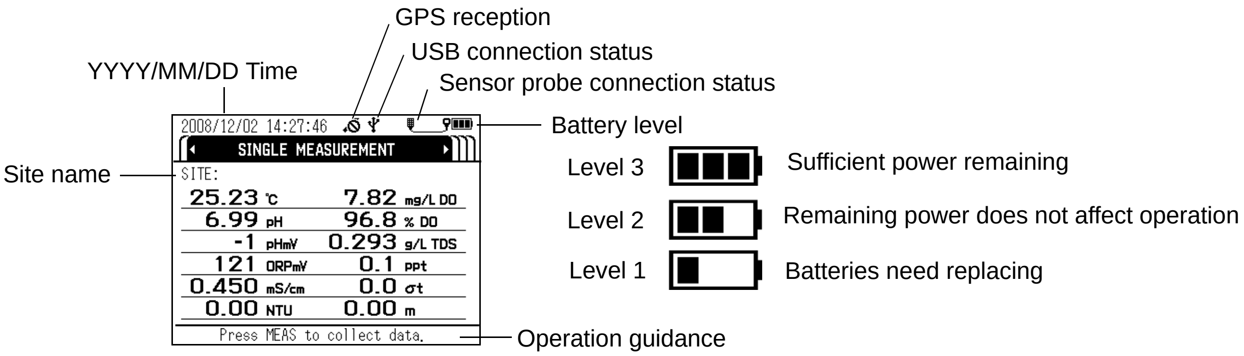
Sensor probe (U-52)



Sensor probe (U-53)



Display screen

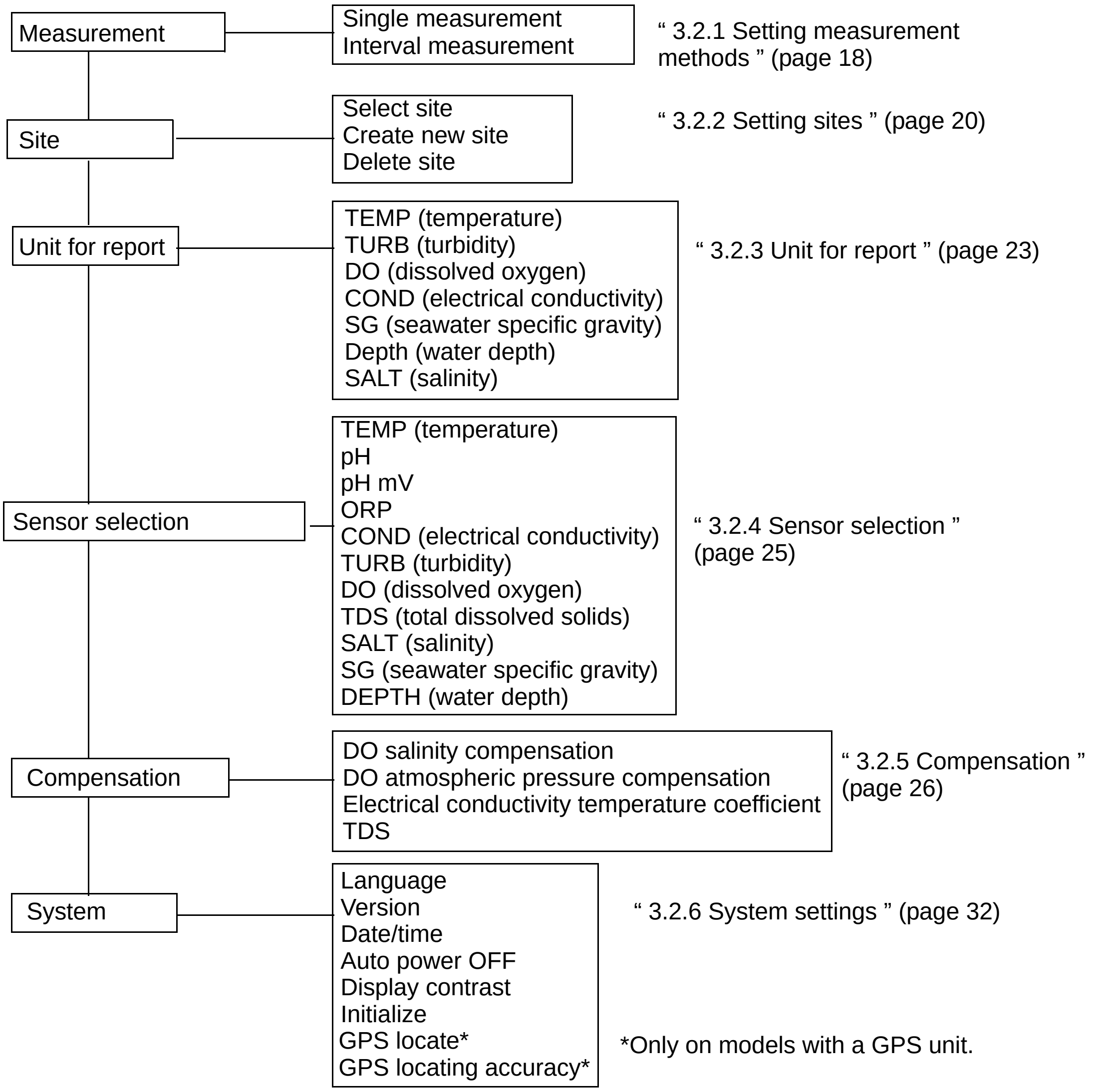


```
2008/12/02 14:27:46
 SINGLE MEASUREMENT
SITE:
25.23 ℃          7.82 mg/L DO
 6.99 pH         96.8 % DO
   -1 pHmV      0.293 g/L TDS
  121 ORPmV       0.1 ppt
0.450 mS/cm       0.0 σt
 0.00 NTU        0.00 m
   Press MEAS to collect data.
```

● Operation key

	Key name	description
POWER	POWER key	Turns the system's power ON/OFF. The initial screen appears immediately after turning the power ON. Press and hold down the POWER key for about 3 seconds to turn the power ON and OFF.
MEAS	MEAS key	When pressed in the measurement screen, used to set the measurement values of all the measurement parameters. Measurement values flash until the data stabilizes.
		When pressed in the setting, calibration or data operation screen, returns to the measurement screen.
ENTER	ENTER key	Used to execute functions, set entered values or store data in memory.
CAL	CAL key	Switches to the calibration screen.
ESC	ESC key	Returns to the immediately preceding operation.
LIGHT	LIGHT key	Turns the backlight ON/OFF. ● Using the backlight shortens battery life. ● The backlight does not light for about 3 seconds after power ON. ● When the sensor probe is connected while the display's backlight is lit, the backlight goes out for about 3 seconds.
◁	Left key	Moves the cursor to the left.
▷	Right key	Moves the cursor to the right.
△	Up key	Moves the cursor up.
▽	Down key	Moves the cursor down.

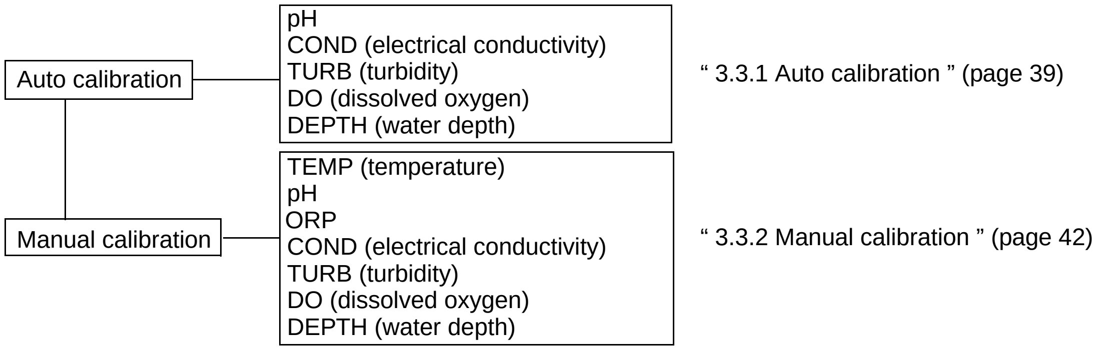
2.4 Setting menu items



- Measurement
  - Single measurement
  - Interval measurement
  - “ 3.2.1 Setting measurement methods ” (page 18)
- Site
  - Select site
  - Create new site
  - Delete site
  - “ 3.2.2 Setting sites ” (page 20)
- Unit for report
  - TEMP (temperature)
  - TURB (turbidity)
  - DO (dissolved oxygen)
  - COND (electrical conductivity)
  - SG (seawater specific gravity)
  - Depth (water depth)
  - SALT (salinity)
  - “ 3.2.3 Unit for report ” (page 23)
- Sensor selection
  - TEMP (temperature)
  - pH
  - pH mV
  - ORP
  - COND (electrical conductivity)
  - TURB (turbidity)
  - DO (dissolved oxygen)
  - TDS (total dissolved solids)
  - SALT (salinity)
  - SG (seawater specific gravity)
  - DEPTH (water depth)
  - “ 3.2.4 Sensor selection ” (page 25)
- Compensation
  - DO salinity compensation
  - DO atmospheric pressure compensation
  - Electrical conductivity temperature coefficient
  - TDS
  - “ 3.2.5 Compensation ” (page 26)
- System
  - Language
  - Version
  - Date/time
  - Auto power OFF
  - Display contrast
  - Initialize
  - GPS locate*
  - GPS locating accuracy*
  - “ 3.2.6 System settings ” (page 32)

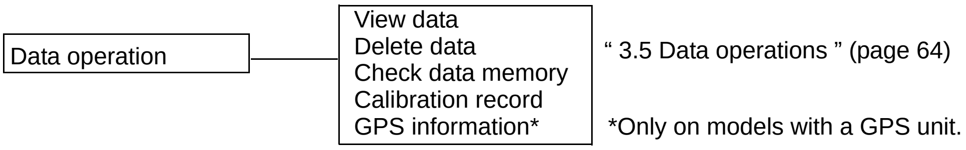
*Only on models with a GPS unit.

2.5 Calibration menu items



- Auto calibration
  - pH
  - COND (electrical conductivity)
  - TURB (turbidity)
  - DO (dissolved oxygen)
  - DEPTH (water depth)
  - “ 3.3.1 Auto calibration ” (page 39)
- Manual calibration
  - TEMP (temperature)
  - pH
  - ORP
  - COND (electrical conductivity)
  - TURB (turbidity)
  - DO (dissolved oxygen)
  - DEPTH (water depth)
  - “ 3.3.2 Manual calibration ” (page 42)

2.6 Data operation menu items



- Data operation
  - View data
  - Delete data
  - Check data memory
  - Calibration record
  - GPS information*
  - “ 3.5 Data operations ” (page 64)

*Only on models with a GPS unit.

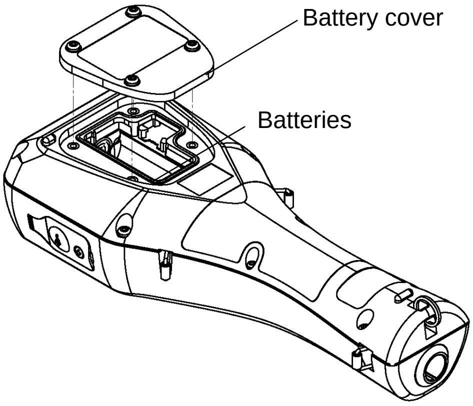
3 Basic Operation

3.1 System setup

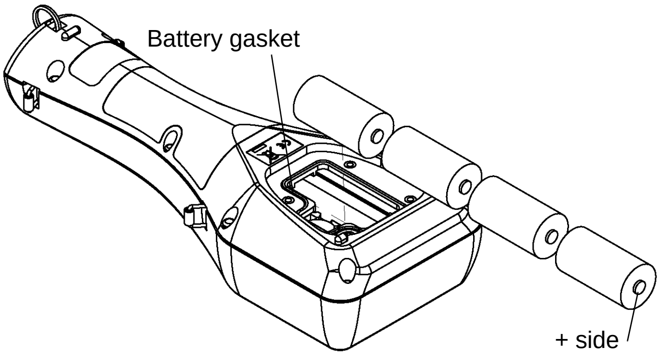
3.1.1 Inserting and replacing the batteries

The control unit is shipped without batteries. Follow the steps below to insert the batteries when using the system for the first time or replacing old batteries.

1. **Loosen the 4 screws on the battery cover by using No. 2 Phillips head screwdriver and remove the cover.**



2. **If replacing the batteries, discard the old batteries.**
3. **Insert new batteries in the control unit.**
   Check that the battery gasket is not dirty or twisted.



4. **Replace the battery cover and fasten it with the 4 screws.**
   Tighten the screws to less than 0.5 N·m.

Note

- **Data and settings will not be lost when the batteries are replaced.**
- **If dirty or twisted, the battery gasket will fail to keep the batteries dry. Check its condition before closing the cover.**
- **To ensure long service life, replacing the battery gasket periodically (once a year) is recommended.**

Precautions when using dry cell batteries

- **Batteries to use: LR14 alkaline dry cell batteries (C-size dry cell batteries) or rechargeable nickel-metal hydride dry cell batteries (C-size)**
  Do not use manganese batteries.
- **Dry cell batteries used incorrectly may leak or burst. Always observe the following**
  - Orient the batteries correctly (positive and negative ends in correct positions).
  - Do not combine new and used batteries, or batteries of different types.
  - Remove the batteries when not using the system for a prolonged period.
  - If batteries leak, have the system inspected at your nearest Horiba service station.

● Battery life

- The battery life for continuous operation when using C-size alkaline dry cell batteries is about 70 hours.
- Using the backlight consumes a proportionate amount of battery power, shortening battery life.
- Searching position information using the GPS unit consumes a proportionate amount of battery power, shortening battery life.
- Nickel-metal hydride secondary batteries can be used, but the battery life is not guaranteed since it will vary according to usage (number of times data is saved, number of charges and amount of each charge). In general, secondary batteries have one-half to one-third the life of C-size alkaline batteries.
- The 70-hour battery life figure applies to a control unit operating temperature of 20°C or more. The battery characteristics shorten the battery life at operating temperatures lower than 20°C, so check the remaining battery level, and replace the batteries before it reaches Level 1.
- The batteries packed with the system at the time of shipment are for checking operation. Their life is not guaranteed.
- The 70-hour battery life figure is the amount of operating time the batteries can provide until the system stops operating. The system may fail during operation if the remaining battery level is low, so it is a good idea to check the remaining battery level and replace the batteries with new ones well before the batteries run out completely.

U-51/52

Battery life: 70 hours (backlight off)

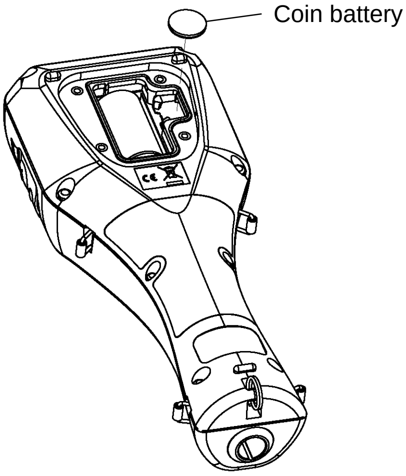
U-53

Battery life: 500 measurements (backlight off)

- Since U-53 is designed for turbidity measurement with wiper, its battery life is estimated in terms of the number of turbidity measurement sequences performed.
- Battery power is also consumed by measurement operations other than turbidity measurement.
- The battery life when turbidity measurement is not performed is about 70 hours.

3.1.2 Replacing the coin battery

- Coin battery to use: CR-2032
- The coin battery is only for the clock. It will provide problem-free operation for three years, but when using the clock continuously, it should be replaced every two years as a precaution.
- When replacing the coin battery for the clock, leave the control unit ON. If the coin battery is replaced when the control unit is turned OFF, the clock will be reset to the default settings.



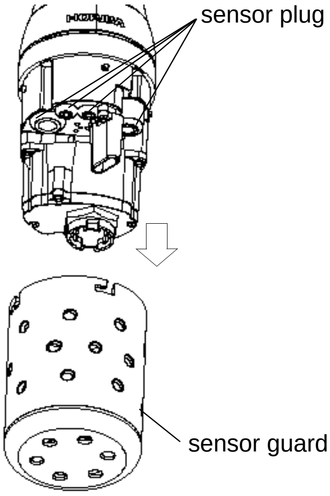
3.1.3 Attaching sensors

Note

- **When attaching or replacing a sensor, wipe any moisture off the sensor probe and sensor.**
- **Be sure to keep water out of sensor connectors. If moisture comes in contact with a sensor connector, blow-dry it with dry air.**
- **The sensor probe is not waterproof when the sensor is not mounted.**
- **Take care not to tighten the sensor too much.**

Attaching the pH sensor

1. **Remove the sensor guard.**

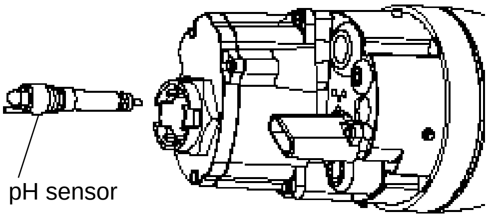


2. **Remove the sensor plug.**
3. **Coat the pH sensor O-ring with a thin layer of silicon grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. **Make sure there is no moisture on the sensor probe’s sensor connector (marked "pH").**
5. **Fasten the pH sensor securely by hand.**



6. **Clean the sensor with an alcohol-soaked cloth.**

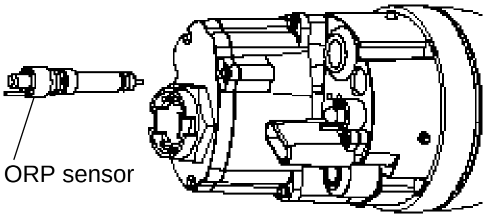
Attaching the ORP sensor

1. **Remove the sensor guard.**
2. **Remove the sensor plug.**
3. **Coat the ORP sensor O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. **Make sure there is no moisture on the sensor probe's sensor connector (marked "ORP").**
5. **Fasten the ORP sensor securely by hand.**



6. **Clean the sensor with an alcohol-soaked cloth.**

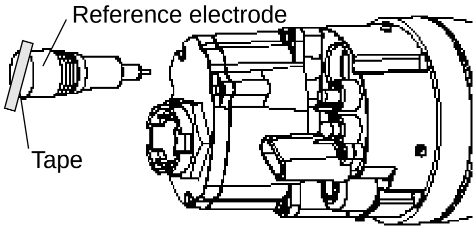
Attaching the reference electrode

1. **Remove the sensor guard.**
2. **Remove the sensor plug.**
3. **Coat the reference electrode O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. **Make sure there is no moisture on the sensor probe's sensor connector (marked "REF").**
5. **Fasten the reference electrode securely by hand.**
6. **Remove the tape from the liquid junction part of the reference electrode.**



● Attaching the dissolved oxygen (DO) sensor

1. **Remove the membrane cap mounted on the DO sensor beforehand, and replace it with the new membrane cap provided. Replace the internal solution with fresh solution. The main component of the internal solution is potassium chloride (KCl), so the old solution can be disposed of down a sink or other drain.**

Reference

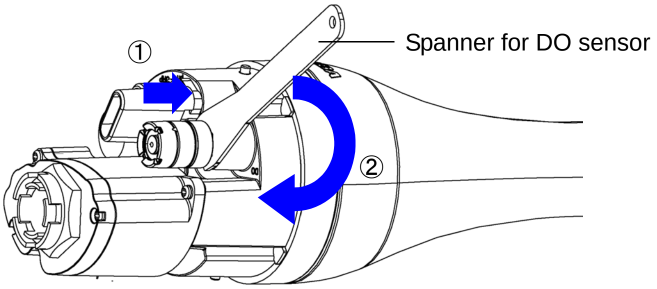
“ 4.5 Replacing the membrane cap ” (page 87)

2. **Screw in the DO sensor to attach it, allowing the internal solution to overflow slightly.**
3. **Use a soft cloth to wipe off the internal solution that overflowed onto the DO sensor.**
4. **Remove the sensor guard.**
5. **Remove the sensor plug.**
6. **Coat the DO sensor O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

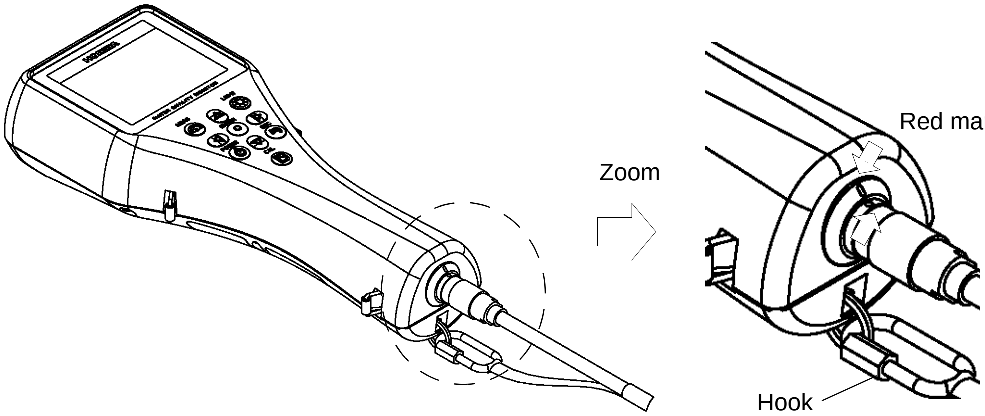
7. **Make sure there is no moisture on the sensor probe’s sensor connector (marked "DO").**
8. **Fasten the DO sensor securely using the spanner for DO sensor.**
   - Hold the DO sensor with the provided spanner for DO sensor and push the sensor down. (Step 1 in figure below)
   - Screw the DO sensor in place. (Step 2 in figure below)



3.1.4 Connecting the control unit and sensor probe

Note

Connect the control unit with its power OFF.



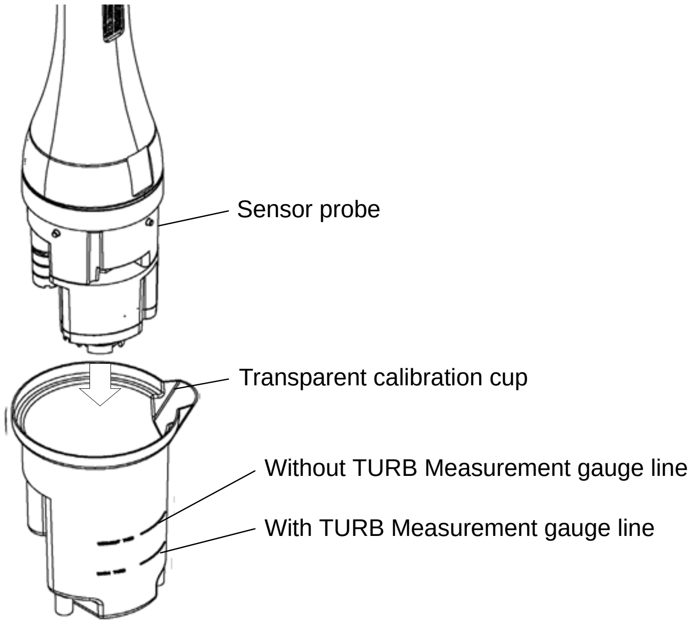
1. **Align the red mark on the connector, and press the connector in until you hear it click.**
2. **Connect the cable’s hook to the display.**

3.1.5 Conditioning

Carry out the steps below when using the unit for the first time or when the system has not been used for 3 months or longer.

1. **Fill the transparent calibration cup to the line with pH 4 standard solution.**

   The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.
2. **Insert the sensor probe in the transparent calibration cup.**



Note

Check that all sensors are attached.

3. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON. Leave the unit for at least 20 minutes to condition the sensors.**

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

Tip

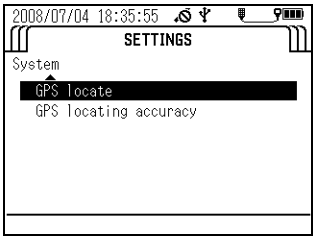
- **The procedure for immersing the sensor probe in the pH standard solution is the same as that described in “ 3.3.1 Auto calibration ” (page 39).**
  Auto calibration can be performed using the same pH 4 standard solution that was used in the conditioning procedure.
- **Immersing the sensor in the standard solution is generally required for sensor conditioning, but a voltage supply is required for DO sensor conditioning. Turning ON the power of the control unit is necessary during sensor conditioning.**

3.1.6 GPS (U-52G, U-53G)

The GPS position measurement precision is proportional to the GPS position measurement time. When the position measurement precision increases, the position measurement time also increases. See " ● GPS locating accuracy" (page 17) for how to set the position measurement precision. See " ● GPS locate" (page 15) below for how to check acquired GPS data.

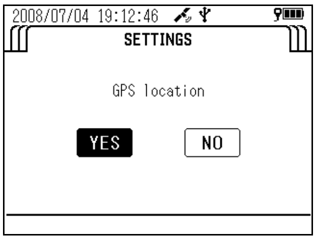
● GPS locate

1. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
2. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**
3. **Press the down (▽) key to move the cursor to "GPS locate", then press the ENTER key.**



4. **The message "Press ENT key to start position measurement." appears. Press the ENTER key.**

5. **The message "Execute GPS position measurement?" appears. Move the cursor to "YES", then press the ENTER key.**

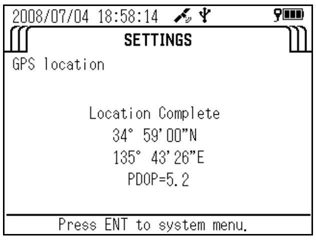


2008/07/04 19:12:46

SETTINGS

GPS location

6. **The message "Warming up. Please wait." appears. Wait until the system has finished warming up (about 10 seconds).**
   - Position measurement starts automatically when warmup has finished. Position measurement is performed up to 10 times.
   - The GPS location complete screen appears after successful position measurement.



2008/07/04 18:58:14

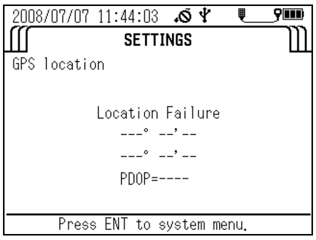
SETTINGS

GPS location

Location Complete
34° 59' 00"N
135° 43' 26"E
PDOP=5.2

Press ENT to system menu.

   - The GPS location failure screen appears after position measurement has failed. Redo the measurement in a location free from obstacles, or wait for the meteorological conditions to improve before redoing the measurement.



2008/07/07 11:44:03

SETTINGS

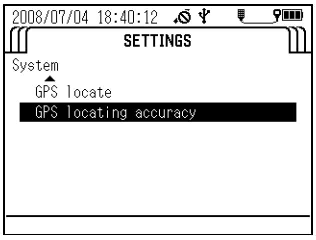
GPS location

Location Failure
---° --'--
---° --'--
PDOP=----

Press ENT to system menu.

● GPS locating accuracy

1. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
2. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**
3. **Press the down (▽) key to move the cursor to "GPS locating accuracy", then press the ENTER key.**



2008/07/04 18:40:12

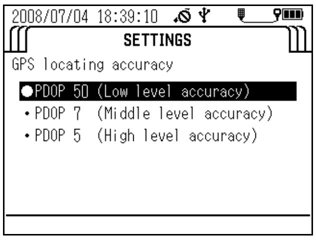
SETTINGS

System

GPS locate

GPS locating accuracy

4. **The screen below appears. Move the cursor to the locating accuracy, then press the ENTER key. The black circle (●) indicates the currently set precision.**



2008/07/04 18:39:10

SETTINGS

GPS locating accuracy

●PDOP 50 (Low level accuracy)
• PDOP 7 (Middle level accuracy)
• PDOP 5 (High level accuracy)

3.2 Settings

3.2.1 Setting measurement methods

This section describes how to set the measurement method.

● Measurement methods

● U-51/U-52

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter.
Interval measurement	Pressing the MEAS key acquires and saves the 5-second average for the selected measurement parameter in the set interval. The measurement interval can be set to any value between 10 seconds and 24 hours.

● U-53

The U-53 turbidity sensor uses a tungsten lamp. The lamp lights for about 10 seconds, and the average measurement value acquired during this interval is displayed.

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter after wiper operation. The 10-second average is acquired when measuring turbidity.
Interval measurement	Pressing the MEAS key acquires and saves the 5-second average for the selected measurement parameter in the set interval. The 10-second average is acquired when measuring turbidity. The measurement interval can be set to any value between 10 seconds (final check of this value required; 30 seconds may be better for U-52) and 24 hour.

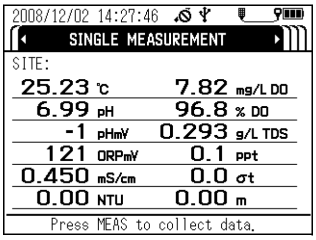
Reference

“ 3.4 Measurement ” (page 61)

● Operation method

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



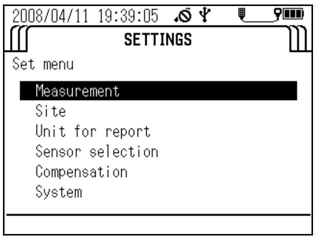
```
2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃          7.82 mg/L DO
 6.99 pH         96.8 % DO
   -1 pHmV      0.293 g/L TDS
  121 ORPmV       0.1 ppt
0.450 mS/cm       0.0 σt
 0.00 NTU        0.00 m
Press MEAS to collect data.
```

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

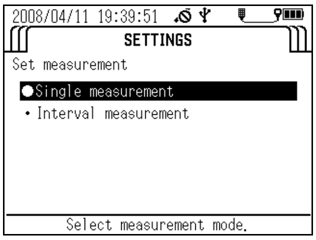
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "Measurement", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to the desired measurement mode. Press the ENTER key to save the setting.**

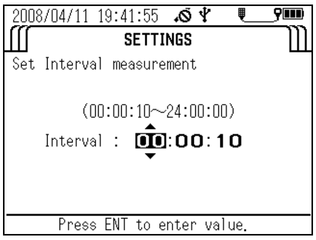
   The black circle (●) indicates the currently selected measurement mode.



Select measurement mode.

5. **If you selected "Interval measurement", the display switches to the screen used to set the measurement interval. Press the up (△) and down (▽) keys to set the measurement interval.**

   The measurement interval can be set to any value between 10 seconds and 24 hours in the case of the U-51 and U-52, or between 30 seconds and 24 hours in the case of the U-53.



Interval : 00:00:10

Press ENT to enter value.

3.2.2 Setting sites

The site function allows position data to be connected to corresponding measurement data. Sites have the following specifications and features:

Site names:	Text data consisting of up to 20 one-byte alphanumeric characters, spaces, etc. Site names can be used for control unit searches and as labels for computer processing. Site names allow measurement data to be saved with a name corresponding to the actual location where it was measured.

You can use site information as a search key when viewing data uploaded by a PC or data saved in the control unit (see “ 3.5 Data operations ” (page 64)).

● Selecting sites

You can select previously created sites. The black circle (●) indicates the name of the currently selected site. No sites are created at new purchasing or after initialization. Select a site after first creating one from the "Create new site" menu.

● Creating new sites

You can create and save new sites. Up to 20 site names can be registered.

● Deleting sites

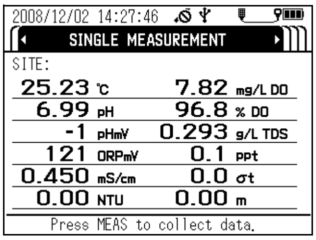
You can select a previously created site and delete it.

● Operation methods

● Selecting a site

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

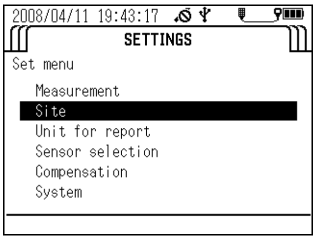


```
2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
 25.23 ℃          7.82 mg/L DO
  6.99 pH         96.8 % DO
    -1 pHmV      0.293 g/L TDS
   121 ORPmV       0.1 ppt
 0.450 mS/cm       0.0 σt
  0.00 NTU        0.00 m
Press MEAS to collect data.
```

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

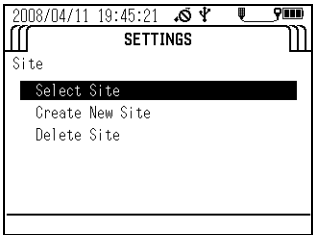
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**



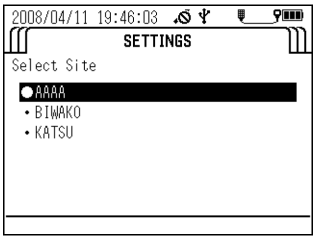
2008/04/11 19:43:17

SETTINGS

4. **Press the down (▽) key to move the cursor to "Select Site", then press the ENTER key to display the names of the currently saved sites.**



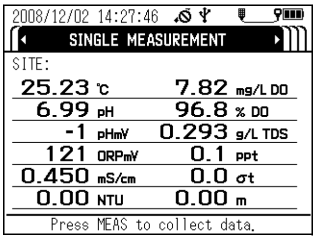
The black circle (●) indicates the currently selected site.



- **Creating a new site**

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

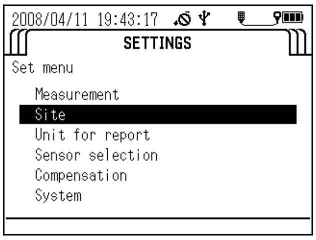


```
SITE:
25.23 ℃        7.82 mg/L DO
 6.99 pH        96.8 % DO
   -1 pHmV     0.293 g/L TDS
  121 ORPmV      0.1 ppt
0.450 mS/cm      0.0 σt
 0.00 NTU       0.00 m
    Press MEAS to collect data.
```

Note

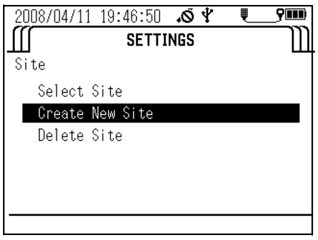
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**

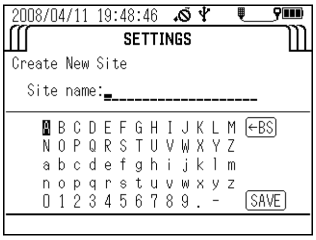


4. **Press the down (▽) key to move the cursor to "Create New Site", then press the ENTER key.**

   Enter the desired site name (up to 20 alphanumeric non-Asian width characters).



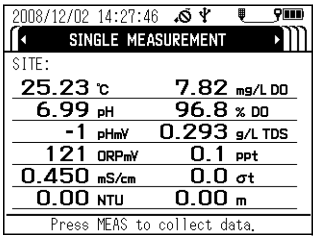
5. **Press the up (△), down (▽), right (▷), and left (◁) keys to move the cursor to each letter or number to use in the name, then press the ENTER key to confirm the entered characters. To delete incorrectly entered characters, move the cursor to "BS" and press the ENTER key to start deleting from the last character. When you have finished entering the name, save it by moving the cursor to "SAVE" and pressing the ENTER key.**



- **Deleting a site**

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

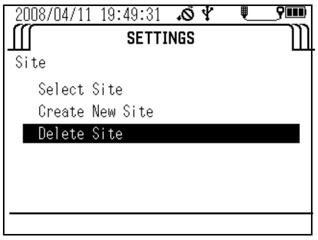


```
 25.23 ℃          7.82 mg/L DO
  6.99 pH         96.8 % DO
    -1 pHmV      0.293 g/L TDS
   121 ORPmV       0.1 ppt
 0.450 mS/cm       0.0 σt
  0.00 NTU        0.00 m
     Press MEAS to collect data.
```

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

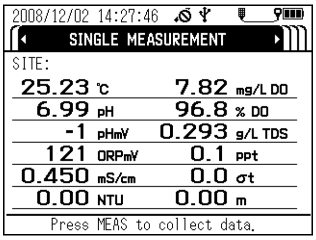
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**



3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**

4. **Press the down (▽) key to move the cursor to "Delete Site", then press the ENTER key.**

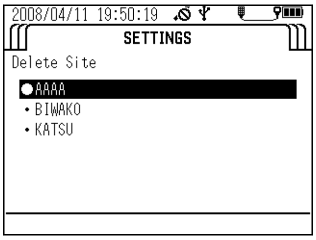
   A list of the currently saved sites appears. The black circle (●) indicates the currently selected site.



```
2008/12/02 14:27:46
◂     SINGLE MEASUREMENT     ▸
SITE:
 25.23 ℃          7.82 mg/L DO
  6.99 pH         96.8 % DO
    -1 pHmV      0.293 g/L TDS
   121 ORPmV       0.1 ppt
 0.450 mS/cm       0.0 σt
  0.00 NTU        0.00 m
   Press MEAS to collect data.
```

5. **Press the down (▽) key to move the cursor to the site to delete, then press the ENTER key to delete it.**

   The currently selected site can be deleted after a different site has been selected from the site selection menu or after all unselected sites have been deleted. The same site name cannot be registered more than once.



```
2008/04/11 19:50:19
           SETTINGS
Delete Site
 ●AAAA
 •BIWAKO
 •KATSU
```

3.2.3 Unit for report

Note

Units can only be selected when the sensor probe is connected.

Follow the steps below to set the measurement units of measurement parameters. No units are displayed if a measurement parameter has not been selected in the measurement parameter selection screen (see “ 3.2.4 Sensor selection ” (page 25)).

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

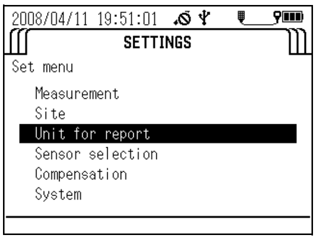
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

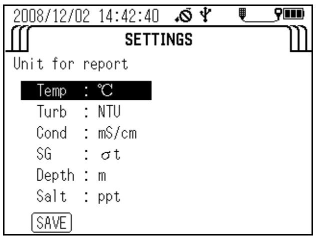
3. **Press the down (▽) key to move the cursor to "Unit for report", then press the ENTER key.**

   A list of the currently selected measurement parameters and their units appears. Note that measurement parameters not selected (in the measurement parameter selection screen) are not displayed.



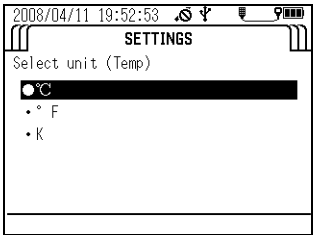
2008/04/11 19:51:01
SETTINGS
Set menu
Measurement
Site
Unit for report
Sensor selection
Compensation
System

4. **Press the up (△) and down (▽) keys to move the cursor to the item to change, then press the ENTER key.**

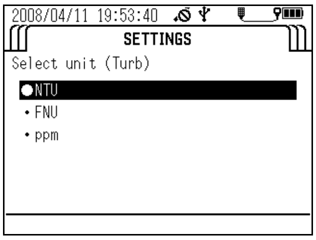


2008/12/02 14:42:40
SETTINGS
Unit for report
Temp : ℃
Turb : NTU
Cond : mS/cm
SG : σt
Depth : m
Salt : ppt
SAVE

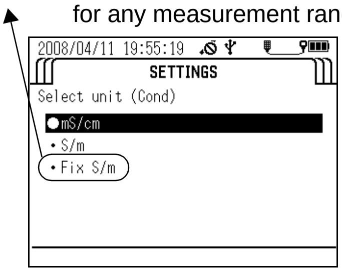
5. **A list of the units that can be selected appears. The black circle (●) indicates the currently selected unit. Press the up (△) and down (▽) keys to move the cursor to the desired unit, then press the ENTER key.**



2008/04/11 19:52:53
SETTINGS
Select unit (Temp)
●℃
• ° F
• K

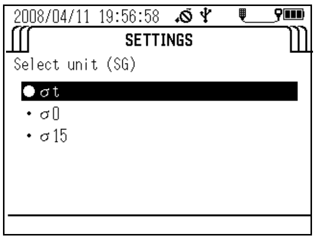


2008/04/11 19:53:40
SETTINGS
Select unit (Turb)
●NTU
• FNU
• ppm

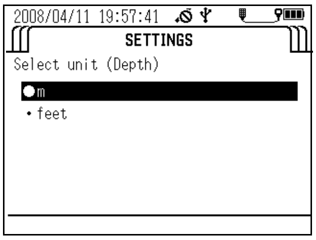


Fix S/m: Fixes S/m with no auxiliary units for any measurement range.

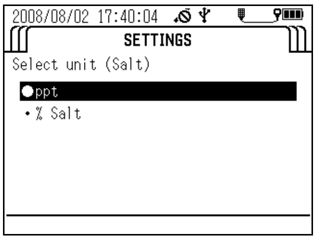
2008/04/11 19:55:19
SETTINGS
Select unit (Cond)
●mS/cm
• S/m
• Fix S/m



2008/04/11 19:56:58
SETTINGS
Select unit (SG)
●σt
• σ0
• σ15

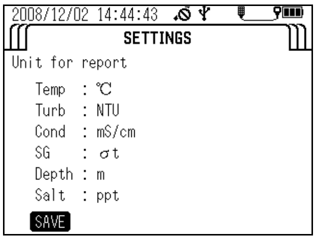


2008/04/11 19:57:41
SETTINGS
Select unit (Depth)
●m
• feet



2008/08/02 17:40:04
SETTINGS
Select unit (Salt)
●ppt
• % Salt

6. **To save the changes, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you do not want to save the changes, press the ESC key.**



2008/12/02 14:44:43
SETTINGS
Unit for report
Temp : ℃
Turb : NTU
Cond : mS/cm
SG : σt
Depth : m
Salt : ppt
SAVE

3.2.4 Sensor selection

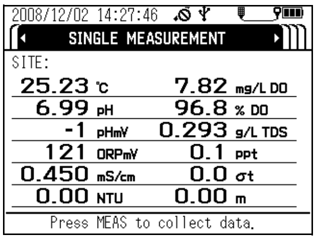
Note

Measurement parameters can only be selected when the sensor probe is connected.

You can set between 1 and 11 measurement parameters to display in the control unit screen. Follow the steps below to select the desired measurement parameters.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

25.23 ℃ 7.82 mg/L DO
6.99 pH 96.8 % DO
-1 pHmV 0.293 g/L TDS
121 ORPmV 0.1 ppt
0.450 mS/cm 0.0 σt
0.00 NTU 0.00 m

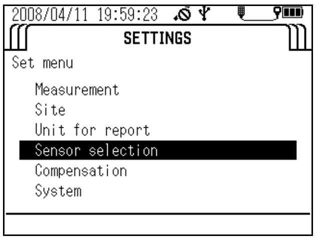
Press MEAS to collect data.

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Sensor selection", then press the ENTER key.**

   A list of the measurement parameters that can be set and the currently set units are displayed.



2008/04/11 19:59:23

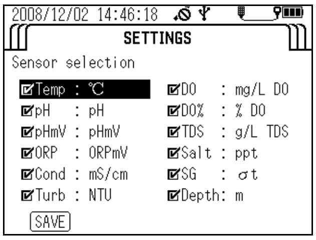
SETTINGS

Set menu

Measurement
Site
Unit for report
Sensor selection
Compensation
System

4. **Move the cursor to each measurement parameter to change, then press the ENTER key.**

   A check in the check box of a measurement parameter indicates it will be displayed.
5. **To save the changes, press the up (△), down (▽), left (◁) and right (▷) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the changes, press the ESC key.**



2008/12/02 14:46:18

SETTINGS

Sensor selection

☑Temp : ℃ ☑DO : mg/L DO
☑pH : pH ☑DO% : % DO
☑pHmV : pHmV ☑TDS : g/L TDS
☑ORP : ORPmV ☑Salt : ppt
☑Cond : mS/cm ☑SG : σt
☑Turb : NTU ☑Depth: m

SAVE

Note

Available measurement parameters differ according to product specifications.

3.2.5 Compensation

Note

Compensation settings can only be made when the sensor probe is connected.

U-50 series have following functions of compensation.

- Salinity compensation and atmospheric pressure compensation for dissolved oxygen (DO)
- Temperature compensation for conductivity (COND)
- Setting total dissolved solid (TDS) coefficient for TDS

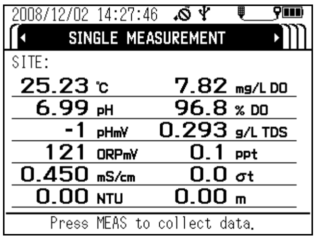
● Salinity compensation (DO)

The dissolved oxygen (DO) value is presented higher than actual value if salinity compensation is not added, because the increase of salinity gives higher DO value. To obtain correct value salinity compensation is needed. The following modes are available for calculation of salinity compensation.

AUTO:	Salinity compensation is performed automatically with salinity converted from conductivity.
Value input:	Press the up (△) and down (▽) keys to enter a setting value when the salinity is known.

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

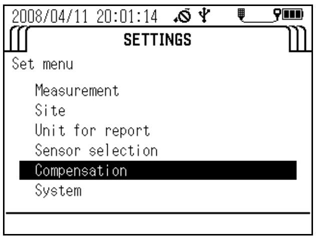


```
2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃          7.82 mg/L DO
 6.99 pH         96.8 % DO
   -1 pHmV      0.293 g/L TDS
  121 ORPmV       0.1 ppt
0.450 mS/cm       0.0 σt
 0.00 NTU        0.00 m
Press MEAS to collect data.
```

Note

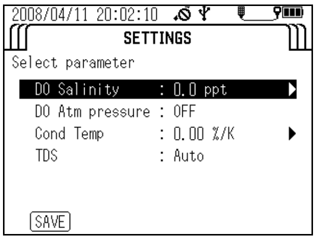
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



```
2008/04/11 20:01:14
SETTINGS
Set menu
   Measurement
   Site
   Unit for report
   Sensor selection
   Compensation
   System
```

4. **Press the down (▽) key to move the cursor to "DO Salinity", then press the ENTER key to toggle the setting between "Auto" and "Input mode".**
   Default: Auto



2008/04/11 20:02:10

SETTINGS

Select parameter

DO Salinity : 0.0 ppt

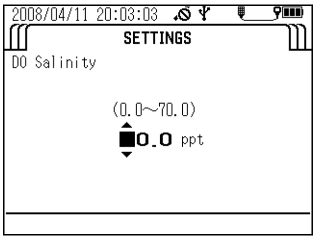
DO Atm pressure : OFF

Cond Temp : 0.00 %/K

TDS : Auto

SAVE

5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



2008/04/11 20:03:03

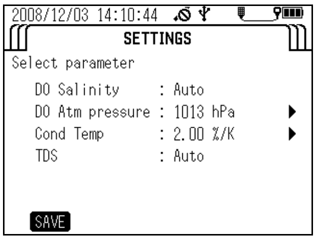
SETTINGS

DO Salinity

(0.0~70.0)

0.0 ppt

6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**



2008/12/03 14:10:44

SETTINGS

Select parameter

DO Salinity : Auto

DO Atm pressure : 1013 hPa

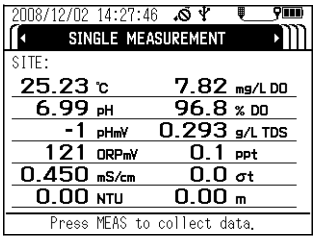
Cond Temp : 2.00 %/K

TDS : Auto

SAVE

- **Atmospheric pressure compensation (DO)**
  Differences in the atmospheric pressure of the measurement location influence the Dissolved Oxygen (DO) measurement. By setting (input) the actual atmospheric pressure of the measurement location into the control unit, it is possible to standardize the measured Dissolved Oxygen (DO) value to a value at the standard atmospheric pressure (1013 hPa).

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

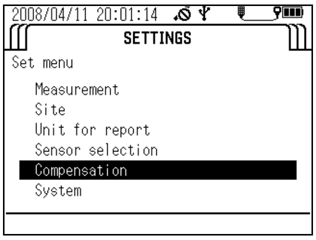
25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

Press MEAS to collect data.

Note

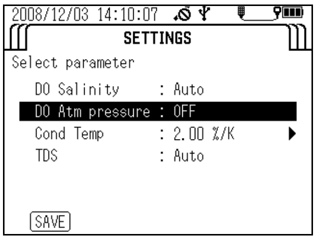
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



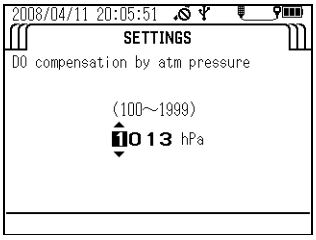
```
2008/04/11 20:01:14
SETTINGS
Set menu
  Measurement
  Site
  Unit for report
  Sensor selection
  Compensation
  System
```

4. **Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".**
   Default: OFF



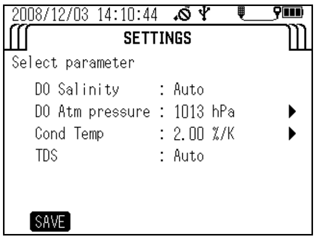
```
2008/12/03 14:10:07
SETTINGS
Select parameter
  DO Salinity     : Auto
  DO Atm pressure : OFF
  Cond Temp       : 2.00 %/K
  TDS             : Auto

 SAVE
```

5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



```
2008/04/11 20:05:51
SETTINGS
DO compensation by atm pressure

            (100~1999)
            1013 hPa
```

6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**



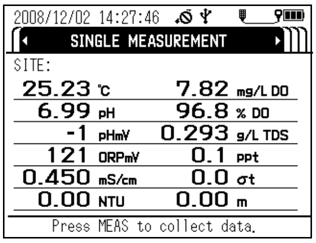
```
2008/12/03 14:10:44
SETTINGS
Select parameter
  DO Salinity     : Auto
  DO Atm pressure : 1013 hPa
  Cond Temp       : 2.00 %/K
  TDS             : Auto

 SAVE
```

● Temperature compensation for conductivity (COND)

Sample conductivity (COND) varies with temperature, and this control unit uses a temperature compensation coefficient to automatically standardize the conductivity (COND) at 25°C. The initial setting coefficient is 2%/K, which is the generally used.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

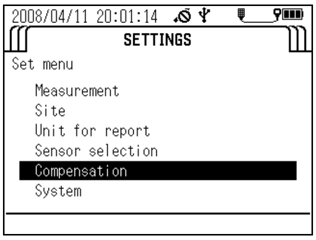
25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

Press MEAS to collect data.

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



2008/04/11 20:01:14

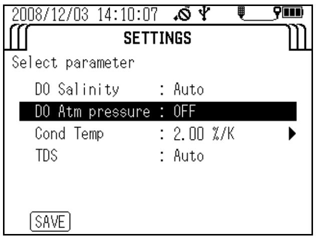
SETTINGS

Set menu

Measurement
Site
Unit for report
Sensor selection
Compensation
System

4. **Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".**

   Default: 2.00%/K



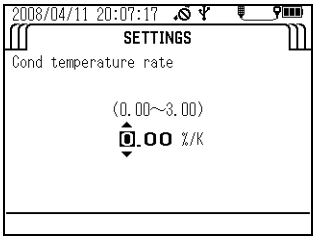
2008/12/03 14:10:07

SETTINGS

Select parameter

DO Salinity : Auto
DO Atm pressure : OFF
Cond Temp : 2.00 %/K
TDS : Auto

5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



2008/04/11 20:07:17

SETTINGS

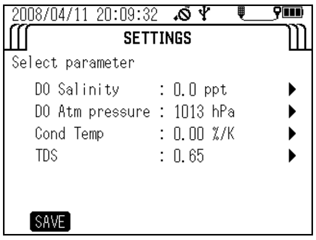
Cond temperature rate

(0.00~3.00)

0.00 %/K

6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key.**

   If you don’t want to save the change, press the ESC key.



2008/04/11 20:09:32

SETTINGS

Select parameter

DO Salinity : 0.0 ppt

DO Atm pressure : 1013 hPa

Cond Temp : 0.00 %/K

TDS : 0.65

SAVE

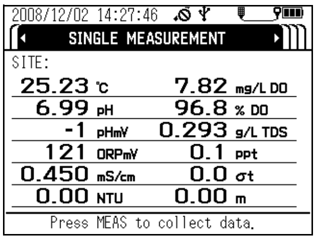
Setting a total dissolved solid (TDS) coefficient

The total dissolved solid amount (TDS) is a converted value obtained by multiplying the conductivity (COND) by a known coefficient. The coefficient initially set for the control unit is based on a conversion for KCl and $CaCO_3$ solutions and it depends on the conductivity (COND) value as shown below.

Conductivity (COND) (S/m)	Conversion coefficient
< 0.05	0.65
0.05 to 0.5	0.64
0.5 to 1	0.63
1 to 3	0.62
3 to 5	0.61
> 5	0.60

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

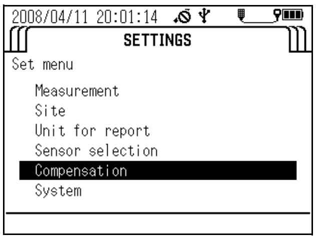
25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

Press MEAS to collect data.

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



2008/04/11 20:01:14

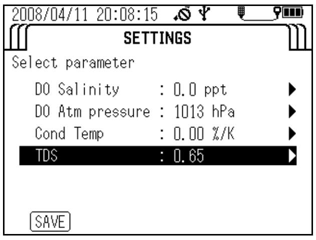
SETTINGS

Set menu

- Measurement
- Site
- Unit for report
- Sensor selection
- Compensation
- System

4. **Press the down (▽) key to move the cursor to "TDS", then press the ENTER key to toggle the setting between "AUTO" and "Input mode".**

   Default: Auto



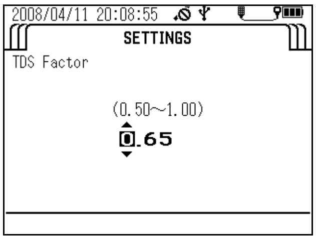
2008/04/11 20:08:15

SETTINGS

Select parameter

DO Salinity : 0.0 ppt
DO Atm pressure : 1013 hPa
Cond Temp : 0.00 %/K
TDS : 0.65

5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



2008/04/11 20:08:55

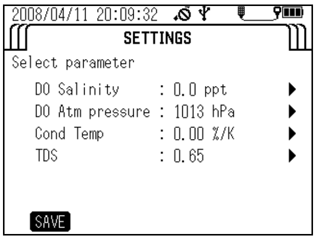
SETTINGS

TDS Factor

(0.50~1.00)

0.65

6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**



2008/04/11 20:09:32

SETTINGS

Select parameter

DO Salinity : 0.0 ppt
DO Atm pressure : 1013 hPa
Cond Temp : 0.00 %/K
TDS : 0.65

3.2.6 System settings

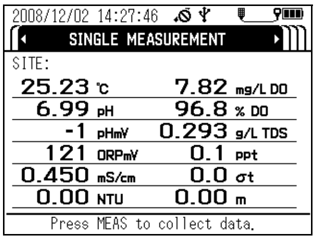
The system settings let you change the display language, check the system software version, set the date/time, set the auto power OFF time, set the display contrast, and initialize the settings.

● Display language

Follow the steps below to select either English or Japanese as the display language.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

25.23 °C 7.82 mg/L DO
6.99 pH 96.8 % DO
-1 pHmV 0.293 g/L TDS
121 ORPmV 0.1 ppt
0.450 mS/cm 0.0 σt
0.00 NTU 0.00 m

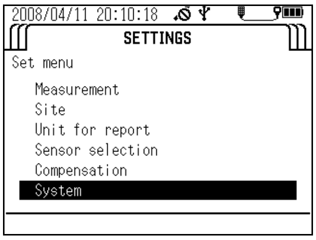
Press MEAS to collect data.

Note

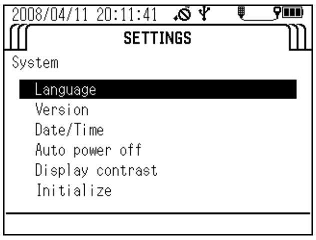
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**

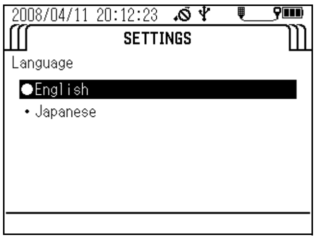


4. **Press the down (▽) key to move the cursor to "Language", then press the ENTER key.**



5. **A list of the supported display languages appears. Press the up (△) and down (▽) keys to move the cursor to the desired language, then press the ENTER key.**

   The black circle (●) indicates the currently selected display language.



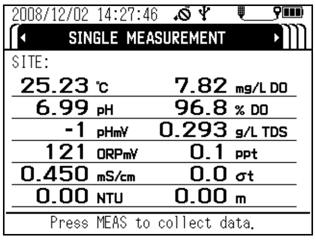
● Version

Follow the steps below to display the program No. and version of the control unit and sensor probe software.

The program No. and version of the sensor probe software will not be displayed if the sensor probe is not connected.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

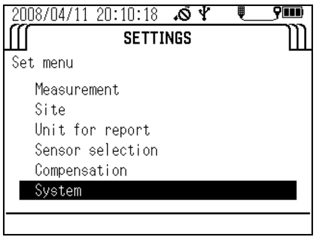


Note

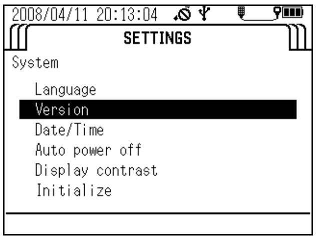
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



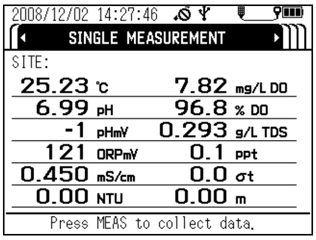
4. **Press the down (▽) key to move the cursor to "Version", then press the ENTER key.**
   The program No. of the control unit and sensor probe software appears.



Setting the date/time

Follow the steps below to set the date and time.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

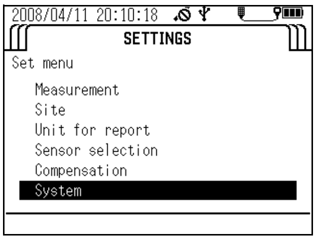


```
SITE:
 25.23 ℃        7.82 mg/L DO
  6.99 pH       96.8 % DO
    -1 pHmV    0.293 g/L TDS
   121 ORPmV     0.1 ppt
 0.450 mS/cm     0.0 σt
  0.00 NTU      0.00 m
   Press MEAS to collect data.
```

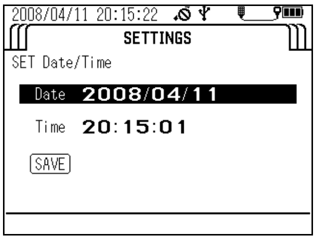
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Date/time", then press the ENTER key.**



2008/04/11 20:15:22

SETTINGS

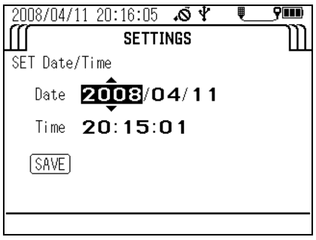
SET Date/Time

Date 2008/04/11

Time 20:15:01

SAVE

5. **Move the cursor to the date, then press the ENTER key.**
6. **Press the right (▷) key to move the cursor to the year, month, day, hour, minute and second, and press the up (△) and down (▽) keys to enter each value.**



2008/04/11 20:16:05

SETTINGS

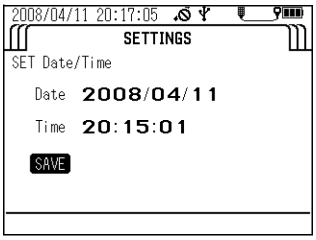
SET Date/Time

Date 2008/04/11

Time 20:15:01

SAVE

7. **When finished entering settings, press the ENTER key to move the cursor to SAVE, then press the ENTER key again to save the settings.**



2008/04/11 20:17:05

SETTINGS

SET Date/Time

Date 2008/04/11

Time 20:15:01

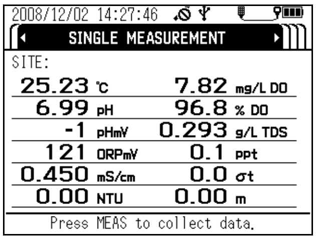
SAVE

- **Setting the auto power OFF time**

  Follow the steps below to set the time for the auto power OFF function (which turns the power OFF automatically when no operation is performed for the preset amount of time).

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

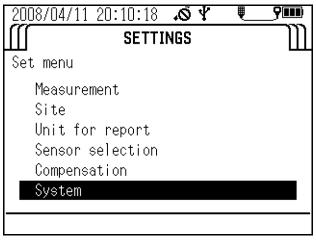
Press MEAS to collect data.

Note

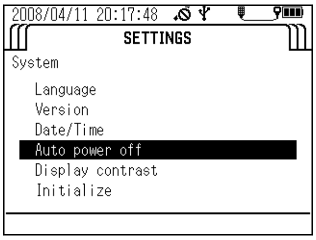
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**

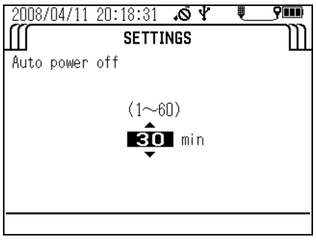


4. **Press the down (▽) key to move the cursor to "Auto power off", then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to select the desired time setting, then press the ENTER key.**

You can select OFF, or settings of 1, 2, 5, 10, 20, 30 or 60 minutes.
Default: 30 minutes

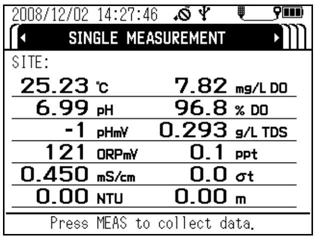


Display contrast

Follow the steps below to adjust the display's contrast.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

The "MEASUREMENT" screen appears after about 10 seconds.



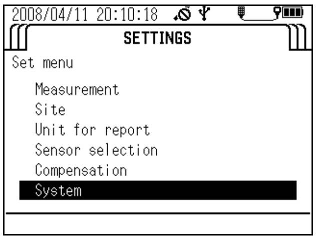
25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

Press MEAS to collect data.

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**

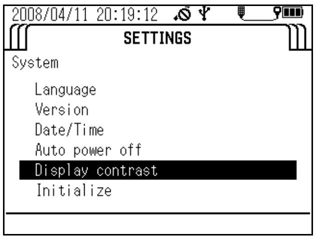


2008/04/11 20:10:18

SETTINGS

Set menu

4. **Press the down (▽) key to move the cursor to "Display contrast", then press the ENTER key.**

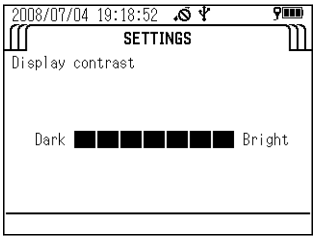


2008/04/11 20:19:12

SETTINGS

System

5. **Press the left (◁) and right (▷) keys to adjust the contrast.**
   Adjustment can be made in 26 steps.



2008/07/04 19:18:52

SETTINGS

Display contrast

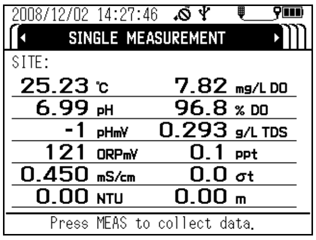
6. **Press the ENTER key.**

● Initialization

Follow the steps below to restore all the settings except date/time to their factory defaults.

Factory default calibration data for the electrical conductivity and turbidity sensors will also be deleted at the same time.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

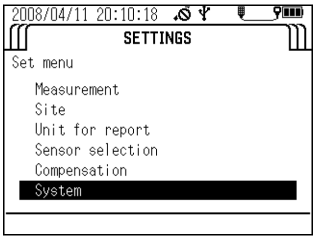
25.23 ℃	7.82 mg/L DO
6.99 pH	96.8 % DO
-1 pHmV	0.293 g/L TDS
121 ORPmV	0.1 ppt
0.450 mS/cm	0.0 σt
0.00 NTU	0.00 m

Press MEAS to collect data.

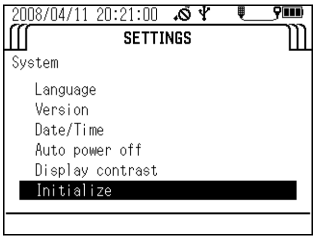
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

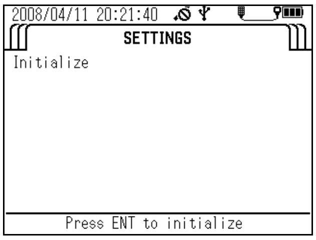
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Initialize", then press the ENTER key.**



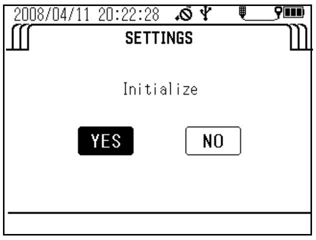
5. **Press the ENTER key again.**



Press ENT to initialize

6. **A confirmation message appears asking whether to execute initialization. Press the left (◁) key to move the cursor to YES, then press the ENTER key.**

   The message "Initialize Complete" appears to indicate the process has finished.



3.3 Calibration

To obtain correct measurement values, the sensors need to be calibrated using standard solution before measurement. You can select simultaneous auto calibration of the pH, COND and TURB sensors in pH4 standard solution and DO and DEP sensors simultaneously in air, or manual calibration of individual measurement parameters. You can check the result of the previous calibration using the procedure on " 3.5.4 Checking the calibration record " (page 70).

Note

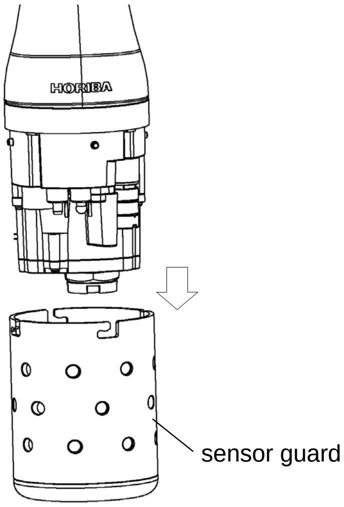
- **Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.**
- **Make the DO and COND compensation settings before calibration since these settings are applied during calibration.**
- **You can select only the desired parameters for calibration and calibrate just those parameters (see " 3.2.4 Sensor selection " (page 25)).**
- **Use about 200 mL of standard solution in the calibration cup.**
- **Calibration data is stored in the sensor probe.**

3.3.1 Auto calibration

Tip

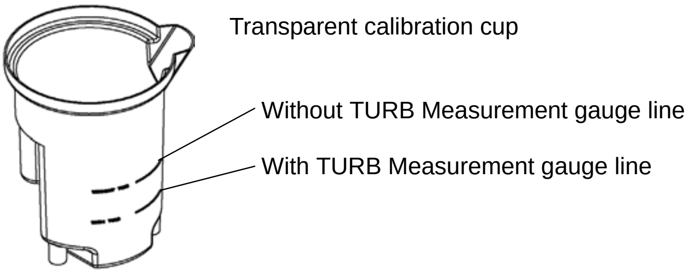
- **The following parameters are calibrated (at 25°C):**
  pH: Set to 4.01 (zero-point calibration); the span is adjusted to the factory default value.
  COND: 0.449 S/m (4.49 mS/cm, span calibration); the zero point is adjusted to the factory default value.
  TURB: 0 NTU (zero-point calibration); the span is adjusted to the factory default value.
  DO: 8.92 mg/L (span calibration); the zero point is adjusted to the factory default value.
  DEP: 0 m (zero-point calibration); the zero point is adjusted to the factory default value.
- **If the air temperature changes, the readout value may not be stable. Ensure that the ambient air temperature is the same temperature as the calibration solution, because the internal probe temperature sensor and external temperature sensor (in the calibration solution) are used for the auto calibration. Allow the probe and standard solution to equilibrate for 1 hour if a thermometer is not available to verify that these temperatures are the same.**
- **Do not hold the probe while performing the auto calibration. Body temperature may elevate the internal temperature sensor measurement creating DO calibration error.**

1. **Remove the sensor guard and wash the sensor probe 2 or 3 times with deionized water.**

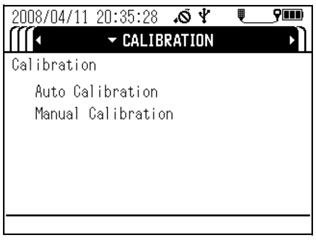


2. **Remove the transparent calibration cup.**
3. **Fill the transparent calibration cup to the line with pH 4 standard solution.**

   The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.



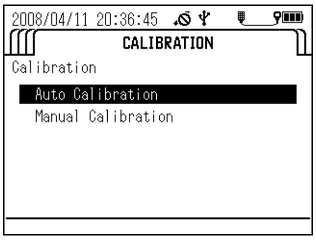
4. **Press the control unit's CAL key to set the calibration mode.**



Calibration

Auto Calibration
Manual Calibration

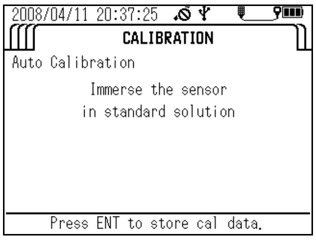
5. **Press the down (▽) key to move the cursor to "Auto Calibration", then press the ENTER key.**



Calibration

Auto Calibration
Manual Calibration

6. **Immerse the sensor probe in the transparent calibration cup.**
   Check that the pH sensor, ORP sensor, reference electrode, COND sensor, TURB sensor and temperature sensor are submerged in the pH 4 standard solution and check that there are no air bubbles on the sensor.



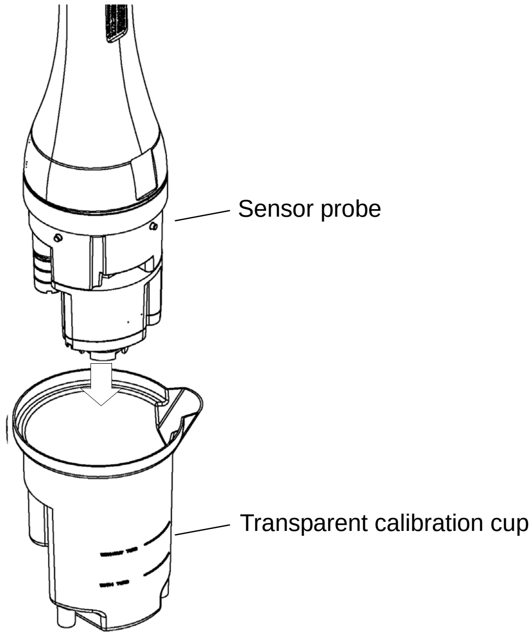
2008/04/11 20:37:25

CALIBRATION

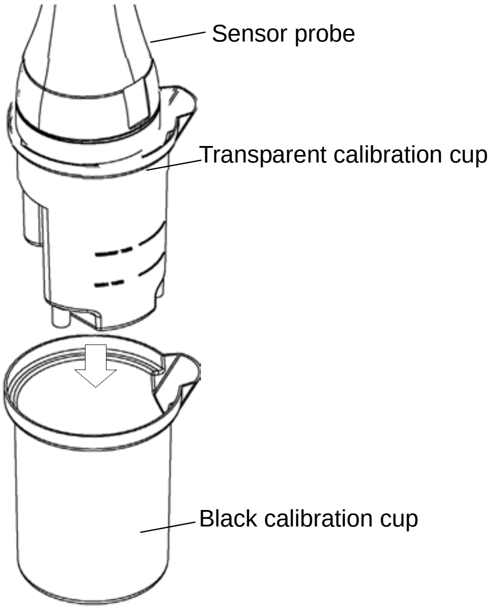
Auto Calibration

Immerse the sensor
in standard solution

Press ENT to store cal data.



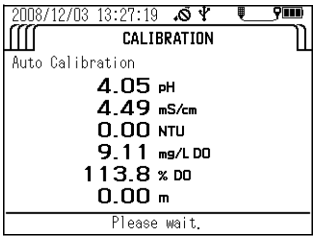
7. **With the sensor probe still in the transparent calibration cup, place the transparent calibration cup into the black calibration cup.**



8. **When all the sensor values have stabilized, press the ENTER key to start calibration.**

Note

Do not remove the sensor probe from the calibration solution. U-53 turbidity data will display “----” until the calibration is completed.


2008/12/03 13:27:19

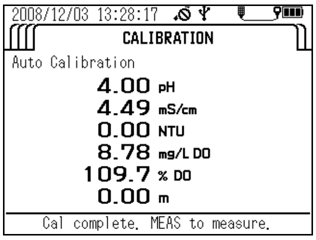
CALIBRATION

Auto Calibration

4.05 pH
4.49 mS/cm
0.00 NTU
9.11 mg/L DO
113.8 % DO
0.00 m

Please wait.

Calibration is finished when the message "Cal complete. MEAS to measure." appears. Press the MEAS key to set the measurement screen, then start measurement.


2008/12/03 13:28:17

CALIBRATION

Auto Calibration

4.00 pH
4.49 mS/cm
0.00 NTU
8.78 mg/L DO
109.7 % DO
0.00 m

Cal complete. MEAS to measure.

If a calibration error occurs, start calibration after first resolving the issue according to the instructions in “ 4.6 Troubleshooting ” (page 89).

3.3.2 Manual calibration

The procedures below describe how to calibrate each sensor individually.

Note

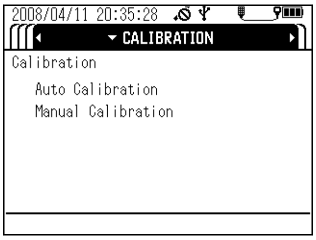
The displayed units are the units set by selecting "Unit for report" in the "SETTINGS" screen.

● Temperature (TEMP) calibration

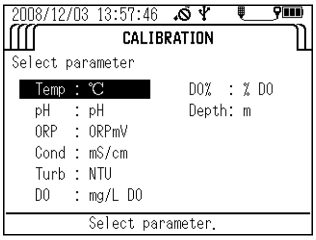
1. **Fill a bucket or similar container with water of a known temperature, and insert the sensor probe in it.**

   Wait 5 minutes before starting calibration to allow the sensor probe temperature to stabilize.

2. **Press the control unit’s CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to “Manual Calibration”, then press the ENTER key.**


2008/04/11 20:35:28

4. **In the parameter selection screen, move the cursor to “Temp”, then press the ENTER key.**



2008/12/03 13:57:46

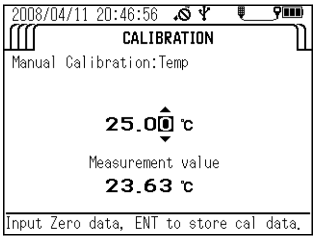
CALIBRATION

Select parameter

Temp : ℃
pH : pH
ORP : ORPmV
Cond : mS/cm
Turb : NTU
DO : mg/L DO
DO% : % DO
Depth: m

Select parameter.

5. **Press the up (△) and down (▽) keys to set the calibration value - the temperature of the water containing the submerged sensor probe.**



2008/04/11 20:46:56

CALIBRATION

Manual Calibration:Temp

25.00 ℃

Measurement value
23.63 ℃

Input Zero data, ENT to store cal data.

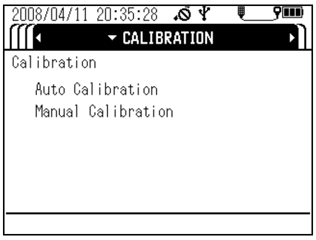
6. **Check that “Measurement value” has stabilized, then press the ENTER key to start calibration.**
   Calibration is finished when the message “Cal complete. CNT to measure.” appears.

● pH calibration

Note

You can select one calibration point (zero-point calibration) or two calibration points (zero-point calibration and span calibration). Carry out two calibration procedures to ensure good measurement precision throughout all measurement ranges.

1. **Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 7 standard solution.**
2. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
3. **Press the control unit’s CAL key to set the calibration mode.**



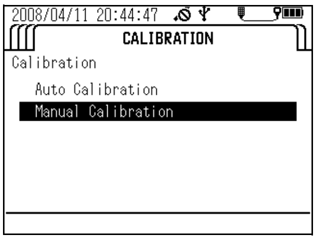
2008/04/11 20:35:28

CALIBRATION

Calibration

Auto Calibration
Manual Calibration

4. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



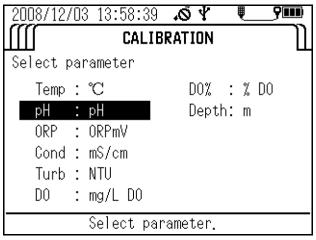
2008/04/11 20:44:47

CALIBRATION

Calibration

Auto Calibration
Manual Calibration

5. **In the parameter selection screen, move the cursor to "pH", then press the ENTER key.**



2008/12/03 13:58:39

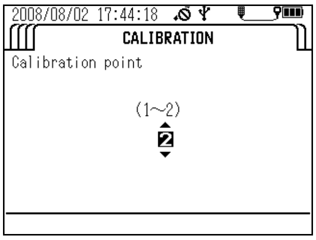
CALIBRATION

Select parameter

Temp : ℃
pH : pH
ORP : ORPmV
Cond : mS/cm
Turb : NTU
DO : mg/L DO
DO% : % DO
Depth: m

Select parameter.

6. **Set the number of calibration points, then press the ENTER key.**



2008/08/02 17:44:18

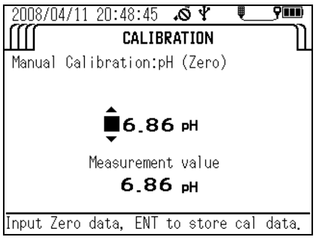
CALIBRATION

Calibration point

(1~2)

2

7. **Press the up (△) and down (▽) keys to set the pH value of the pH 7 standard solution containing the submerged sensor probe at the measurement temperature**



2008/04/11 20:48:45

CALIBRATION

Manual Calibration:pH (Zero)

6.86 pH

Measurement value

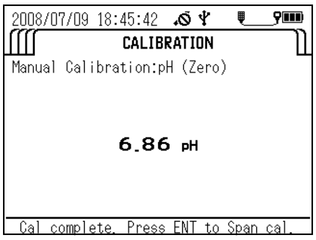
6.86 pH

Input Zero data, ENT to store cal data.

Temp. (°C)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

9. **Press the ENTER key to start the span calibration procedure when the message "Cal complete. Press ENT to Span cal." appears.**



2008/07/09 18:45:42

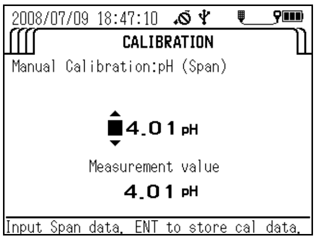
CALIBRATION

Manual Calibration:pH (Zero)

6.86 pH

Cal complete. Press ENT to Span cal.

10. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 4 or pH 9 standard solution.**
11. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
12. **Press the up (△) and down (▽) keys to set the pH value of the pH 4 or pH 9 standard solution containing the submerged sensor probe at the measurement temperature.**



2008/07/09 18:47:10

CALIBRATION

Manual Calibration:pH (Span)

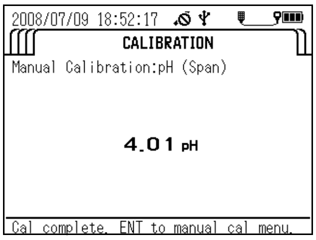
4.01 pH

Measurement value

4.01 pH

Input Span data. ENT to store cal data.

13. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
14. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter**



2008/07/09 18:52:17

CALIBRATION

Manual Calibration:pH (Span)

4.01 pH

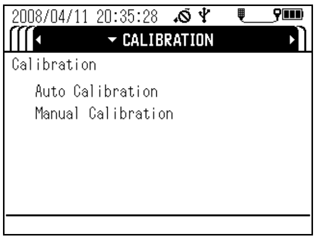
Cal complete. ENT to manual cal menu.

ORP calibration

Note

- **If the prepared ORP standard solution is left in open air for one hour or more, the solution may be transformed. For this reason ORP standard solution cannot be stored.**
  Calibrate within one hour of preparing the solution.
- **When measuring sample with low concentrations of oxidants and reductants after conducting an operational check using a standard substance, the measured values may not stabilize or the results of measurement might not be repeatable. If this is the case, start the measurement after immersing the sensors in the sample water sufficiently.**
- **Note that when measuring the ORP of solution with extremely low concentrations of oxidants and reductants, such as tap water, well water, or water treated with purifying equipment, there may be less responsiveness, repeatability, and stability, in general.**
- **When alkaline ion water is left for 5 minutes, its ORP undergoes changes significantly. Always measure alkaline ion water promptly.**

1. **Fill a clean beaker with one bag of ORP standard powder No. 160-22 or No. 160-51. Add 250 mL of deionized water and agitate the solution thoroughly (there will be some excess quinhydrone (a black powder) that floats on the surface when agitating the solution). Fill the transparent calibration cup to the reference line with this standard solution.**
2. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
3. **Press the control unit's CAL key to set the calibration mode.**
4. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



2008/04/11 20:35:28

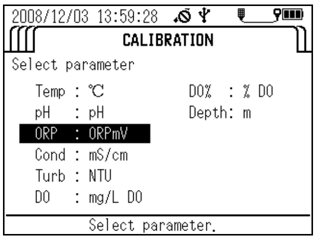
CALIBRATION

Calibration

Auto Calibration

Manual Calibration

5. **In the parameter selection screen, move the cursor to ORP, then press the ENTER key.**



2008/12/03 13:59:28

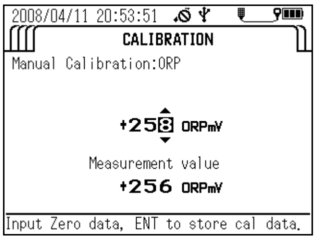
CALIBRATION

Select parameter

Temp : ℃
pH : pH
ORP : ORPmV
Cond : mS/cm
Turb : NTU
DO : mg/L DO
DO% : % DO
Depth: m

Select parameter.

6. **Press the up (△) and down (▽) keys to set the mV value of the ORP standard solution containing the submerged sensor probe at the measurement temperature.**



2008/04/11 20:53:51

CALIBRATION

Manual Calibration:ORP

+258 ORPmV

Measurement value

+256 ORPmV

Input Zero data, ENT to store cal data.

Table 1 Indicated value of ORP standard solution at various temperatures (mV)

Temperature	160-22	16051
5	+274	+112
10	+271	+107
15	+267	+101
20	+263	+95
25	+258	+89
30	+254	+83
35	+249	+76
40	+244	+69

7. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
8. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**

Conductivity (COND) calibration

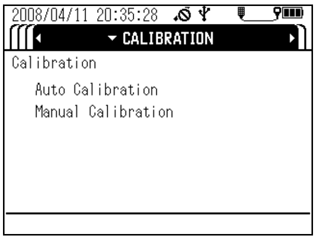
Note

- **To support a wide range of sample concentrations, electrical conductivity is divided into three measurement ranges: 0.0 mS/m to 99.9 mS/m, 0.090 S/m to 0.999 S/m, and 0.9 S/m to 9.99 S/m.**
- **When manually calibrating conductivity, you can select two calibration points (one zero-point calibration point and a span calibration point for one of the three measurement ranges) or four calibration points (one zero-point calibration point and span calibration points for all three measurement ranges). Carry out the four calibration points to ensure good measurement precision throughout all measurement ranges.**
- **Make the compensation setting before calibration since this setting is applied during calibration. (Refer to “ 6.5.3 Temperature coefficient ” (page 104)).**

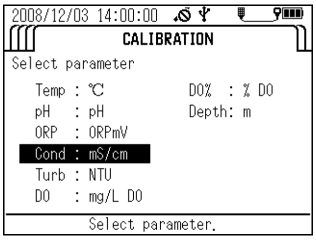
1. **Prepare the standard solution. Dry Potassium chloride (KCl) powder (high-grade commercially available) at 105°C for two hours, and leave it to cool in a desiccator.**
2. **Consult the following table and weigh potassium chloride (KCl), then prepare three standard potassium chloride (KCl) solutions following the procedure below.**

Potassium chloride (KCl) standard solution	Conductivity (COND) value	Potassium chloride (KCl) mass (g) at solution temperature of 25 °C	Calibration range
0.005 mol/L	71.8 mS/m (0.718 mS/cm)	0.373	0.0 mS/m to 99.9 mS/m (0.00 mS/cm to 0.999 mS/cm)
0.050 mol/L	0.667 S/m (6.67 mS/cm)	3.73	0.090 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)
0.500 mol/L	5.87 S/m (58.7 mS/cm)	37.2	0.9 S/m to 9.99 S/m (10.0 mS/cm to 99.9 mS/cm)

3. **Dissolve the weighed Potassium Chloride (KCl) in deionized water.**
4. **Put the dissolved Potassium Chloride (KCl) into a 1 L measuring flask, and fill to the 1 L mark with deionized water.**
5. **Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).**
6. **Press the control unit’s CAL key to set the calibration mode.**
7. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



8. **In the parameter selection screen, move the cursor to “Cond”, then press the ENTER key.**



2008/12/03 14:00:00

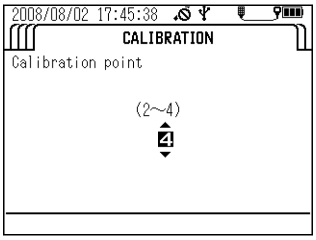
CALIBRATION

Select parameter

Temp : ℃
pH : pH
ORP : ORPmV
Cond : mS/cm
Turb : NTU
DO : mg/L DO
DO% : % DO
Depth: m

Select parameter.

9. **Set the number of calibration points, then press the ENTER key.**



2008/08/02 17:45:38

CALIBRATION

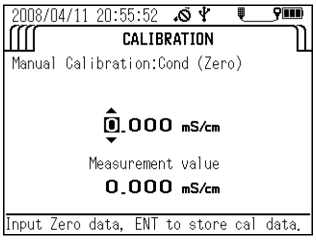
Calibration point

(2~4)

4

The instructions below assume that four calibration points have been set.

10. **Press the up (△) and down (▽) keys to set the "Cond" value to 0.0 mS/m (0.000 mS/cm).**
11. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



2008/04/11 20:55:52

CALIBRATION

Manual Calibration:Cond (Zero)

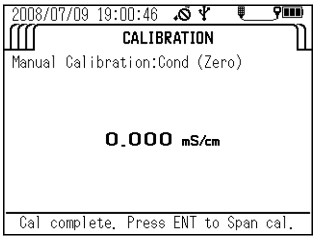
0.000 mS/cm

Measurement value

0.000 mS/cm

Input Zero data, ENT to store cal data.

12. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.**



2008/07/09 19:00:46

CALIBRATION

Manual Calibration:Cond (Zero)

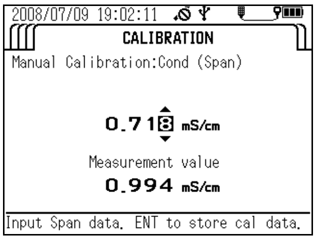
0.000 mS/cm

Cal complete. Press ENT to Span cal.

13. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 71.8 mS/m (0.718 mS/cm) standard solution.**
14. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

15. **Press the up (△) and down (▽) keys to set the "Cond" value to 71.8 mS/m (0.718 mS/cm).**

Calibration range = 0 mS/m to 99.9 mS/m (0 mS/cm to 0.999 mS/cm)



2008/07/09 19:02:11

CALIBRATION

Manual Calibration:Cond (Span)

0.718 mS/cm

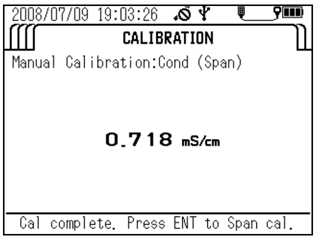
Measurement value

0.994 mS/cm

Input Span data. ENT to store cal data.

16. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

17. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



2008/07/09 19:03:26

CALIBRATION

Manual Calibration:Cond (Span)

0.718 mS/cm

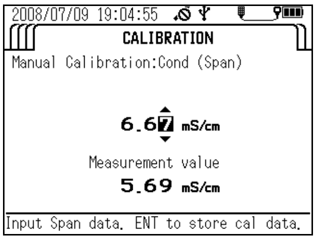
Cal complete. Press ENT to Span cal.

18. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 0.667 S/m (6.67 mS/cm) standard solution.**

19. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

20. **Press the up (△) and down (▽) keys to set the "Cond" value to 0.667 S/m (6.67 mS/cm).**

Calibration range = 0.100 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)



2008/07/09 19:04:55

CALIBRATION

Manual Calibration:Cond (Span)

6.67 mS/cm

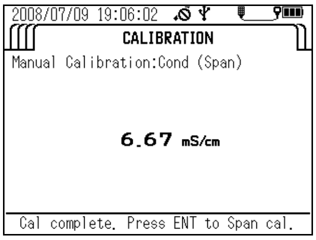
Measurement value

5.69 mS/cm

Input Span data. ENT to store cal data.

21. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

22. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



2008/07/09 19:06:02

CALIBRATION

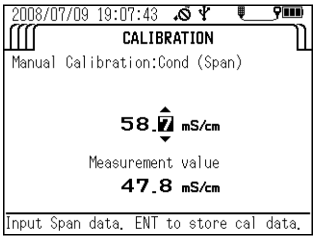
Manual Calibration:Cond (Span)

6.67 mS/cm

Cal complete. Press ENT to Span cal.

23. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 5.87 S/m (58.7 mS/cm) standard solution.**
24. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
25. **Press the up (△) and down (▽) keys to set the "Cond" value to 5.87 S/m (58.7 mS/cm).**

    Calibration range = 1.00 S/m to 10.00 S/m(10.0 mS/cm to 100.0 mS/cm)



2008/07/09 19:07:43

CALIBRATION

Manual Calibration:Cond (Span)

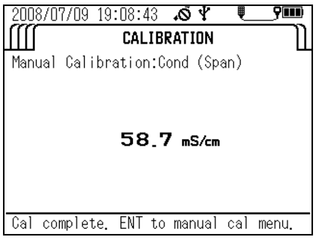
58.7 mS/cm

Measurement value

47.8 mS/cm

Input Span data. ENT to store cal data.

26. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
27. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



2008/07/09 19:08:43

CALIBRATION

Manual Calibration:Cond (Span)

58.7 mS/cm

Cal complete. ENT to manual cal menu.

Turbidity (TURB) calibration

Note

- **To support a wide range of sample concentrations, turbidity is divided into three measurement ranges: 0.0 to 9.9 NTU, 10 to 100 NTU, and over 100 NTU.**
- **When manually calibrating turbidity, you can select two calibration procedures (one zero-point calibration procedure and a span calibration procedure for one of the three measurement ranges), three calibration procedures (one zero-point calibration procedure and a span calibration procedure for two of the three measurement ranges) or four calibration procedures (one zero-point calibration procedure and span calibration procedures for all three measurement ranges). Carry out the four calibration procedures to ensure good measurement precision throughout all measurement ranges.**
- **Always use the calibration cup provided. Using other containers can create effects from ambient light that cause incorrect calibration.**

Preparing the standard solutions

1. **Weigh out 5.0 g of hydrazine sulfate (commercial special grade or above), and dissolve it in 400 mL of deionized water. Dissolve 50 g of hexamethylene tetramine (commercial special grade or above) in 400 mL of deionized water in anther flask.**
2. **Mix the two solutions and add deionized water until the total solution volume is 1000 mL, and mix well. Store this solution at a temperature of 25°C ±3°C for 48 hours.**
   The turbidity value (TURB) of this solution is equivalent to 4000 NTU.
3. **Dilute 4000 NTU-solution 5 times (use a pipette to measure 50 mL of the 4000 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 800 NTU.
4. **Dilute 800 NTU solution 10 times (use a pipette to measure 25 mL of the 800 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 80 NTU.
5. **Dilute 80 NTU solution 10 times (use a pipette to measure 25 mL of the 80 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 8 NTU.

Note

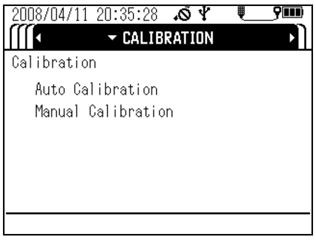
Instead of the standard solutions above, you can use other standard solutions of known concentration measured with other standard instruments.

U-52, U-53 turbidity calibration

Set the number of calibration points.

You can set between 2 and 4 points.

1. **Press the control unit's CAL key to set the calibration mode.**
2. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



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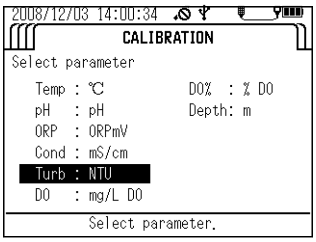
3. **In the parameter selection screen, move the cursor to "Turb", then press the ENTER key.**



2008/12/03 14:00:34

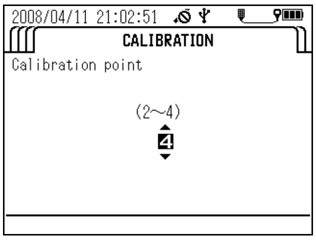
CALIBRATION

Select parameter

Temp : ℃
pH : pH
ORP : ORPmV
Cond : mS/cm
Turb : NTU
DO : mg/L DO
DO% : % DO
Depth: m

Select parameter.

4. **Press the up (△) and down (▽) keys to set the number of calibration points, then press the ENTER key.**



2008/04/11 21:02:51

CALIBRATION

Calibration point

(2~4)

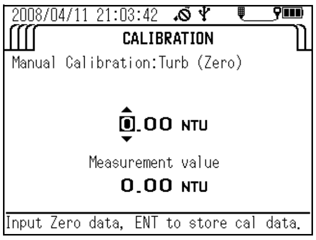
4

The instructions below assume that four calibration points have been set.

5. **Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with deionized water.**

6. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

7. **Press the up (△) and down (▽) keys to set the "Turb" value to 0.0 NTU.**



2008/04/11 21:03:42

CALIBRATION

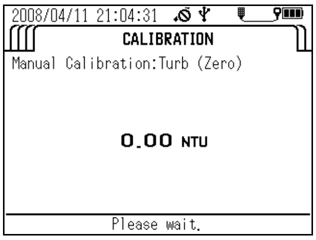
Manual Calibration:Turb (Zero)

0.00 NTU

Measurement value
0.00 NTU

Input Zero data, ENT to store cal data.

8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



2008/04/11 21:04:31

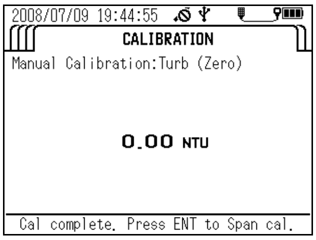
CALIBRATION

Manual Calibration:Turb (Zero)

0.00 NTU

Please wait.

9. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.**



2008/07/09 19:44:55

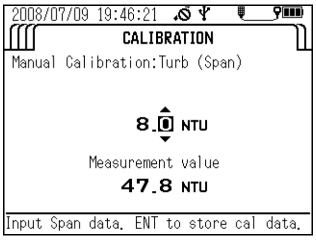
CALIBRATION

Manual Calibration:Turb (Zero)

0.00 NTU

Cal complete. Press ENT to Span cal.

10. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 8 NTU standard solution, or a standard solution of known concentration between 0.1 and 10 NTU.**
11. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
12. **Press the up (△) and down (▽) keys to set the "TURB" value to 8 NTU, or to the known concentration of the standard solution between 0.1 and 10 NTU. (Input range = 0 NTU to 9.9 NTU (U-51) or 0 NTU to 9.99 NTU (U-52))**



2008/07/09 19:46:21

CALIBRATION

Manual Calibration:Turb (Span)

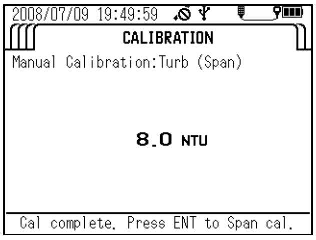
8.0 NTU

Measurement value

47.8 NTU

Input Span data. ENT to store cal data.

13. **Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.**
14. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



2008/07/09 19:49:59

CALIBRATION

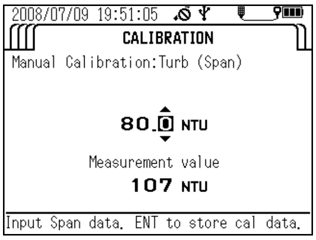
Manual Calibration:Turb (Span)

8.0 NTU

Cal complete. Press ENT to Span cal.

15. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 80 NTU standard solution, or a standard solution of known concentration between 10 and 100 NTU.**
16. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

17. **Press the up (△) and down (▽) keys to set the "Turb" value to 80 NTU, or to the known concentration of the standard solution between 10 and 100 NTU. (Input range = 10.0 NTU to 99.9 NTU)**



2008/07/09 19:51:05

CALIBRATION

Manual Calibration:Turb (Span)

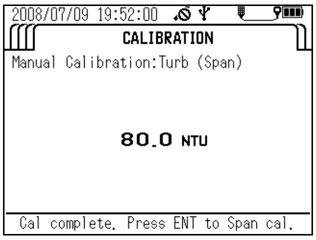
80.0 NTU

Measurement value

107 NTU

Input Span data. ENT to store cal data.

18. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
19. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



2008/07/09 19:52:00

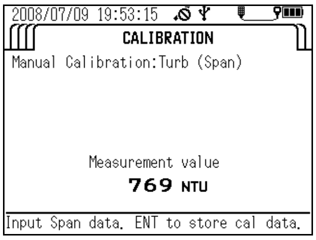
CALIBRATION

Manual Calibration:Turb (Span)

80.0 NTU

Cal complete. Press ENT to Span cal.

20. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 800 NTU standard solution, or a standard solution of known concentration 100 NTU above.**
21. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
22. **Press the up (△) and down (▽) keys to set the "TURB" value to 800 NTU, or to the known concentration of the standard solution 100 NTU above.**
    (Input range = 100 NTU to 800 NTU (U-51), 100 NTU to 1000 NTU (U-52))



2008/07/09 19:53:15

CALIBRATION

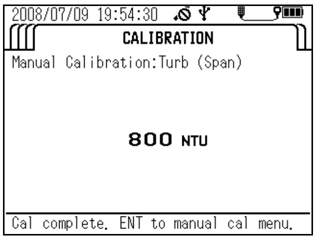
Manual Calibration:Turb (Span)

Measurement value

769 NTU

Input Span data. ENT to store cal data.

23. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
24. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



2008/07/09 19:54:30

CALIBRATION

Manual Calibration:Turb (Span)

800 NTU

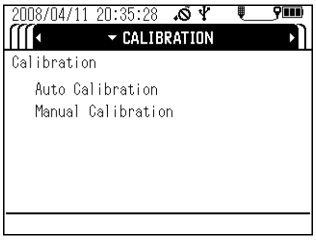
Cal complete. ENT to manual cal menu.

Dissolved oxygen (DO) calibration

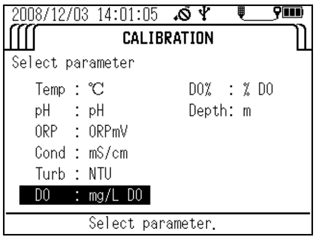
Note

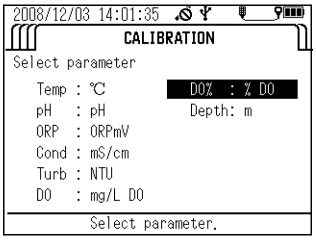
- **You can select one calibration procedure (span calibration) or two calibration procedures (zero-point calibration and span calibration). Carry out the two calibration procedures to ensure good measurement precision throughout all measurement ranges.**
- **It is necessary to prepare new solution before calibration of the Dissolved Oxygen (DO) sensor.**
- **The calibration cup (included) cannot be used to manually calibrate the DO sensor. Use a suitable bottle in which the DO sensor and the temperature sensor can be immersed.**
- **Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.**
- **Make the compensation setting before calibration since the setting is applied during calibration.**
- **The DO sensor is affected by flow. When performing span calibration with saturated dissolved oxygen water, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) or agitate the saturated dissolved oxygen water.**

1. **Prepare the standard solution.**
   - Add about 50 g of sodium sulfite to 1000 mL of water (either deionized water or tap water) and stir the mixture to dissolve the sodium sulfite in it.
   - Pour 1 to 2 liters of water into a suitable flask (either deionized water or tap water). Using a air pump, feed air into the water and aerate the solution until oxygen is saturated.
2. **First, calibrate the zero point. Press the control unit's CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**

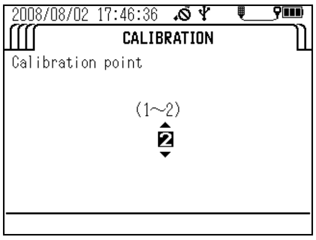


4. **In the parameter selection screen, move the cursor to DO or DO%, then press the ENTER key.**



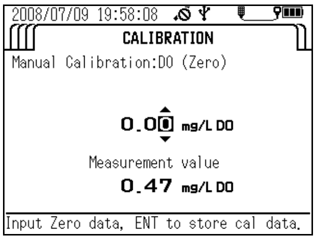


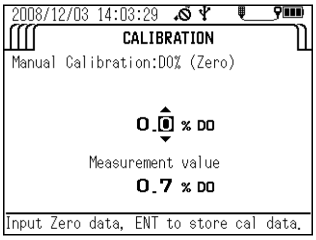
5. **Set the number of calibration procedures, then press the ENTER key.**



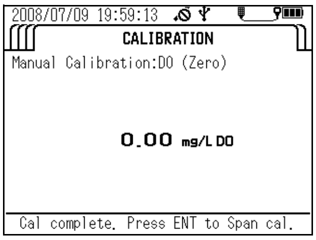
The instructions below assume that two calibration points have been set.

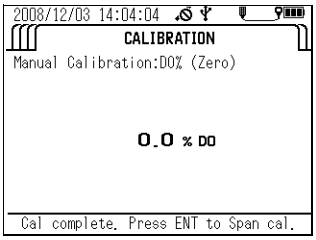
6. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the bottle.**
7. **Press the up (△) and down (▽) keys to set the DO value to 0.00 mg/L or 0.0%.**


2008/07/09 19:58:08
CALIBRATION
Manual Calibration:DO (Zero)
0.00 mg/L DO
Measurement value
0.47 mg/L DO
Input Zero data, ENT to store cal data.

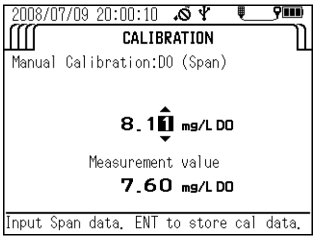

2008/12/03 14:03:29
CALIBRATION
Manual Calibration:DO% (Zero)
0.0 % DO
Measurement value
0.7 % DO
Input Zero data, ENT to store cal data.

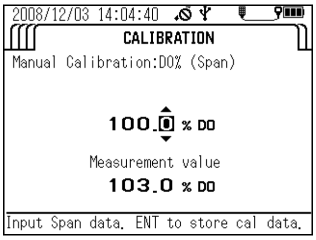
8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
9. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the span calibration procedure.**


2008/07/09 19:59:13
CALIBRATION
Manual Calibration:DO (Zero)
0.00 mg/L DO
Cal complete. Press ENT to Span cal.

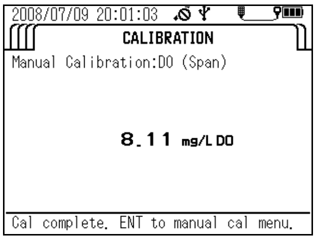

2008/12/03 14:04:04
CALIBRATION
Manual Calibration:DO% (Zero)
0.0 % DO
Cal complete. Press ENT to Span cal.

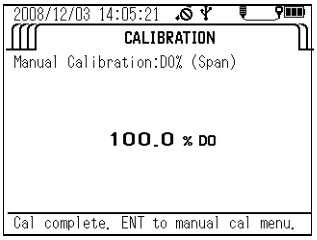
10. **Wash the sensor probe 2 or 3 times with deionized water to remove any dirt, then submerge the sensor probe in the container filled with the span solution.**
11. **Press the up (△) and down (▽) keys to set the DO value to the saturated dissolved oxygen value (mg/L) of the water at that temperature or the dissolved oxygen saturation ratio.**


2008/07/09 20:00:10
CALIBRATION
Manual Calibration:DO (Span)
8.11 mg/L DO
Measurement value
7.60 mg/L DO
Input Span data. ENT to store cal data.


2008/12/03 14:04:40
CALIBRATION
Manual Calibration:DO% (Span)
100.0 % DO
Measurement value
103.0 % DO
Input Span data. ENT to store cal data.

12. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
13. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**


2008/07/09 20:01:03
CALIBRATION
Manual Calibration:DO (Span)
8.11 mg/L DO
Cal complete. ENT to manual cal menu.


2008/12/03 14:05:21
CALIBRATION
Manual Calibration:DO% (Span)
100.0 % DO
Cal complete. ENT to manual cal menu.

Amounts of saturated dissolved oxygen in water at various temperatures (salinity=0.0%)

JIS K0101

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.16						
1	13.77	11	10.67	21	8.68	31	7.42
2	13.40	12	10.43	22	8.53	32	7.32
3	13.04	13	10.20	23	8.39	33	7.22
4	12.70	14	9.97	24	8.25	34	7.13
5	12.37	15	9.76	25	8.11	35	7.04
6	12.06	16	9.56	26	7.99	36	6.94
7	11.75	17	9.37	27	7.87	37	6.86
8	11.47	18	9.18	28	7.75	38	6.76
9	11.19	19	9.01	29	7.64	39	6.68
10	10.92	20	8.84	30	7.53	40	6.59

ISO5814

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.62				
1	14.22	11	11.03	21	8.91
2	13.83	12	10.78	22	8.74
3	13.46	13	10.54	23	8.58
4	13.11	14	10.31	24	8.42
5	12.77	15	10.08	25	8.26
6	12.45	16	9.87	26	8.11
7	12.14	17	9.66	27	7.97
8	11.84	18	9.47	28	7.83
9	11.56	19	9.28	29	7.69
10	11.29	20	9.09	30	7.56

● Span setting values for calibration in air

The software should display these values when auto calibration is performed.
Use this table to input values for manual span calibrations in air.

Tip

The DO measurement value of “air-saturated water” and air are different.
Due to the pressure difference against the membrane in air versus the membrane in water, the measurement value in air is about 10% higher than the value of air-saturated water on average.

Amounts of saturated dissolved oxygen in air at various temperatures

Following tables are applicable only to the air calibration of the U-50 DO sensor. Do not use them for other purpose.

Air calibration value in adopting evaluation based on JIS K0101

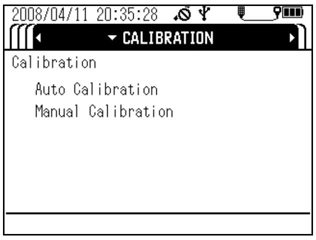
Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
0	15.58						
1	15.15	11	11.74	21	9.55	31	8.16
2	14.74	12	11.47	22	9.38	32	8.05
3	14.34	13	11.22	23	9.23	33	7.94
4	13.97	14	10.97	24	9.08	34	7.84
5	13.61	15	10.74	25	8.92	35	7.74
6	13.27	16	10.52	26	8.79	36	7.63
7	12.93	17	10.31	27	8.66	37	7.55
8	12.62	18	10.10	28	8.53	38	7.44
9	12.31	19	9.91	29	8.40	39	7.35
10	12.01	20	9.72	30	8.28	40	7.25

Air calibration value in adopting evaluation based on ISO5814

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	16.08				
1	15.64	11	12.13	21	9.80
2	15.21	12	11.86	22	9.61
3	14.81	13	11.59	23	9.44
4	14.42	14	11.34	24	9.26
5	14.05	15	11.09	25	9.09
6	13.70	16	10.86	26	8.92
7	13.35	17	10.63	27	8.77
8	13.02	18	10.42	28	8.61
9	12.72	19	10.21	29	8.46
10	12.42	20	10.00	30	8.32

● Water depth (DEPTH) calibration

1. **Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).**
2. **Press the control unit's CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



2008/04/11 20:35:28

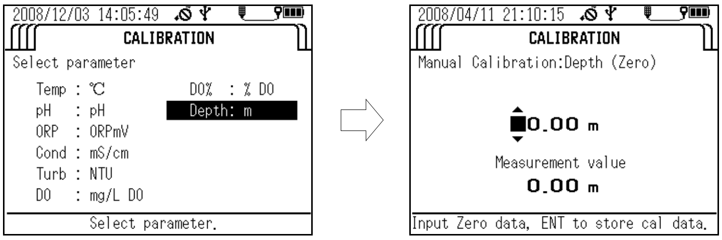
CALIBRATION

Calibration

Auto Calibration

Manual Calibration

4. **In the parameter selection screen, move the cursor to "Depth", then press the ENTER key.**



2008/12/03 14:05:49

CALIBRATION

Select parameter

Temp : ℃
pH : pH
ORP : ORPmV
Cond : mS/cm
Turb : NTU
DO : mg/L DO
DO% : % DO
Depth: m

Select parameter.

2008/04/11 21:10:15

CALIBRATION

Manual Calibration:Depth (Zero)

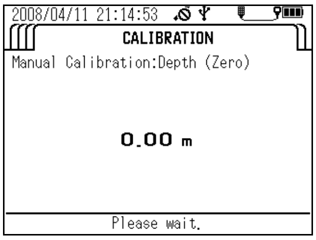
0.00 m

Measurement value

0.00 m

Input Zero data. ENT to store cal data.

5. **Press the up (△) and down (▽) keys to set the "Depth" value to 0.00 m.**
6. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



2008/04/11 21:14:53

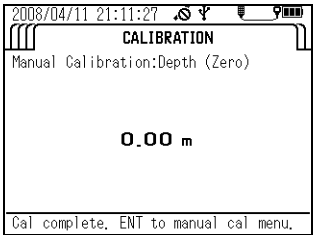
CALIBRATION

Manual Calibration:Depth (Zero)

0.00 m

Please wait.

7. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



2008/04/11 21:11:27

CALIBRATION

Manual Calibration:Depth (Zero)

0.00 m

Cal complete. ENT to manual cal menu.

3.4 Measurement

You can perform measurement by either of the methods below.

- Storing data in memory manually with reference to the measurement value (single measurement)
- Having data stored in memory automatically and continuously
  U-51/U-52: Interval measurement (minimum memory interval of 10 seconds)
  U-53: Interval measurement (minimum memory interval of 30 seconds)

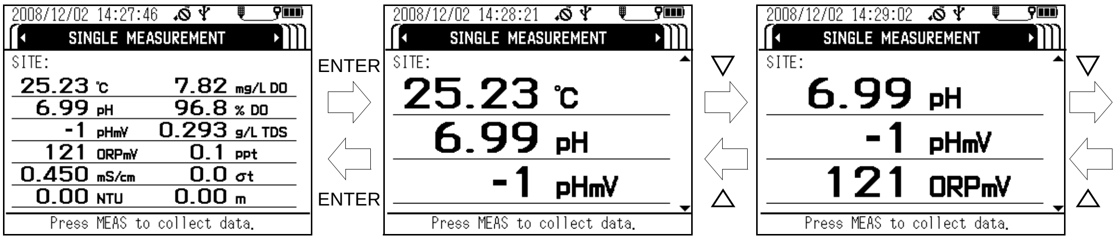
Select the measurement method that meets your requirements.

Note

- **Lower sensor probe slowly when submerging them in samples.**
- **Sensors may break if sensor probe are dropped from a height of 1 meter or more.**
- **Do not submerge sensor probe in water depths of over 30 meters. Sensor probe are only resistant to water pressure of up to 30 meters.**
- **After turning the power ON, check that the DO readout value has stabilized before starting measurement (takes around 20 minutes).**

Tip

- **When on the measurement screen, pressing the ENTER key enlarges the display and shows three measured values at a time.**
- **Pressing the up (△) and down (▽) keys scrolls through the measured values one item at a time.**
- **Pressing the ENTER key again reverts to the normal measurement screen display.**



2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃ 7.82 mg/L DO
6.99 pH 96.8 % DO
-1 pHmV 0.293 g/L TDS
121 ORPmV 0.1 ppt
0.450 mS/cm 0.0 σt
0.00 NTU 0.00 m
Press MEAS to collect data.

2008/12/02 14:28:21
SINGLE MEASUREMENT
SITE:
25.23 ℃
6.99 pH
-1 pHmV
Press MEAS to collect data.

2008/12/02 14:29:02
SINGLE MEASUREMENT
SITE:
6.99 pH
-1 pHmV
121 ORPmV
Press MEAS to collect data.

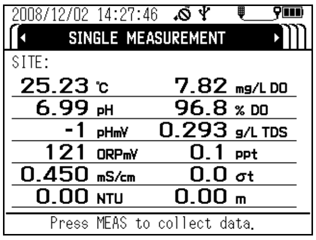
Measurement screen Normal Enlarged

3.4.1 Storing data in memory manually

Follow the steps below to manually store data in memory while referring to the measurement value to check the readout value is stable.

● **U-51/U-52**

1. **Check that each sensor and sensor guard is mounted.**
2. **Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.**

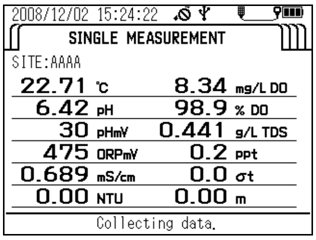


2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃ 7.82 mg/L DO
6.99 pH 96.8 % DO
-1 pHmV 0.293 g/L TDS
121 ORPmV 0.1 ppt
0.450 mS/cm 0.0 σt
0.00 NTU 0.00 m
Press MEAS to collect data.

3. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**

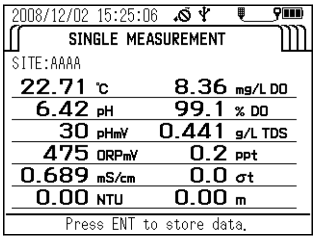
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.

4. **When the measurement values are stable, press the MEAS key to acquire the 5-second average.**



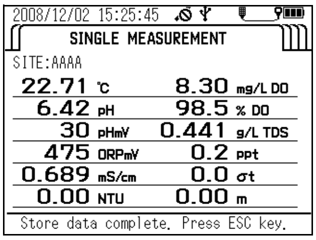
```
2008/12/02 15:24:22
SINGLE MEASUREMENT
SITE:AAAA
22.71 ℃        8.34 mg/L DO
 6.42 pH       98.9 % DO
   30 pHmV    0.441 g/L TDS
  475 ORPmV     0.2 ppt
0.689 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Collecting data.
```

5. **Press the ENTER key to save the held measurement values, or press the ESC key to cancel the operation.**



```
2008/12/02 15:25:06
SINGLE MEASUREMENT
SITE:AAAA
22.71 ℃        8.36 mg/L DO
 6.42 pH       99.1 % DO
   30 pHmV    0.441 g/L TDS
  475 ORPmV     0.2 ppt
0.689 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Press ENT to store data.
```

⇨



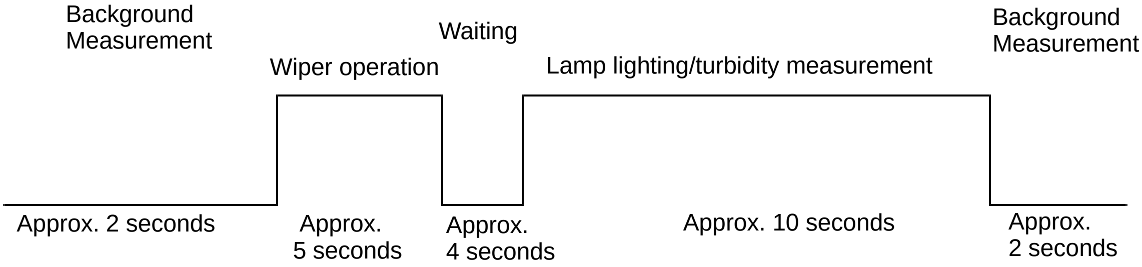
```
2008/12/02 15:25:45
SINGLE MEASUREMENT
SITE:AAAA
22.71 ℃        8.30 mg/L DO
 6.42 pH       98.5 % DO
   30 pHmV    0.441 g/L TDS
  475 ORPmV     0.2 ppt
0.689 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Store data complete. Press ESC key.
```

● U-53

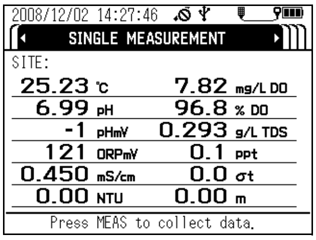
Note

Do not perform turbidity measurement in air as it may damage the wiper.

U-53 turbidity measurement follows the sequence below. The measurement values are held after each sequence.



1. **Check that each sensor and sensor guard is mounted.**
2. **Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.**

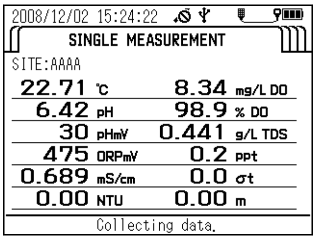


```
2008/12/02 14:27:46
◀ SINGLE MEASUREMENT ▶
SITE:
25.23 ℃        7.82 mg/L DO
 6.99 pH       96.8 % DO
   -1 pHmV    0.293 g/L TDS
  121 ORPmV     0.1 ppt
0.450 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Press MEAS to collect data.
```

3. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**

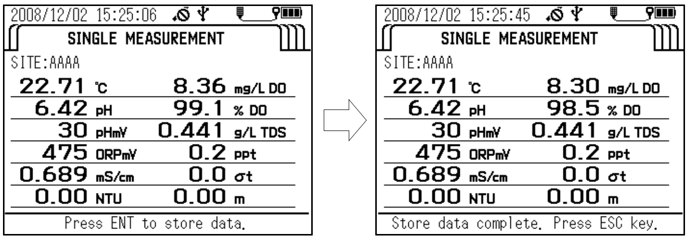
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.

4. **When the non-turbidity meter measurement values are stable, press the MEAS key to start the sequence above.**



```
2008/12/02 15:24:22
SINGLE MEASUREMENT
SITE:AAAA
22.71 ℃        8.34 mg/L DO
 6.42 pH       98.9 % DO
   30 pHmV    0.441 g/L TDS
  475 ORPmV     0.2 ppt
0.689 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Collecting data.
```

5. **When the sequence has finished, hold the measurement values. Press the ENTER key to store the held measurement values, or press the ESC key to cancel the operation.**



```
2008/12/02 15:25:06
SINGLE MEASUREMENT
SITE:AAAA
22.71 ℃        8.36 mg/L DO
 6.42 pH       99.1 % DO
   30 pHmV    0.441 g/L TDS
  475 ORPmV     0.2 ppt
0.689 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Press ENT to store data.
```

```
2008/12/02 15:25:45
SINGLE MEASUREMENT
SITE:AAAA
22.71 ℃        8.30 mg/L DO
 6.42 pH       98.5 % DO
   30 pHmV    0.441 g/L TDS
  475 ORPmV     0.2 ppt
0.689 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Store data complete. Press ESC key.
```

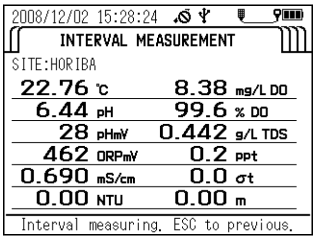
3.4.2 Automatic, continuous measurement

● Interval measurement

1. **Select the "Interval measurement" measurement setting (see “ 3.2.1 Setting measurement methods ” (page 18)).**
2. **Press the up (△) and down (▽) keys to set the interval value to the desired value (U-51/U-52: minimum interval: 10 seconds, U-53: minimum interval: 30 seconds), then press the ENTER key.**

   The measurement screen appears automatically, and the system becomes ready for measurement.
3. **Check that each sensor and sensor guard is mounted.**
4. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**

   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
5. **Press the ENTER key to start measurement.**



```
2008/12/02 15:28:24
INTERVAL MEASUREMENT
SITE:HORIBA
22.76 ℃        8.38 mg/L DO
 6.44 pH       99.6 % DO
   28 pHmV    0.442 g/L TDS
  462 ORPmV     0.2 ppt
0.690 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Interval measuring. ESC to previous.
```

3.5 Data operations

Use the procedures below to retrieve data stored in memory, delete all the data, check the remaining data memory capacity, and check the calibration record.

3.5.1 Displaying data

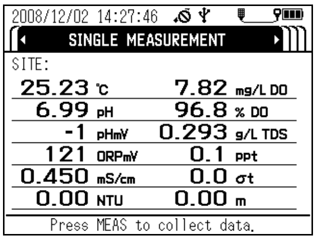
For maximum efficiency, there are 3 methods of displaying data.

- Displaying the data for a specified site
- Displaying the data for a specified date/time
- Displaying all the data

Use the method that best suits your requirements.

● Displaying the data for a specified site

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

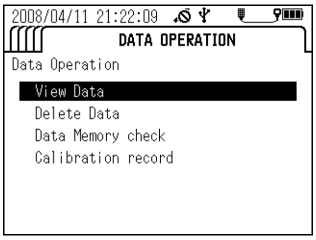


```
2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃        7.82 mg/L DO
 6.99 pH       96.8 % DO
   -1 pHmV    0.293 g/L TDS
  121 ORPmV     0.1 ppt
0.450 mS/cm     0.0 σt
 0.00 NTU      0.00 m
Press MEAS to collect data.
```

Note

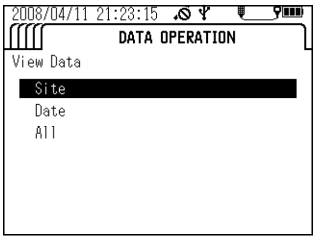
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



```
2008/04/11 21:22:09
DATA OPERATION
Data Operation
  View Data
  Delete Data
  Data Memory check
  Calibration record
```

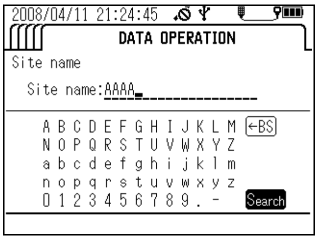
4. **Move the cursor to "Site", then press the ENTER key.**



```
2008/04/11 21:23:15
DATA OPERATION
View Data
  Site
  Date
  All
```

5. **Press the up (△), down (▽), left (◁) and right (▷) keys to enter the site to retrieve.**

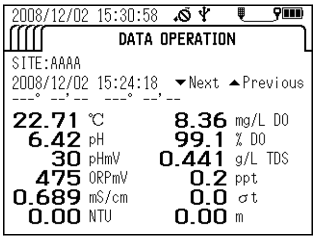
6. **Move the cursor to "Search", then press the ENTER key.**



```
2008/04/11 21:24:45
DATA OPERATION
Site name
  Site name:AAAA_
    A B C D E F G H I J K L M  ←BS
    N O P Q R S T U V W X Y Z
    a b c d e f g h i j k l m
    n o p q r s t u v w x y z
    0 1 2 3 4 5 6 7 8 9 . -   Search
```

All site names that begin with the entered text are displayed.
The most recently measured data for the entered site is displayed.

7. **Press the up (△) and down (▽) keys to display earlier data.**

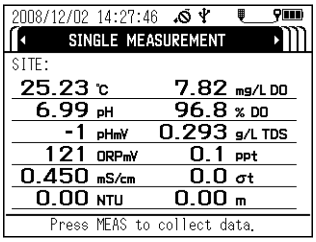


```
2008/12/02 15:30:58
DATA OPERATION
SITE:AAAA
2008/12/02 15:24:18  ▼Next ▲Previous
---° --'--  ---° --'--
22.71 ℃          8.36 mg/L DO
 6.42 pH         99.1 % DO
   30 pHmV      0.441 g/L TDS
  475 ORPmV       0.2 ppt
0.689 mS/cm       0.0 σt
 0.00 NTU        0.00 m
```

- **Displaying the data for a specified date/time**

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

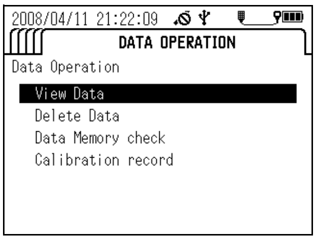


```
2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃          7.82 mg/L DO
 6.99 pH         96.8 % DO
   -1 pHmV      0.293 g/L TDS
  121 ORPmV       0.1 ppt
0.450 mS/cm       0.0 σt
 0.00 NTU        0.00 m
Press MEAS to collect data.
```

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

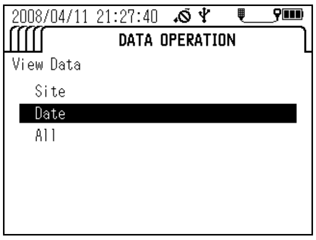
2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



```
2008/04/11 21:22:09
DATA OPERATION
Data Operation
   View Data
   Delete Data
   Data Memory check
   Calibration record
```

4. **Move the cursor to "Date", then press the ENTER key.**

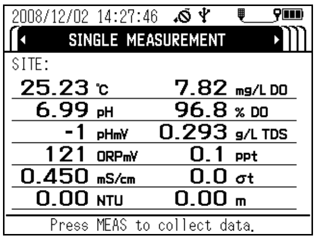
5. **With the cursor on the Date, press the ENTER key.**



6. **Press the up (△), down (▽), left (◁) and right (▷) keys to enter the desired date/time, then press the ENTER key to apply the setting.**
7. **The cursor moves to "Search". Press the ENTER key to start the search.**
8. **Press the up (△) and down (▽) keys to display earlier data.**

● Displaying all the data

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

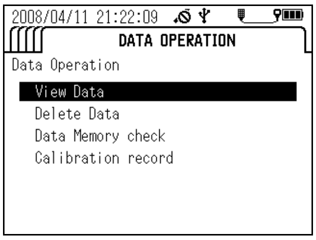


25.23 ℃ 7.82 mg/L DO
6.99 pH 96.8 % DO
-1 pHmV 0.293 g/L TDS
121 ORPmV 0.1 ppt
0.450 mS/cm 0.0 σt
0.00 NTU 0.00 m
Press MEAS to collect data.

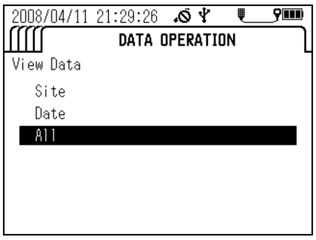
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



4. **Move the cursor to "All", then press the ENTER key.**
   The most recently measured data is displayed.



View Data
Site
Date
All

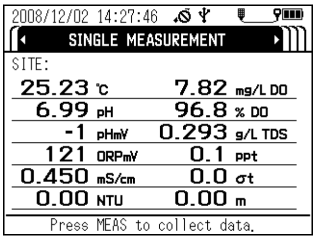
5. **Press the up (△) and down (▽) keys to display earlier data.**

3.5.2 Deleting data

Follow the steps below to delete all the data stored in memory.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

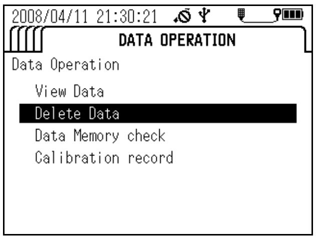


```
2008/12/02 14:27:46
SINGLE MEASUREMENT
SITE:
25.23 ℃          7.82 mg/L DO
 6.99 pH         96.8 % DO
   -1 pHmV      0.293 g/L TDS
  121 ORPmV       0.1 ppt
0.450 mS/cm       0.0 σt
 0.00 NTU        0.00 m
Press MEAS to collect data.
```

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

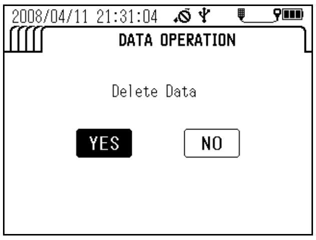
2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Delete Data", then press the ENTER key.**



```
2008/04/11 21:30:21
DATA OPERATION
Data Operation
  View Data
  Delete Data
  Data Memory check
  Calibration record
```

4. **Press the left (◁) key to move the cursor to YES, then press the ENTER key.**

   All the data has been deleted when the indicator appears along with the message "No data exists".



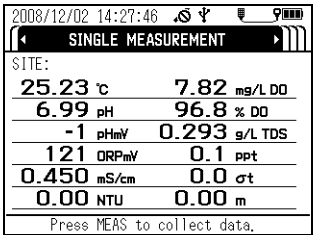
```
2008/04/11 21:31:04
DATA OPERATION
Delete Data
YES   NO
```

3.5.3 Checking the data memory

You can check the used data capacity and the remaining data capacity.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

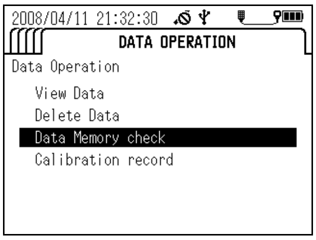
25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

Press MEAS to collect data.

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Data Memory Check", then press the ENTER key.**



2008/04/11 21:32:30

DATA OPERATION

Data Operation

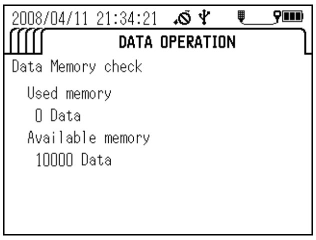
View Data

Delete Data

Data Memory check

Calibration record

The amount of memory in use and amount of available memory are displayed.



2008/04/11 21:34:21

DATA OPERATION

Data Memory check

Used memory

0 Data

Available memory

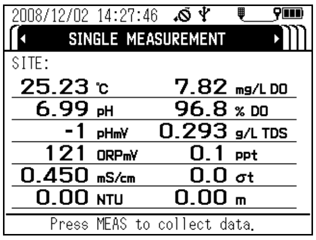
10000 Data

3.5.4 Checking the calibration record

Follow the steps below to check the latest calibration history.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.



2008/12/02 14:27:46

SINGLE MEASUREMENT

SITE:

25.23	℃	7.82	mg/L DO
6.99	pH	96.8	% DO
-1	pHmV	0.293	g/L TDS
121	ORPmV	0.1	ppt
0.450	mS/cm	0.0	σt
0.00	NTU	0.00	m

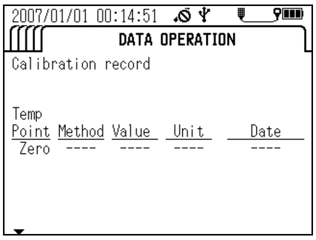
Press MEAS to collect data.

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Calibration record", then press the ENTER key.**

   The latest calibration record is displayed.



2007/01/01 00:14:51

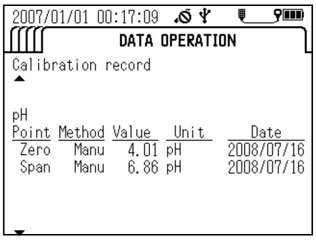
DATA OPERATION

Calibration record

Temp

Point	Method	Value	Unit	Date
Zero	----	----	----	----

▽



2007/01/01 00:17:09

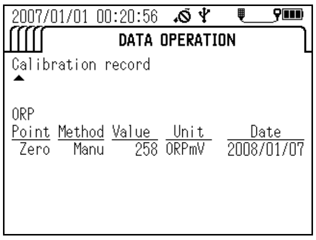
DATA OPERATION

Calibration record

pH

Point	Method	Value	Unit	Date
Zero	Manu	4.01	pH	2008/07/16
Span	Manu	6.86	pH	2008/07/16

▽



2007/01/01 00:20:56

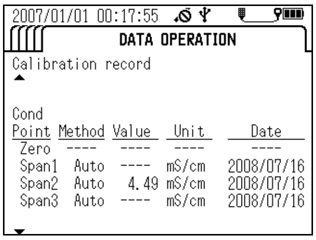
DATA OPERATION

Calibration record

ORP

Point	Method	Value	Unit	Date
Zero	Manu	258	ORPmV	2008/01/07

▽



2007/01/01 00:17:55

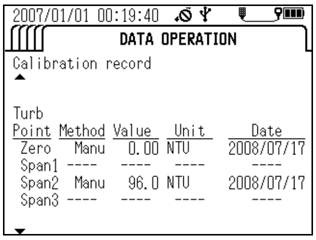
DATA OPERATION

Calibration record

Cond

Point	Method	Value	Unit	Date
Zero	----	----	----	----
Span1	Auto	----	mS/cm	2008/07/16
Span2	Auto	4.49	mS/cm	2008/07/16
Span3	Auto	----	mS/cm	2008/07/16

▽



2007/01/01 00:19:40

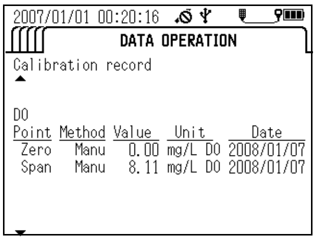
DATA OPERATION

Calibration record

Turb

Point	Method	Value	Unit	Date
Zero	Manu	0.00	NTU	2008/07/17
Span1	----	----	----	----
Span2	Manu	96.0	NTU	2008/07/17
Span3	----	----	----	----

▽



2007/01/01 00:20:16

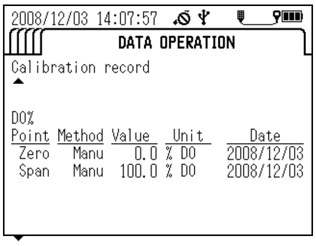
DATA OPERATION

Calibration record

DO

Point	Method	Value	Unit	Date
Zero	Manu	0.00	mg/L DO	2008/01/07
Span	Manu	8.11	mg/L DO	2008/01/07

▽



2008/12/03 14:07:57

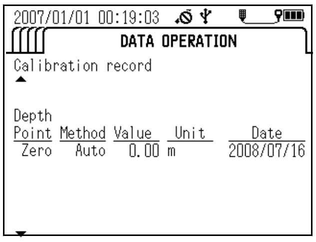
DATA OPERATION

Calibration record

DO%

Point	Method	Value	Unit	Date
Zero	Manu	0.0	% DO	2008/12/03
Span	Manu	100.0	% DO	2008/12/03

▽



2007/01/01 00:19:03

DATA OPERATION

Calibration record

Depth

Point	Method	Value	Unit	Date
Zero	Auto	0.00	m	2008/07/16

3.5.5 GPS data operations

The menu for GPS data operations appears on the display to which the GPS unit is mounted.

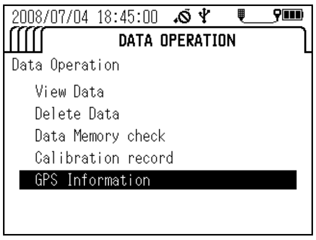
GPS information

Follow the steps below to display acquired GPS information.

Note

Turning the power OFF erases the GPS information.

1. **Press the right (▷) key to switch the display to the "DATA OPERATION" screen.**
2. **the down (▽) key to move the cursor to "GPS Information", then press the ENTER key.**



2008/07/04 18:45:00

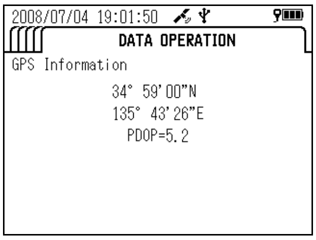
DATA OPERATION

Data Operation

View Data
Delete Data
Data Memory check
Calibration record
GPS Information

The last GPS information acquired is displayed.

- When received data exists



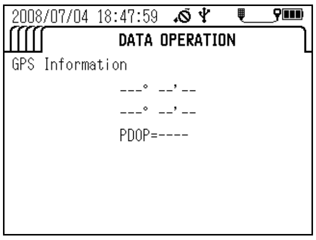
2008/07/04 19:01:50

DATA OPERATION

GPS Information

34° 59’00”N
135° 43’26”E
PDOP=5.2

- When no received data exists



2008/07/04 18:47:59

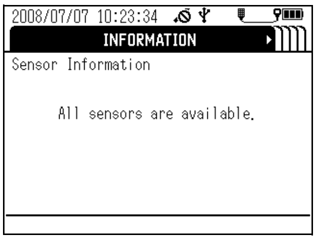
DATA OPERATION

GPS Information

---° --’--
---° --’--
PDOP=----

3.6 Sensor information

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.
2. **Press the left (◁) key once to display the "INFORMATION" screen.**
   The "Sensor Information" screen displays the sensor probe's status.
   - When the sensor probe is normal, the display below appears.



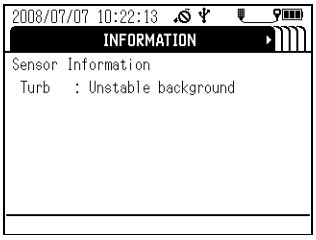
2008/07/07 10:23:34

INFORMATION

Sensor Information

All sensors are available.

   - When there is a sensor probe problem, individual measurement parameters generate messages such as the one shown below. Follow the troubleshooting information to remove the problem before continuing to operate the system.



2008/07/07 10:22:13

INFORMATION

Sensor Information

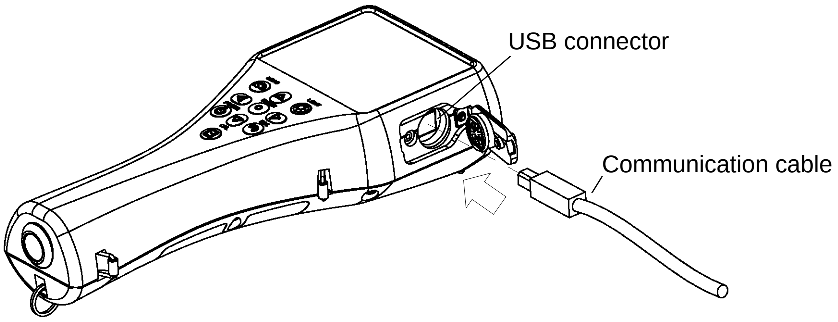
Turb : Unstable background

3.7 USB communication

The separately-sold, dedicated PC connection cable comes with data collection software. This software allows data to be downloaded from the control unit in CSV format.

This section contains instructions for communication commands used for USB communication.

● Connecting the cable



Dedicated cable

Part name: Communication cable (with data collection software)

Part no.: 3200174823

● Cautions when using USB communication

Take care to observe the following when using USB communication.

- Use the dedicated cable (with data collection software) or a commercially-available USB cable (A-B type) to connect to a PC.
- Be sure to match the transmission format on the control unit and the computer.
  The control unit uses the following transmission format:

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

Tip

If the transmission formats do not match, a communication error occurs and USB communication will not function normally. After changing the transmission format, restart the control unit and the computer.

- If received data is not sent back or an error occurs after a data request has been sent, adjust the program configuration so that it allows a little waiting time before a data request is sent again. This will enable more stable communication.
- The unit does not use DCD, CTS, or DSR signals. Take care of this when creating programs.

3.7.1 Communication settings

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

3.7.2 Commands

● Instant data requests

● Request command format

#	RD	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character	1 character
4	Frame check sequence (FCS)	2 characters

The two ASCII-code characters created by converting the 8 bits of data created by successively combining the value of each character from # through @ in an exclusive OR (XOR) operation with the value of the next character.

Example: #RD@

(1)	0	XOR	35	(ASCII code of # symbol)	⇒	35
(2)	35	XOR	82	(ASCII code of R)	⇒	113
(3)	113	XOR	68	(ASCII code of D)	⇒	53
(4)	53	XOR	64	(ASCII code of @ symbol)	⇒	117 (decimal) ↓ 75 (hex) ↓ Sets "75".

Example: 35 XOR 82 operation

35 in binary	⇒	0	0	1	0	0	0	1	1		
82 in binary	⇒	0	1	0	1	0	0	1	0		
XOR result		0	1	1	1	0	0	0	1	⇒	113 (decimal)

Note: Set "XX" if you do not want to test for communication frame errors with FCS.

● Response format

#	RD	AAAAAAAAAAAAAAAAAAAA	X	X	XXXX	XX	X	X	XXXXX	X
1	2	3	4	5	6	7	8	9	10	11

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
42	43	44	45	46	47	48	49	50	51	52	53	54	55	56

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71

XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	XXX	XX	XX	X	X	@	XX	[CR]	[LF]
72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89		

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
4	Probe status	(3) Status code	1 character
5	Probe error	(4) Status error code	1 character
6	Unused		4 characters
7	Parameter 1 code	(1) Parameter code	2 characters
8	Parameter 1 status	(5) Parameter status code	1 character
9	Parameter 1 error	(6) Parameter error code	1 character
10	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
11	Parameter 1 unit	(2) Unit code	1 character
12	Parameter 2 code	(1) Parameter code	2 characters
13	Parameter 2 status	(5) Parameter status code	1 character
14	Parameter 2 error	(6) Parameter error code	1 character
15	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
16	Parameter 2 unit	(2) Unit code	1 character
17	Parameter 3 code	(1) Parameter code	2 characters
18	Parameter 3 status	(5) Parameter status code	1 character
19	Parameter 3 error	(6) Parameter error code	1 character
20	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
21	Parameter 3 unit	(2) Unit code	1 character
22	Parameter 4 code	(1) Parameter code	2 characters
23	Parameter 4 status	(5) Parameter status code	1 character
24	Parameter 4 error	(6) Parameter error code	1 character
25	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
26	Parameter 4 unit	(2) Unit code	1 character
27	Parameter 5 code	(1) Parameter code	2 characters
28	Parameter 5 status	(5) Parameter status code	1 character
29	Parameter 5 error	(6) Parameter error code	1 character
30	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
31	Parameter 5 unit	(2) Unit code	1 character
32	Parameter 6 code	(1) Parameter code	2 characters
33	Parameter 6 status	(5) Parameter status code	1 character
34	Parameter 6 error	(6) Parameter error code	1 character

35	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
36	Parameter 6 unit	(2) Unit code	1 character
37	Parameter 7 code	(1) Parameter code	2 characters
38	Parameter 7 status	(5) Parameter status code	1 character
39	Parameter 7 error	(6) Parameter error code	1 character
40	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
41	Parameter 7 unit	(2) Unit code	1 character
42	Parameter 8 code	(1) Parameter code	2 characters
43	Parameter 8 status	(5) Parameter status code	1 character
44	Parameter 8 error	(6) Parameter error code	1 character
45	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
46	Parameter 8 unit	(2) Unit code	1 character
47	Parameter 9 code	(1) Parameter code	2 characters
48	Parameter 9 status	(5) Parameter status code	1 character
49	Parameter 9 error	(6) Parameter error code	1 character
50	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
51	Parameter 9 unit	(2) Unit code	1 character
52	Parameter 10 code	(1) Parameter code	2 characters
53	Parameter 10 status	(5) Parameter status code	1 character
54	Parameter 10 error	(6) Parameter error code	1 character
55	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
56	Parameter 10 unit	(2) Unit code	1 character
57	Parameter 11 code	(1) Parameter code	2 characters
58	Parameter 11 status	(5) Parameter status code	1 character
59	Parameter 11 error	(6) Parameter error code	1 character
60	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
61	Parameter 11 unit	(2) Unit code	1 character
62	Parameter 12 code	(1) Parameter code	2 characters
63	Parameter 12 status	(5) Parameter status code	1 character
64	Parameter 12 error	(6) Parameter error code	1 character
65	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
66	Parameter 12 unit	(2) Unit code (6) Parameter error code	1 character
67	Parameter 13 code	(1) Parameter code	2 characters
68	Parameter 13 status	(5) Parameter status code	1 character
69	Parameter 13 error	(6) Parameter error code	1 character
70	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
71	Parameter 13 unit	(2) Unit code	1 character
72	Year	00 to 99	2 characters

73	Month	01 to 12	2 characters
74	Day	01 to 31	2 characters
75	Hour	00 to 23	2 characters
76	Minute	00 to 59	2 characters
77	Second	00 to 59	2 characters
78	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
79	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
80	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
81	Unused	1 character	1 character
82	North latitude/South latitude	N: North; S: South	1 character
83	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
84	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
85	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
86	Unused		1 character
87	East longitude/West longitude	E: East; W: West	1 character
88	Delimiter character		1 character
89	Frame check sequence (FCS)		2 characters

Memory data requests

Request command format

#	RM	X	X	AAAAAAAAAAAAAAAAAAAA	XX	XX	XX	@	XX	[CR]	[LF]
1	2	3	4	5	6	7	8	9	10		

1	Header		1 character
2	Command		2 characters
3	Data specification[*1]	0: Start search; 1: Next data item; 2: Previous data item; 3: Request same data again	1 character
4	Search method specification	0: All data; 1: Site search; 2: Date search	1 character
5	Search site[*2]	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
6	Search year[*3]	00 to 99	2 characters
7	Search month[*3]	01 to 12	2 characters
8	Search day[*3]	01 to 31	2 characters
9	Delimiter character		1 character
10	Frame check sequence (FCS)		2 characters

*1: When sending the RM command, first send 0 [Start search], then 1 [Next data item], 2 [Previous data item] or 3 [Request same data again].

*2: [Search site] is only needed when [Site search] is specified as the search method. If another search method is specified, fill this field with spaces.

*3: [Search year], [Search month] and [Search day] are only needed when [Date search] is specified as the search method. If another search method is specified, fill this field with spaces.

- **Response format**

(when data exists)

```
#    RM   AAAAAAAAAAAAAAAAAAAA    XX   X    X    XXXXX    X
1    2    3                       4    5    6    7        8

XX   X    X    XXXXX    X    XX   X    X    XXXXX    X    XX   X    X    XXXXX   X
9    10   11   12       13   14   15   16   17       18   19   20   21   22      23

XX   X    X    XXXXX    X    XX   X    X    XXXXX    X    XX   X    X    XXXXX    X
24   25   26   27       28   29   30   31   32       33   34   35   36   37       38

XX   X    X    XXXXX    X    XX   X    X    XXXXX    X    XX   X    X    XXXXX    X
39   40   41   42       43   44   45   46   47       48   49   50   51   52       53

XX   X    X    XXXXX    X    XX   X    X    XXXXX    X    XX   X    X    XXXXX    X
54   55   56   57       58   59   60   61   62       63   64   65   66   67       68

XX   XX   XX   XX   XX   XX   XX   XX   XX   X    X   XXX    XX   XX   X    X   @   XX   [CR]  [LF]
69   70   71   72   73   74   75   76   77   78   79  80     81   82   83   84  85  86
```

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
4	Parameter 1 code	(1) Parameter code	2 characters
5	Parameter 1 selection	0: No selection; 1: Selection made	1 character
6	Parameter 1 error	(6) Parameter error code	1 character
7	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
8	Parameter 1 unit	(2) Unit code	1 character
9	Parameter 2 code	(1) Parameter code	2 characters
10	Parameter 2 selection	0: No selection; 1: Selection made	1 character
11	Parameter 2 error	(6) Parameter error code	1 character
12	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
13	Parameter 2 unit	(2) Unit code	1 character
14	Parameter 3 code	(1) Parameter code	2 characters
15	Parameter 3 selection	0: No selection; 1: Selection made	1 character
16	Parameter 3 error	(6) Parameter error code	1 character
17	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
18	Parameter 3 unit	(2) Unit code	1 character
19	Parameter 4 code	(1) Parameter code	2 characters
20	Parameter 4 selection	0: No selection; 1: Selection made	1 character

21	Parameter 4 error	(6) Parameter error code	1 character
22	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
23	Parameter 4 unit	(2) Unit code	1 character
24	Parameter 5 code	(1) Parameter code	2 characters
25	Parameter 5 selection	0: No selection; 1: Selection made	1 character
26	Parameter 5 error	(6) Parameter error code	1 character
27	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
28	Parameter 5 unit	(2) Unit code	1 character
29	Parameter 6 code	(1) Parameter code	2 characters
30	Parameter 6 selection	0: No selection; 1: Selection made	1 character
31	Parameter 6 error	(6) Parameter error code	1 character
32	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
33	Parameter 6 unit	(2) Unit code	1 character
34	Parameter 7 code	(1) Parameter code	2 characters
35	Parameter 7 selection	0: No selection; 1: Selection made	1 character
36	Parameter 7 error	(6) Parameter error code	1 character
37	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
38	Parameter 7 unit	(2) Unit code	1 character
39	Parameter 8 code	(1) Parameter code	2 characters
40	Parameter 8 selection	0: No selection; 1: Selection made	1 character
41	Parameter 8 error	(6) Parameter error code	1 character
42	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
43	Parameter 8 unit	(2) Unit code	1 character
44	Parameter 9 code	(1) Parameter code	2 characters
45	Parameter 9 selection	0: No selection; 1: Selection made	1 character
46	Parameter 9 error	(6) Parameter error code	1 character
47	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
48	Parameter 9 unit	(2) Unit code	1 character
49	Parameter 10 code	(1) Parameter code	2 characters
50	Parameter 10 selection	0: No selection; 1: Selection made	1 character
51	Parameter 10 error	(6) Parameter error code	1 character
52	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
53	Parameter 10 unit	(2) Unit code	1 character
54	Parameter 11 code	(1) Parameter code	2 characters
55	Parameter 11 selection	0: No selection; 1: Selection made	1 character
56	Parameter 11 error	(6) Parameter error code	1 character
57	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
58	Parameter 11 unit	(2) Unit code	1 character
59	Parameter 12 code	(1) Parameter code	2 characters

60	Parameter 12 selection	0: No selection; 1: Selection made	1 character
61	Parameter 12 error	(6) Parameter error code	1 character
62	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
63	Parameter 12 unit	(2) Unit code	1 character
64	Parameter 13 code	(1) Parameter code	2 characters
65	Parameter 13 selection	0: No selection; 1: Selection made	1 character
66	Parameter 13 error	(6) Parameter error code	1 character
67	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
68	Parameter 13 unit	(2) Unit code	1 character
69	Year	00 to 99	2 characters
70	Month	01 to 12	2 characters
71	Day	01 to 31	2 characters
72	Hour	00 to 23	2 characters
73	Minute	00 to 59	2 characters
74	Second	00 to 5	2 characters
75	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
76	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
77	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
78	Unused		1 character
79	North latitude/South latitude	N: North; S: South	1 character
80	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
81	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
82	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
83	Unused		1 character
84	East longitude/West longitude	E: East; W: West	1 character
85	Delimiter character		1 character
86	Frame check sequence (FCS)		2 characters

When no data exists, or memory is at capacity)

#	RM	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

Memory data count request

Request command format

```
#   RN   @    XX   [CR]  [LF]
1   2    3    4
```

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

Response format

```
#   RN   XXXXX     @     XX    [CR]   [LF]
1   2    3         4     5
```

1	Header		1 character
2	Command		2 characters
3	Total data count	0 to 10000	5 characters
4	Delimiter character\		1 character
5	Frame check sequence (FCS)		2 characters

Command parse failure response

```
#    ??   X    XX   X    @    XX   [CR]  [LF]
1    2    3    4    5    6    7
```

1	Header	1 character
2	Command	2 characters
3	Command parse failure reason*4	1 character
4	Received command*5	2 characters
5	(3) Status code for probe status*5	1 character
6	Delimiter character	1 character
7	Frame check sequence (FCS)	2 characters

*4: List of command parse failure reasons

1: Frame length error
2: FCS mismatch
3: Undefined command
4: Data error
5: Data out of range
6: No "@" delimiter character
7: No "#" header character
8: No [Carriage return] + [Line feed] footer
9: Cannot accept command in this timing.

*5: Only set for command parse failure reason 9, [Cannot accept command in this timing]. Otherwise this field is filled with spaces.

4 Maintenance

Tip

HORIBA recommends regular manufacturer maintenance checks in order to ensure a long product life.

4.1 Routine care

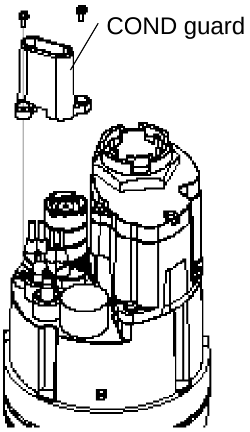
● After measurement

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power OFF.**

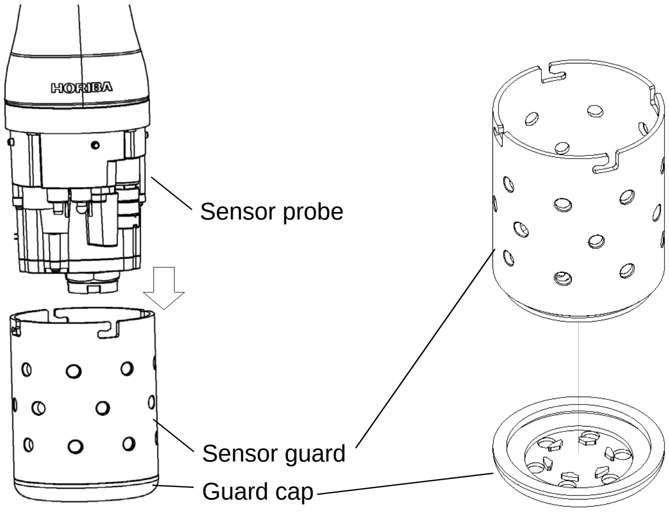
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Remove the sensor guard, and clean the sensor with tap water.**
3. **Clean the turbidity sensor with the cleaning brush provided.**
4. **Remove the two screws securing the COND guard, and the COND guard itself, and use a test tube brush to gently remove any dirt from the electrical conductivity electrode.**



5. **Wipe off any dirt with a soft cloth. If parts are very dirty, clean them with neutral detergent, then rinse them. If parts are contaminated by oil, wipe it off with a soft cloth soaked in alcohol.**
6. **Put the COND guard back in place.**
7. **Remove the sensor guard's guard cap, wash off any dirt with tap water, then put the guard cap back in place.**



4.2 Every 2 months maintenance

● Dissolved oxygen (DO) sensor

Note

- **The DO sensor's internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.**
- **Internal solution can be disposed of down a sink.**

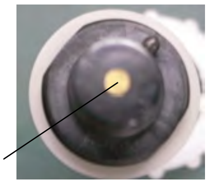
- Replace the membrane cap.
- Polish the gold and silver electrodes when replacing the membrane cap.
  The gold electrode does not need to be polished if it is not dirty.

- **Silver electrode**

  Polish a silver electrode part with sandpaper (#500) and then wash metal electrode parts with water.

- **Gold electrode**

  Polish a gold electrode part with sandpaper (#8000) and then wash metal electrode parts with water.



Replace a membrane cap after clean metal electrodes parts.
Refer to “ 4.5 Replacing the membrane cap ” (page 87).

Reference electrode

Note

- **The pH reference internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.**
- **Internal solution can be disposed of down a sink.**

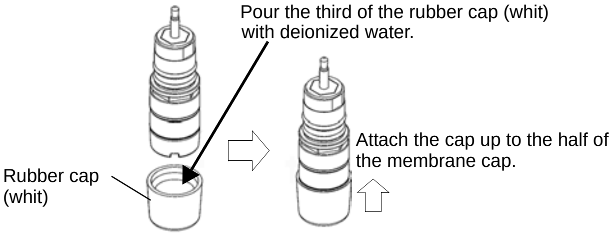
1. **Remove the rubber liquid junction plug from the reference electrode and dispose of the internal solution.**
2. **To prevent air entering, fill the reference electrode to the brim with its internal solution (No. 330).**
3. **Put the rubber liquid junction plug back in place.**

   If the rubber liquid junction plug is dirty, replace the liquid junctions (set of two; No. 9037005100). The reference electrode's internal solution will spill when replacing the liquid junctions. Rinse parts with tap water and dry them with a soft cloth.

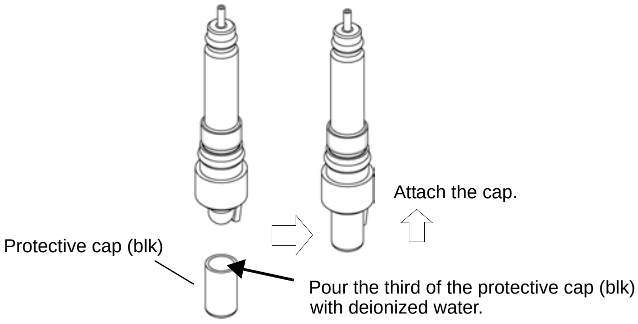
4.3 Storage

Short-term (under 2 months) storage

- Before storing the DO sensor, pour the third of the rubber cap (whit) provided with deionized water and cover the DO sensor with them.



- Before storing the pH sensor, pour the third of the protective cap (blk) provided with deionized water and cover the pH sensor with them.



Note

Before measuerment, remove the rubber cap (whit) and the protective cap (blk).

Long-term (2 months or more) storage

- Remove a membrane cap from DO sensor, and wash the gold electrode and silver electrode parts with water. Wipe off the moisture before storing DO sensor in the pack.
- Prevent internal solution seeping out of the reference chip by taping over the point of seepage with electrical tape.
- Before storing the system, remove the control unit's batteries to prevent battery leakage.

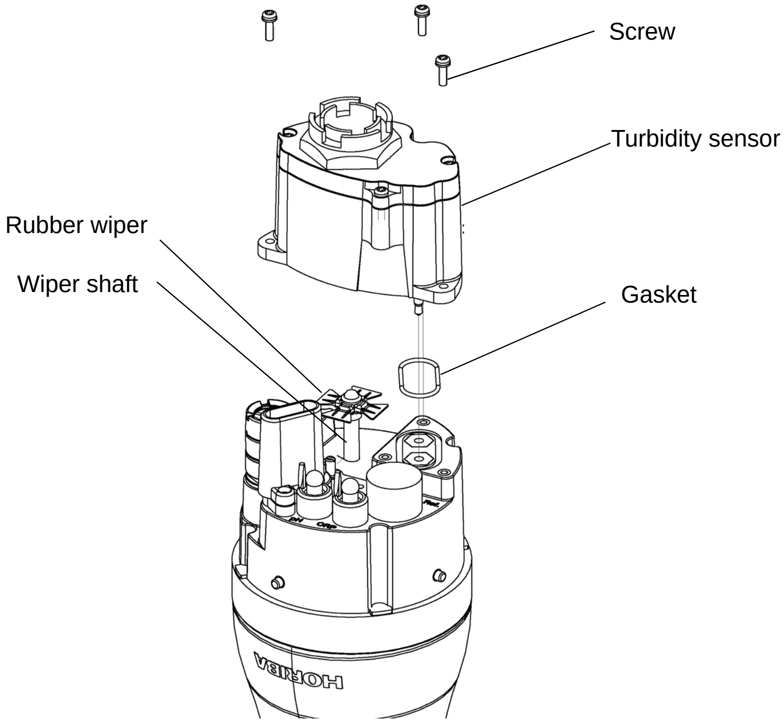
4.4 Replacing the turbidity sensor

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power OFF.**

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Remove the sensor guard, and clean the sensor probe with tap water.**
3. **Use dry air to blow away and dry off any moisture.**
4. **Remove the three screws holding the turbidity sensor by using No. 2 Phillips head screwdriver.**
5. **Pull out the turbidity sensor horizontally.**
6. **Remove the rubber wiper and gasket, and use a soft cloth to wipe off any dirt from the wiper shaft and turbidity sensor attachment. If parts are very dirty, use a soft cloth soaked in neutral detergent or alcohol.**
7. **Replace the rubber wiper and gasket with new ones. Coat the gasket with a thin layer of grease (No. 3014017718).**
8. **Attach the new turbidity sensor and fasten it in place with the three screws.**
9. **Perform four-point calibration before using the sensor.**



4.5 Replacing the membrane cap

● Replacement procedure

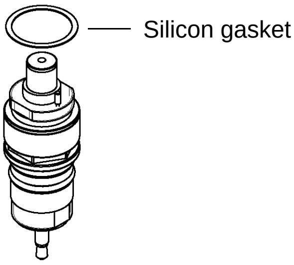
1. **Prepare the DO sensor.**
   - Take a DO sensor out of pack (newly purchasing).
   - Remove a DO sensor from the sensor probe (after use).

Newly purchasing

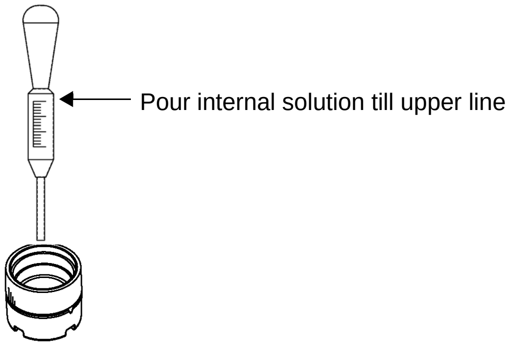
Undo a DO sensor from the sensor probe

   - Twist a membrane cap from DO sensor.
   - Wash the gold electrode and silver electrode parts with water.

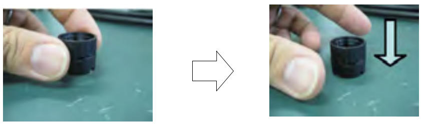
2. **Replace the silicone gasket with a new one.**



3. **Pour internal solution into a membrane cap with a dropper.**

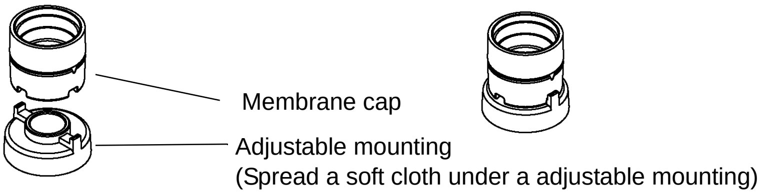


   - Check air bubbles in a membrane cap.

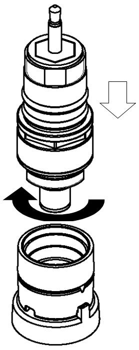


Pick a Cap up and drop it down, if there is air bubbles in internal solution of it.

4. **Set up a membrane cap on a adjustable mounting.**



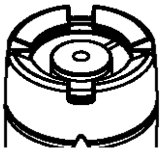
5. Attach a membrane cap to DO sensor



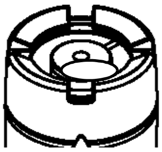
Twist a DO sensor
with holding a membrane cap tight.

6. Check for membrane surface

Check air bubbles in a membrane cap.



Good: Limited air bubbles



NG: Air bubbles of more than 5 mm in diameter

- ● NG → Replace a membrane cap again.
- ● Check that span calibration can be performed.

If the membrane cap is not attached correctly, sensitivity may be lost or response speed may decrease.

4.6 Troubleshooting

Note

If the sensor probe is removed while the control unit is indicating an error, errors cannot be canceled by using the ESC key. Either reconnect the sensor probe or restart the control unit.

4.6.1 Error displays

Error	Cause	Solution
Probe ADC error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/Factory	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/User	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Turbidity sensor light source error	Turbidity sensor light source failure	Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.
Turbidity sensor wiper motor error	The turbidity sensor wiper is not operating.	Press the ESC key. Check there are no obstacles near the wiper, then perform the measurement again. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired.
Probe capacitor error	Low battery voltage or internal IC failure	Turn the power OFF. Replace the display's batteries. If the error persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error	Internal IC failure	Press the ESC key, then redo the operation. If the error persists, turn the power OFF, then restart the system (the current data will not be saved). If the error still persists, contact your nearest sales outlet to have the display repaired.
Probe board error	Probe board failure	Turn the power OFF. Contact your nearest sales outlet to have the sensor probe repaired.

Error	Cause	Solution
Zero-point calibration error	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor is broken.	COND sensor 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. There are air bubbles in the internal solution. 2. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	Water depth sensor 1. The water depth sensor is dirty. 2. The water depth sensor has failed.	Water depth sensor 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.

Error	Cause	Solution
Span calibration error	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP electrode has failed.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refil the reference electrode's internal solution. 4. Replace the ORP electrode.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor The temperature sensor has failed.	Temperature sensor Contact your nearest sales outlet.
Calibration stability error	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensor. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Turbidity calibration error	Error in turbidity measurement sequence	Turbidity calibration failed. Redo calibration after removing the displayed error.
Wet check	The cable connector is submerged.	Turn the power OFF and disconnect the cable connector. Wipe or blow-dry off all the water droplets on the probe. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Power voltage error	The display's power board has failed.	This error could also be caused by poor cable contact. Turn the power OFF and disconnect the cable connector. Reconnect the connector and turn the power ON. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Turbidity lamp power voltage error	The remaining battery level is low.	Turn the power OFF and replace the display's batteries with new ones.

Error	Cause	Solution
Display RTC error	The time display is incorrect.	Replace the coin battery.
Display FROM error	Internal IC failure	Contact your nearest sales outlet to have the control unit repaired.
Display EEPROM error	Internal IC failure	Contact your nearest sales outlet to have the control unit repaired.
Display save error	Insufficient memory space	Move data from the display, use the data operations screen to delete data, then redo the measurement.
Measurement sequence error	● When the measurement item is turbidity 1. The battery power is low. 2. The wiper is not operating normally. 3. The light source lamp is not lit. ● If items other than turbidity are also displayed 4. Board failure	1. Replace the batteries with new ones. 2. Check there are no obstacles near the wiper, then redo the measurement. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired. 3. Wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor. 4. Contact your nearest sales outlet to have the sensor probe repaired.
Out of measurement range	The attempted measurement is outside the measurement range supported for that item.	The system must be used within its supported measurement ranges.
Last zero-point calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. There are air bubbles in the internal solution. 2. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	Water depth sensor 1. The water depth sensor is dirty. 2. The water depth sensor has failed.	Water depth sensor 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		

Error	Cause	Solution
Last span calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP sensor glass is broken.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor ● The temperature sensor has failed.	Temperature sensor ● Contact your nearest sales outlet.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		
Last span calibration invalid	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensors. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		
Calibration value is factory default value.	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.

Error	Cause	Solution
Sample is unstable.	1. The concentration of the sample is unstable. 2. External light disturbance has affected the sensor. 3. Water has entered the turbidity sensor's connector.	1. Use a stirrer to agitate the sample during measurement. 2. Perform measurement away from direct sunlight. 3. Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.

4.6.2 Error displays in sensor information

Error display	Cause	Solution
Measurement sequence error	Measurement sequence error	Turn the power OFF, then restart the system. If the error persists, have the probe repaired.
Out of measurement range	The measurement value is outside the measurement range.	Samples for measurement must be within the measurement range.
Last calibration invalid	The last calibration failed.	Redo calibration.
Calibration invalid	The calibration value is the factory default value.	Redo calibration.
Background unstable	The U-53 turbidity sensor is exposed to direct light.	Mount the guard cap and sensor guard and perform measurement away from direct sunlight.
	The turbidity value changed rapidly during measurement.	Measure a sample that has stable turbidity.

5 Specifications

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Sensor probe	Measurement temperature range	–10°C to 55°C	✓	✓	✓	✓	✓
	Maximum sensor outer diameter	Approx. 96 mm					
	Sensor length	Approx. 340 mm					
	Cable length	2 m (standard) 10 m/30 m (options)					
	Mass	Approx. 1800 g					
	Auto calibration function	Uses pH 4 standard solution.					
	Measurement depth	30 m max.	✓	✓	✓	✓	✓
	Wet-part materials[*3]	PPS, glass, SUS316L, SUS304, FKM, PEEK, Q, titanium, FEP membrane, POM					
	Waterproofing standard	IP-68					
Control unit	Outer dimensions (W × D × H)	115 × 66 × 283 mm	✓	✓	—	✓	—
		115 × 66 × 335 mm	—	—	✓	—	✓
	Mass	Approx. 800 g	✓	✓	✓	✓	✓
	LCD	320 × 240 mm graphic LCD (monochrome) with backlight	✓	✓	✓	✓	✓
	Memory data items	10000	✓	✓	✓	✓	✓
	Communication interface	USB peripheral	✓	✓	✓	✓	✓
	Batteries	C-size dry cells (×4)	✓	✓	✓	✓	✓
	Waterproofing standard	IP-67	✓	✓	✓	✓	✓
	GPS unit	● Reception method (12 channel parallel) ● Measurement precision [With PDOP (high precision): 30 m or less (2 drms)]	—	—	✓	—	✓
	Estimated battery life[*1]	—	70 hours (no backlight)			500 measurements (no backlight)	
	Storage temperature range	–10°C to 60°C	✓	✓	✓	✓	✓
	Ambient temperature range	–5°C to 45°C					

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
pH measurement Two calibration	Measurement method	Glass electrode method	✓	✓	✓	✓	✓
	Range	pH 0 to 14					
	Resolution	0.01 pH					
	Precision[*2]	±0.1 pH					
Dissolved oxygen measurement ● Salinity conversion (0 to 70 PPT, automatic) ● Automatic temperature compensation	Measurement method	Polarographic method	✓	✓	✓	✓	✓
	Film thickness	25 µm					
	Range	0 mg/L to 50.0 mg/L					
	Resolution	0.01 mg/L					
	Precision[*2]	0 mg/L to 20 mg/L: ±0.2 mg/L 20 mg/L to 50 mg/L: ±0.5 mg/L					
Electrical conductivity measurement ● Auto range ● Automatic temperature conversion (25°C)	Measurement method	Four-AC-electrode method	✓	✓	✓	✓	✓
	Range	0 S/m to 10 S/m (0 mS/cm to 100 mS/cm)					
	Resolution	0.000 mS/cm to 0.999 mS/cm: 0.001 1.00 mS/cm to 9.99 mS/cm: 0.01 10.0 mS/cm to 99.9 mS/cm: 0.1 0.0 mS/m to 99.9 mS/m: 0.1 0.100 S/m to 0.999 S/m: 0.001 1.00 S/m to 9.99 S/m: 0.01					
	Precision[*2]	1% of full-scale (midpoint of two calibration points)					
Salinity measurement	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 PPT to 70 PPT (parts per thousand)					
	Resolution	0.1 PPT					
	Precision	±3 PPT					
TDS (total dissolved solid) measurement ● Conversion coefficient setting	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 g/L to 100 g/L					
	Resolution	0.1% of full-scale					
	Repeatability	±2 g/L					
	Precision	±5 g/L					
Seawater specific gravity measurement ● σt, σ0, σ15 display	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 σt to 50 σt					
	Resolution	0.1 σt					
	Precision	±5 σt					

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Temperature measurement	Measurement method	Platinum temperature sensor	✓	✓	✓	✓	✓
	Range	−10°C to 55°C					
	Resolution	0.01°C					
	Sensor	Platinum temperature sensor, JIS Class B (0.3 + 0.005 |t|)					
Turbidity measurement	Measurement method		–	LED forward 30° transmission/ scattering method		Tungsten lamp 90° transmission scattering method	
	Range			0 NTU to 800 NTU		0 NTU to 1000 NTU	
	Resolution			0.1 NTU		0.01 NTU	
	Precision[*2]			±5%of readout or ±1 NTU, whichever is larger		● ±0.5NTU (for 0 NTU to 10 NTU measurement range) ● 3% of readout or 1 NTU, whichever is larger (for 10 NTU to 1000 NTU measurement range)	
	Turbidity sensor wiper			–		✓	
Water depth measurement	Measurement method	Pressure method	–	–	✓	✓	✓
	Range	0 m to 30 m					
	Resolution	0.05 m					
	Precision[*2]	±0.3 m					
ORP (oxidation reduction potential) measurement	Measurement method	Platinum electrode method	✓	✓	✓	✓	✓
	Range	−2000 ~ +2000 mV					
	Resolution	1 mV					
	Precision[*2]	±15 mV					

*1: Battery life is estimated under following conditions.
- Continuous operation
- Using batteries: C-size alkaline dry cells
- Ambient temperature of the control unit: 20°C or more
- Backlight off

*2: The precision is defined by measuring the standard solution in the following cases.
- Turbidity and conductivity: after four point calibration
- pH and DO: after two point calibration
- Water depth and ORP: after one point calibration

*3: Metallic parts are made of stainless steel. Immersing in seawater may erode metallic parts.

6 Reference

6.1 Consumable parts

● Sensor

Name	Model	No.	Description
pH sensor	#7112	3014057312	Standard type pH sensor
pH sensor ToupH	#7113	3200170923	Tough glass type pH sensor
ORP sensor	#7313	3200170920	
DO sensor	#7543	3200170924	
Reference electrode	#7210	3200043582	
R bush unit	—	3200043587	Reference electrode liquid junction
TURB cell U-52	#7800	3200172803	For U-52/U-52G
TURB cell U-53	#7801	3200172800	For U-53/U-53G
Membrane cap	—	3200170194	For DO sensor

● Standard solution and inner solution

Name	Model	No.	Description
pH 4 (For automatic calibration) 500 mL	#100-4	3200043638	Standard solution for auto calibration. Also used for manual pH span calibration.
pH 4 (For automatic calibration) 4 L	#140-4	3200174430	
pH 7 500 mL	#100-7	3200043637	Standard solution for pH zero-point calibration.
pH 9 500 mL	#100-9	3200043636	Standard solution for pH manual span calibration.
Powder for ORP standard solution 10 packs	#160-51	3200043618	For ORP calibration.
Powder for ORP standard solution 10 packs	#160-22	3200043617	
Inner solution for DO sensor, 50 mL	#306	3200170938	Internal solution for DO sensor.
Internal solution for pH, 250 mL	#330	3200043641	Supplementary internal solution for pH reference electrode.

● Others

Name	Model	No.	Description
Silicone grease	—	3014017718	Silicone grease for coating sensor O-ring.
Sponge brush unit	—	3200169531	Brush for cleaning sensor probe.
O-ring set for reference electrode	—	3200169376	O-rings for reference electrode.
O-ring set for DO sensor	—	3200169426	O-rings for DO sensor.
Rubber cap set for sensor guard	—	3200169428	Rubber caps used between sensor guard and sensor probe.
O-ring set for pH and ORP sensor	—	3200169520	O-rings for pH and ORP sensors.
Wiper unit	—	3200169789	Rubber wiper for U-53/U-53G turbidity sensors.
Protective cap (blk) for pH sensor	—	3200175019	Cap attached to tip of pH sensor for sensor probe storage.
Rubber cap (whit) for DO sensor	—	3200175020	Cap attached to tip of DO sensor for sensor probe storage.

6.2 Options sold separately

Name	Model	No.	Description
Bag	U-5030	3200174772	Storage bag for sensor probes and flow cell. Can be carried in one hand.
Flow cell assy	—	3200156570	Used when collecting measurement samples by pump.
Probe guard	—	3200167002	Used for taking measurements in locations where there is a current or where there is a thick layer of sludge.
Communication cable	—	3200174823	A PC connection cable. Comes with data collection software.

6.3 pH measurement

6.3.1 Principle of pH measurement

U-50 series use the glass electrode method for pH measurements. The glass electrode method measures a potential difference between the glass film for pH and the reference electrode. For more information, refer to “JIS Z 8802 pH measurement method”.

6.3.2 Temperature compensation

The electromotive force generated by the glass electrode changes depending on the temperature of the solution.

Temperature compensation is used to compensate for the change in electromotive force caused by temperature.

This function does not compensate the change in pH caused by the temperature of the solution. When pH is to be measured, the temperature of the solution must be recorded along with that pH value, even if a pH meter has automatic temperature compensation function. If the solution temperature is not recorded, the results of the pH measurement may be meaningless.

6.3.3 Standard solutions

When measuring pH, the pH meter must be calibrated using standard solution. There are five kinds of standard solutions specified in “JIS Z 8802 pH measurement”. For normal measurement, two of standard solutions with pH of 4, 7, and 9 are sufficient to accurately calibrate the meter.

For standard solutions, refer to “JIS Z 8802 pH measurement”.

pH 4 standard solution: (Phthalate)	0.05 mol/L potassium hydrogen phthalate aqueous solution
pH 7 standard solutio: (Neutral phosphate)	0.025 mol/L potassium dihydrogenphosphate, 0.025 mol/L disodium hydrogenphosphate aqueous solution
pH 9 standard solution: (Borate)	0.01 mol/L sodium tetraborate aqueous solution

Table 2 pH values of pH standard solutions at various temperatures settings

Temp. (℃)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

6.4 DO measurement

6.4.1 Principle of DO measurement

Dissolved oxygen (DO) refers to the amount of oxygen that is contained in water.

The concentration of dissolved oxygen is generally given as mg/L or as a percentage value (the dissolved oxygen saturation ratio).

Dissolved oxygen is essential for maintaining the self-purifying ability of rivers and seas and also for fish to live. The concentration of dissolved oxygen acts as an indicator of water quality. It is often measured when processing waste water and managing water quality. Fig. 1 provides an overview of the principles behind dissolved oxygen sensor measurement.

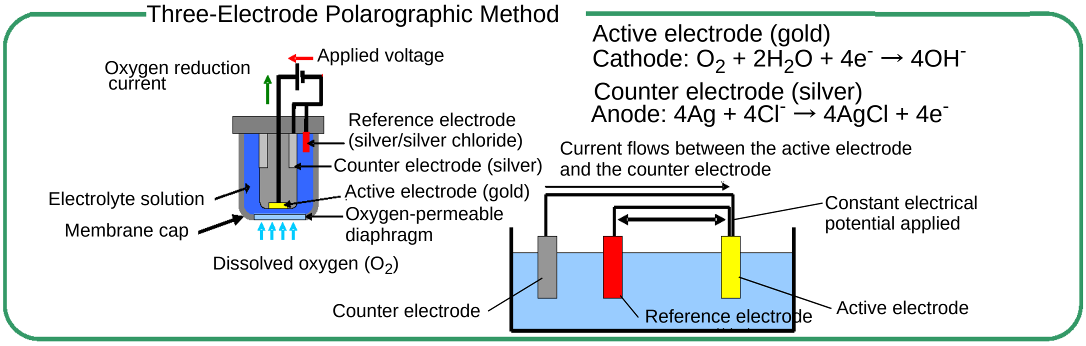


Fig. 1 Overview of principles behind dissolved oxygen sensor

The polarographic oxygen sensor is an enclosed sensor wherein voltage is applied to a cathode made of a precious metal (such as gold or platinum) and an anode also made of a precious metal (such as silver) via an external circuit, and a cap with an oxygen permeable diaphragm (membrane) is filled with electrolyte solution. As indicated in Fig. 1, the concentration of dissolved oxygen can be measured by measuring the current proportional to the amount of reduced oxygen when oxygen that has dispersed through the oxygen permeable diaphragm produces a reductive reaction on the surface of the active electrode (gold). The method of measuring dissolved oxygen based on the above principle is called the Membrane Electrode Method. Compared to the Chemical Analysis Method, which requires complicated pre-processing to alleviate the effect of reduced materials and oxidizing materials, this method allows dissolved oxygen to be measured very easily. It is also easy to remove undesired buildup from the silver electrode by polishing and cleaning if an insulator forms on it due to oxidation, making the method reusable.

6.4.2 Salinity calibration

When the solution and air come into contact and form an equilibrium (i.e. saturation), the relationship between the concentration of dissolved oxygen in the solution, C, [mol/L], and the partial pressure of oxygen in the air, Ps, [MPa/(mg/L)], can be represented by the following formula:

$$C = Ps/H$$

Where H [MPa/(mg/L)] is the Henry constant, a value that changes according to the composition of the solution. As H typically becomes larger as the salinity of the water increases, C becomes smaller.

The DO sensor detects the partial pressure of oxygen (Ps) in the above formula. Accordingly, if the DO sensor is immersed in deionized water saturated with air, or in an aqueous solution containing salt, the output current does not change, resulting in an erroneous measurement. For example, when salt is added to a sample, the amount of oxygen that can be dissolved in the solution decreases, but because the partial pressure of oxygen does not change, the value displayed by the control unit stays the same regardless of salt content. This concept is indicated in graph form below. (Fig. 2)

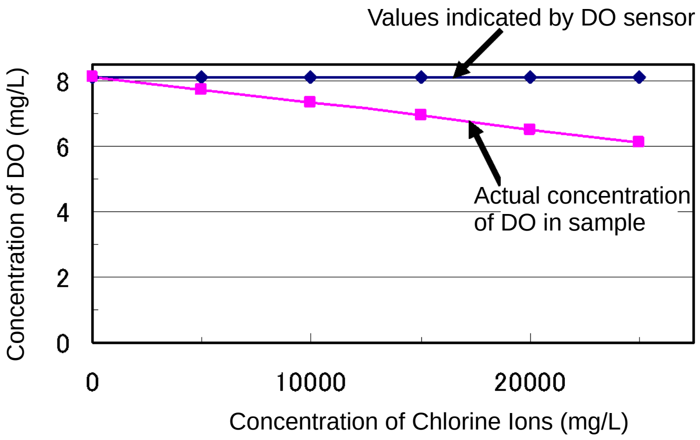


Fig. 2 Relationship between chlorine ion concentration and dissolved oxygen concentration

In samples with a high salt concentration, the solubility of oxygen is lower, but as the partial pressure of oxygen does not change, the value actually indicated on the control unit is higher than the actual value. In order to obtain a measurement of the concentration of dissolved oxygen in an aqueous solution that contains salt, it is therefore necessary to first perform salinity compensation. Conventionally, dissolved oxygen sensors have performed salinity compensation by inputting the salinity of the sample. This is fine as long as the salinity is already known. However, in most cases salinity is unknown, so even if dissolved oxygen sensors contained a salinity compensation function, it was of no practical use.

The U-50 Series can calculate and measure salinity in samples from electrical conductivity values, and can thus be used to automatically compensate for salinity.

6.5 Conductivity (COND) measurement

6.5.1 Four-AC-electrode method

Conductivity is an index of the flow of electrical current in a substance.

Salts dissolved in water are separated into cations and anions. Such solution is called electrolytic solution.

Electrolytic solution has the property of allowing the flow of current according to Ohm’s law. This property is referred

to as ionic conductivity, since current flow is caused by ion movement in electrolytic solution.

Metals, on the other hand, allow the flow of current by means of electrons. This property is called electronic conductivity,

which is distinguished from ionic conductivity.

A cube with 1 m on each side, as shown in Fig. 3, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with solution. If the resistance between these two electrode plates is represented by r(Ω), the conductivity of the solution L($S{\cdot}m^{-1}$) is represented as L=1/r. S stands for Siemens, a unit of measurement of conductance.

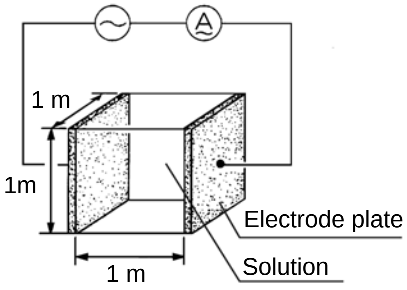


Fig. 3 Definition of conductivity

The most general method for measuring conductivity is based on the above principle, and is called the 2-electrode method.

In the 2-electrode method the influence of polarization cannot be ignored for solutions with high conductivity and conductivity cannot be measure accurately. In addition, contamination on the surface of the electrode increases apparent resistance, resulting in inaccurate measurement of conductivity.

The U-50 series has adopted the 4-electrode method to overcome these disadvantages of the the 2-electrode method.

As shown in Fig. 4, the U-50 series uses two voltage-detecting electrodes and two voltage-applying electrodes, for a total of four electrodes. The voltage-detecting electrodes are for detecting AC voltage, and the voltage-applying electrodes are for applying AC voltage.

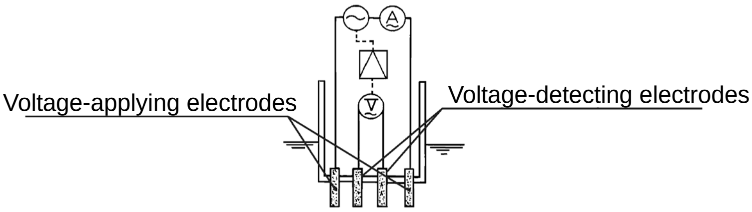


Fig. 4 Principle of the 4-electrode method

Let us assume that the current, I(A), flows in a sample of conductivity L – under automatic control of the voltage-applying electrodes – so that the voltage at the voltage-detecting-electrodes, E(V), remains constant at all times.

Then, the resistance of the sample, R(Ω), across the voltage-detecting electrodes is represented as R=E/I. The resistance, R, of the sample is inversely proportional to its conductivity, L. Accordingly, a measurement of current, Is,

of a standard solution of known conductivity, Ls, enables calculation of conductivity of a sample according to the formula L = Ls (I/Is) from the ratio L : Ls = I : Is.

Even in the 4-electrode method, polarization occurs, since AC current flows in the voltage-applying electrodes. The voltage-detecting electrodes are, however, free from the effects of polarization, since they are separated from the voltage-applying electrodes, and furthermore, current flow is negligible. Therefore, the 4-electrode method is an excellent method to enable measurement of conductivity covering a very high range.

6.5.2 SI units

New measurement units, called SI units, have been in use from 1996. Accordingly, the U-50 series also uses SI units. The following conversion table is provided for people who use the conventional kind of conductivity meter.

Note that along with the change in unit systems, the measurement values and cell counts have also changed.

	Former units	→	SI unit
Measurement value	0.1 mS/cm 1 mS/cm 100 mS/cm	→ → →	0.01 S/m 0.1 S/m 10 S/m

6.5.3 Temperature coefficient

In general, the conductivity of a solution varies largely with its temperature.

The conductivity of a solution depends on the ionic conductivity, described earlier. As the temperature rises, conductivity becomes higher since the movement of the ions becomes more active.

The temperature coefficient shows the change in % of conductivity per °C, with a certain temperature taken as the reference temperature. This is expressed in units of %/°C. The temperature coefficient assumes the premise that the conductivity of a sample changes linearly according to temperature.

Strictly speaking, with actual samples, however, conductivity changes along a curve. Furthermore, the cuve varies with the type of sample. In the ranges of smaller temperature changes, however, samples are said to have the temperature coefficient of 2%/°C (at reference temperature 25°C); this holds for most samples, except in certain special cases.

(The temperature coefficients for various types of solutions are listed on the next page.)

The U-50 series uses an automatic temperature conversion function to calculate conductivity at 25°C at a temperature

coefficient of 2 %/°C based on the measured value of the temperature. Results are displayed on the readout.

The U-50 series’s temperature conversion function is based on the following formula.

$L_{25} = L_t / \{ 1 + K (t - 25) \}$

L_{25} : Conductivity of solution converted to 25°C

t : Temperature of solution at time of measurement (°C)

L_t : Conductivity of solution at t (°C)

K : Temperature coefficient (%/°C)

Conductivity and temperature coefficient for various solutions

Conductivity and related temperature coefficients of representative substances (at 25°C) are shown in the table below.

Substance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)	Substance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)
NaOH	15	5	19.69	2.01	NaCl	18	5	6.72	2.17
		10	31.24	2.17			10	12.11	2.14
		15	34.63	2.49			15	16.42	2.12
		20	32.70	2.99			20	19.57	2.16
		30	20.22	4.50			25	21.35	2.27
		40	11.64	6.48	Na_2SO_4	18	5	4.09	2.36
KOH	15	25.2	54.03	2.09			10	6.87	2.49
		29.4	54.34	2.21			15	8.86	2.56
		33.6	52.21	2.36	Na_2CO_3	18	5	4.56	2.52
		42	42.12	2.83			10	7.05	2.71
NH_3	15	0.1	0.0251	2.46			15	8.36	2.94
		1.6	0.0867	2.38	KCl	18	5	6.90	2.01
		4.01	0.1095	2.50			10	13.59	1.88
		8.03	0.1038	2.62			15	20.20	1.79
		16.15	0.0632	3.01			20	26.77	1.68
HF	18	1.5	1.98	7.20			21	28.10	1.66
		4.8	5.93	6.66	KBr	15	5	4.65	2.06
		24.5	28.32	5.83			10	9.28	1.94
HCl	18	5	39.48	1.58			20	19.07	1.77
		10	63.02	1.56	KCN	15	3.25	5.07	2.07
		20	76.15	1.54			6.5	10.26	1.93
		30	66.20	1.52			—	—	—
H_2S0_4	18	5	20.85	1.21	NH_4Cl	18	5	9.18	1.98
		10	39.15	1.28			10	17.76	1.86
		20	65.27	1.45			15	25.86	1.71
		40	68.00	1.78			20	33.65	1.61
		50	54.05	1.93			25	40.25	1.54
		60	37.26	2.13	NH_4NO_3	15	5	5.90	2.03
		80	11.05	3.49			10	11.17	1.94
		100.14	1.87	0.30			30	28.41	1.68
		—	—	—			50	36.22	1.56
HNO_3	18	6.2	31.23	1.47	$CuSO_4$	18	2.5	10.90	2.13
		12.4	54.18	1.42			5	18.90	2.16
		31	78.19	1.39			10	32.00	2.18
		49.6	63.41	1.57			15	42.10	2.31
		62	49.64	1.57	CH_3COOH	18	10	15.26	1.69
H_3PO_4	15	10	5.66	1.04			15	16.19	1.74
		20	11.29	1.14			20	16.05	1.79
		40	20.70	1.50			30	14.01	1.86
		45	20.87	1.61			40	10.81	1.96
		50	20.73	1.74			60	4.56	2.06

6.6 Salinity (SAL) conversion

The U-50 series is designed to calculate salinity as well as the other parameters.

Note that the “salinity” here is the salinity of sea water. There is a constant relation between conductivity and salinity at certain temperatures.

Therefore, if data on the conductivity and temperature are available, the corresponding salinity can be known. In other words, the salinity measurement of the U-50 series is based on the principle of calculating the salt content, making use of the measured values of conductivity and temperature.

Note therefore, that measured results of all substances whose conductivity is detected are displayed as salinity. For example, the measured result is displayed as NaCl concentration, even if in fact the sample component is, hydrochloric acid (HCl).

6.7 TDS conversion

TDS is short for Total Dissolved Solids and means the total dissolved solid amount.

The conductivity of a solution is affected by the amount of salinity, minerals, and dissolved gases. That is, conductivity is an index that shows the total amount of all substances in the solution. Of these substances, TDS indicates only the amount of dissolved solids.

TDS can be used for a comparison of the state of substances composed of a single component such as NaCl. However, the use of TDS for the comparison of solutions of different types causes serious errors.

Conductivity and TDS are expressed by the following formulas.

Conductivity in SI units (S/m) .... TDS(g/L) = L (S/m) × K × 10

TDS(g/L) = L (mS/m) × K ÷ 100

Conductivity in the old units (mS/cm) .... TDS(g/L) = L (mS/cm)× K

K = TDS coefficient

Initial settings use the values listed in the table (Page 80) that generally uses TDS coefficients.

For accurate TDS comparisons, find the TDS coefficient from measured conductivity values. Then set the value thus obtained and make measurements.

6.8 σt conversion

● Specific gravity of seawater

The density and specific gravity of seawater are equal numerically and generally are not distinguished strictly. Since seawater density ρ is between 1.000 and 1.031, 1 is subtracted from ρ and σ is obtained by multiplying the value by 1000.

The resultant value is used as the specific gravity of seawater.

$\sigma = (\rho - 1) \times 1000$

The density of seawater ρ is expressed by function of temperature, hydraulic pressure, and salinity. The density of seawater under the atmospheric pressure is expressed as σ_t. The density of seawater under the atmospheric pressure is determined by temperature and salinity.

The U-50 Series models make salinity measurement through temperature measurements and conductivity conversion and find σ_t through calculations.

In Japan σ_{15} at 15°C is called a standard specific gravity and widely used while in foreign countries σ_0 at 0°C is employed. σ_{15} and σ_0 are determined by the function of salinity.

In ocean surveys, in particular, these values σ_t, σ_{15}, and σ_0 are more widely used than conductivity and salinity and, in the U-50 Series models, newly added as measurement components.

6.9 Turbidity (TURB) measurement

6.9.1 Principle of turbidity measurement

U-52 and U-53 sensors measure turbidity using the Transmitting and Scattering Method shown in Fig. 5. U-52 sensors use a pulse light LED (infra-red emitting diode) as a light source, and detect scattered light from a 30° angle off center. U-53 sensors use a tungsten lamp as a light source and detect scattered light from a 90° angle. Both models display turbidity as a ratio of scattered light to transmitted light to reduce the affect of the color of the sample. The U-53 method conforms to EPA Method 180.1, and employs wipers to reduce the affect of air bubbles.

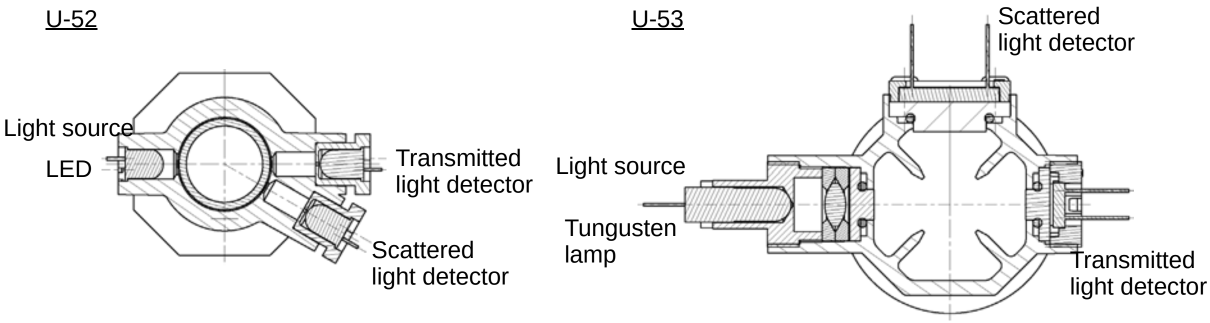


Fig. 5 Turbidity cell

6.9.2 Standard solution

U-50 series can perform calibration using formazin (NTU) or kaolin standard solutions as a turbidity standard solution. However, units for the solution used for calibration should be displayed in measurements. Do not use more than 400 mg/L of kaolin standard solution because it increases precipitation speed, resulting in measurement error.

6.10 Depth (DEPTH) measurement

6.10.1 Principle of depth measurement

For the W-22XD and W-23XD models, depth measurement can be made through use of a pressure gauge. The principle of the depth measurement uses the relation between depth and pressure.

Although the measurement with the depth sensor is affected by atmospheric pressure, the depth sensor, however, makes zero-point adjustments through the automatic calibration before measurements.

6.10.2 Influence of temperature and calibration

The depth sensor depends greatly on temperature. For a wide difference between the temperature at which the sensor has been automatically calibrated and the temperature of the measurement sample, the sensor can make depth measurements with a higher accuracy by the following method:

1. **Immerse the depth sensor of the sensor probe in the sample.**
2. **Keep the sensor immersed in the sample for about 30 minutes until the temperatures of the sensor and the sample are the same.**
3. **Then make the zero calibration of the sensor manually.**

6.11 Oxidation reduction potential (ORP) measurement

6.11.1 Principle of ORP measurement

ORP is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants (M^{Z+}) and reductants $M^{(Z-N)+}$ that coexist within a solution.

$$M^{Z+} + ne^{-} \Leftrightarrow M^{(Z-N)+} \quad \cdots (1)$$

If only the solution, forming the ORP measuring system shown in Fig. 6. The difference of potential between two electrodes is generally expressed by the following equation.

$$E = E_0 - \frac{RT}{nF} \ln \frac{a_M{}^{(z-n)+}}{a_M{}^{z+}} \quad \cdots (2)$$

E: Electric potential E_0 : Constant R: Gas constant T : Absolute temperature
n: Electron count F : Faraday constant a : Activity

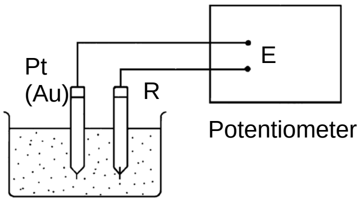


Fig. 6 Measuring mV

For example, for a solution in which trivalent iron ions coexist with bivalent iron ions, equations 1 and 2 would be as follows.

$$Fe^{3+} + e^{-} \Leftrightarrow Fe^{2+} \quad \cdots (1)$$

$$E = E_0 - \frac{RT}{F} \ln \frac{a_{Fe}{}^{2+}}{a_{Fe}{}^{3+}} \quad \cdots (2)$$

When only one type of state of equilibrium uniquely by equation (Fe^{3+}) and the reductant (Fe^{2+}) (using the equation $a_{Fe}{}^{2+}/ a_{Fe}{}^{3+}$). Actually, however many kinds of states of equilibrium exist simultaneously between various kinds of ions, in most solutions. This means that under actual circumstances, ORP cannot be expressed using the simple equation shown above and that the physical and chemical significance with respect to the solution is not very clear.

In this respect, the value of ORP must be understood to be only one indicator of the property of a solution. The measurement of ORP is widely used, however, as an important index in the analysis of solutions (potentiometric titration) and in the waste water treatment.

6.11.2 Standard electrode (reference electrode) types and ORP

The ORP is obtained comparing with corresponding reference electrode employed.

If different kinds of reference electrodes are used for measurement, the ORP value of the same solution may appear to be different. HORIBA’s reference electrode uses Ag/AgCl with 3.33 mol/L KCl as inner solution. According to general technical literature, normal hydrogen electrodes (N.H.E.) are often used as the standard electrode.

The relationship between N.H.E. and the ORP that is measured using an Ag/AgCl with 3.33 mol/L KCl electrode is expressed by the following equation.

$E_{N.H.E.} = E + 206 - 0.7(t - 25)$ mV $t = 0$ - 60°C

$E_{N.H.E.}$: Measured ORP value using N.H.E. as the reference electrode

E: Measured ORP value using Ag/AgCl with 3.33 mol/L KCl as the reference electrode

Potential sign

Standard ORP is expressed in the following way, in literature related to electrochemistry and analytical chemistry.

A $Li^+ + e^- \rightarrow Li$

$E_0 = -3.024$ V VS N.H.E.

However, in some literature, the "+" and "-" signs are reversed.

B $Li \rightarrow Li^+ + e^-$

$E_0 = +3.024$ V VS N.H.E.

In expressions like B, above, the reaction is just reversed and there is no essential difference. But this kind of expression does invite confusion. The majority of the world, today, is consistent in its use of the signs as they are used in A, above.

For this reason, HORIBA, too, uses signs concerning ORP that are consistent with A, above.

HORIBA, Ltd.
2 Miyanohigashi, Kisshoin Minami-ku, Kyoto 601-8510 Japan
http://www.horiba.com

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image/WEEE_and_Batteries.tif 3
image/W_Danger.tif @ 1200 dpi 4
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MiniRAE 3000
User's Guide

Rev. C
August 2010
P/N 059-4020-000

FCC Information

Contains FCC ID: PI4411B

The enclosed device complies with part 15 of the FCC rules. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

Contents

Read Before Operating

This manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions. The user should understand how to set the correct parameters and interpret the obtained results.

CAUTION!

To reduce the risk of electric shock, turn the power off before removing the instrument cover. Disconnect the battery before removing sensor module for service. Never operate the instrument when the cover is removed. Remove instrument cover and sensor module only in an area known to be non-hazardous.

Special Notes

⚠ When the instrument is taken out of the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the instrument. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

⚠ The battery of the instrument discharges slowly even if it is turned off. If the instrument has not been charged for 5 to 7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the instrument before using it. It is also recommended to fully charge the instrument for *at least 10 hours* before first use. Refer to this User Guide’s section on battery charging for more information on battery charging and replacement.

WARNINGS

STATIC HAZARD: Clean only with damp cloth.

For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.

Use only RAE Systems battery packs, part numbers 059-3051-000, 059-3052-000, and 059-3054-000. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.

Do not mix old and new batteries or batteries from different manufacturers.

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service.

For maximum safety, the accuracy of the instrument should be checked by exposing it to a known concentration calibration gas before each day's use.

Do not use USB/PC communication in hazardous locations.

AVERTISSEMENT

DANGER RISQUE D'ORIGINE ELECTROSTATIQUE: Nettoyer uniquement avec un chiffon humide.

Pour des raisons de sécurité, cet équipment doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Utiliser seulement l'ensemble de batterie RAE Systems, la reference 059-3051-000 au 059-3052-000 au 059-3054-000. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsique. Ne charger les batteries que dans emplacements désignés non-dangereuse.

Ne pas melanger les anciennes et les nouvelles batteries, ou bien encore les batteries de differents fabriquants.

La calibration de toute instruments de RAE Systems doivent être testé en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant de mettre en service l'instrument pour la première fois.

Pour une securite maximale, la sensibilité du l'instrument doit être verifier en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.

Ne pas utiliser de connection USB/PC en zone dangereuse.

Standard Contents

Instrument
Calibration Kit
Charging Cradle
AC/DC Adapter
Alkaline Battery Adapter
Data Cable
CD-ROM With User's Guide, Quick Start Guide, and related materials

General Information

The compact instrument is designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a photoionization detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas-discharge lamp. Features are:

Lightweight and Compact

- Compact, lightweight, rugged design
- Built-in sample draw pump

Dependable and Accurate

- Up to 16 hours of continuous monitoring with rechargeable battery pack
- Designed to continuously monitor VOC vapor at parts-per-million (ppm) levels

User-friendly

- Preset alarm thresholds for STEL, TWA, low- and high-level peak values.
- Audio buzzer and flashing LED display are activated when the limits are exceeded.

Datalogging Capabilities

- 260,000-point datalogging storage capacity for data download to PC

The instrument consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged case with a backlit LCD and 3 keys to provide easy user interface. It also has a built-in flashlight for operational ease in dark locations.

Physical Description

The main components of the portable VOC monitoring instrument include:

- Three keys for user to interact with the instrument: 3 operation/programming keys for normal operation or programming
- LCD display with back light for direct readout and calculated measurements
- Built-in flashlight for illuminating testing points in dark environments
- Buzzer and red LEDs for alarm signaling whenever exposures exceed preset limits
- Charge contacts for plugging directly to its charging station
- Gas entry and exit ports
- USB communication port for PC interface
- Protective rubber cover

Specifications

Size:	9.25" L x 3.6" W x 2.9" H
Weight:	28 oz with battery pack
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 3.7V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only) Alkaline battery holder (for 4 AA batteries)
Battery Charging:	Less than 8 hours to full charge
Operating Hours:	Up to16 hours continuous operation
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0.1 ppm to 15,000 ppm	0.1 ppm
9.8 eV	0.1 ppm to 5,000 ppm	0.1 ppm
11.7 eV	0.1 ppm to 2,000 ppm	0.1 ppm

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	10 to 2000 ppm: ±3% at calibration point.
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration:	Two-point field calibration of zero and standard reference gases
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing
Radio module:	Bluetooth (2.4GHz), RF module (433MHz, 868MHz , 915MHz, or 2.4GHz)
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A, B, C, D Europe: ATEX (0575 Ex II 2G Ex ia IIC/IIB T4 Gb) KEMA 07 ATEX 0127 Complies with EN60079-0:2009, EN60079-11:2007

	IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0:2007, IEC 60079-11:2006 (IIC: 059-3051-000 Li-ion bat pack or 059-3054-000 NiMH bat pack; IIB: 059-3052-000 alkaline bat pack)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC R&TTE (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 30cm and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station.
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

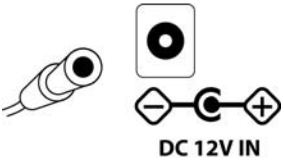
Charging The Battery

Always fully charge the battery before using the instrument. The instrument’s Li-ion battery is charged by placing the instrument in its cradle. Contacts on the bottom of the instrument meet the cradle’s contacts, transferring power without other connections.

Note: Before setting the instrument into its charging cradle, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter’s barrel connector into the instrument’s cradle.



2. Plug the AC/DC adapter into the wall outlet.
3. Place the instrument into the cradle, press down, and lean it back. It locks in place and the LED in the cradle glow

The instrument begins charging automatically. The “Primary” LED in the cradle blinks green to indicate charging. During charging, the diagonal lines in the battery icon on the instrument’s display are animated and you see the message “Charging...”

When the instrument’s battery is fully charged, the battery icon is no longer animated and shows a full battery. The message “Fully charged!” is shown. The cradle’s LED glows continuously green.

Note: If you see the “Battery Charging Error” icon (a battery outline with an exclamation mark inside), check that the instrument or rechargeable battery has been set into the cradle properly. If you still receive the message, check the Troubleshooting section of this guide.

Note: If the instrument or battery has been in the cradle for more than 10 hours and you see the "Battery Charging Error" icon and a message that says, "Charging Too Long," this indicates that the battery is not reaching a full charge. Try changing the battery and make sure the contacts between the instrument (or battery) are meeting the cradle. If the message is still shown, consult your distributor or RAE Systems Technical Services.

Charging A Spare Rechargeable Battery

A rechargeable Li-ion battery can be charged when it is not inside the monitor. The charging cradle is designed to accommodate both types of charging. Contacts on the bottom of the battery meet the contacts on the cradle, transferring power without other connections, and a spring-loaded capture holds the battery in place during charging.

1. Plug the AC/DC adapter into the monitor's cradle.
2. Place the battery into the cradle, with the gold-plated contacts on top of the six matching charging pins.
3. Plug the AC/DC adapter into the wall outlet.

The battery begins charging automatically. During charging, the Secondary LED in the cradle blinks green. When charging is complete, it glows steady green.

Release the battery from the cradle by pulling it back toward the rear of the cradle and tilting it out of its slot.

Note: If you need to replace the Li-ion battery pack, replacements are available from RAE Systems. The part number is 059-3051-000.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. Remove and replace batteries only in areas known to be non-hazardous.

Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the "empty battery" icon blinks on and off once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion battery or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

Data Protection While Power Is Off

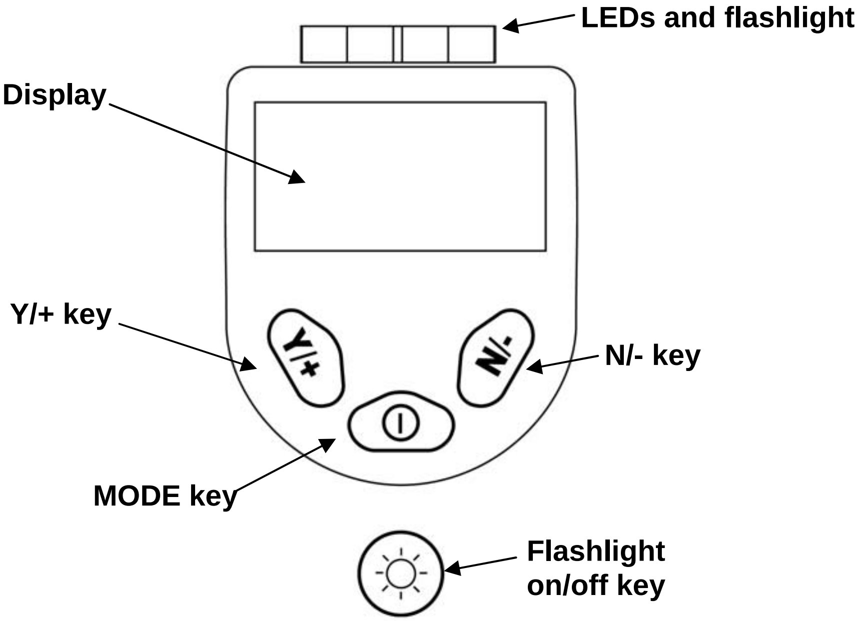
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

User Interface

The instrument's user interface consists of the display, LEDs, an alarm transducer, and four keys. The keys are:

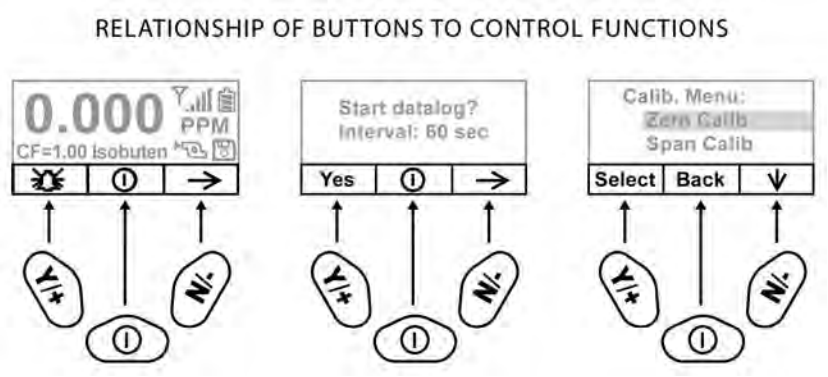
Y/+
MODE
N/-
Flashlight on/off

The LCD display provides visual feedback that includes the reading, time, battery condition, and other functions.



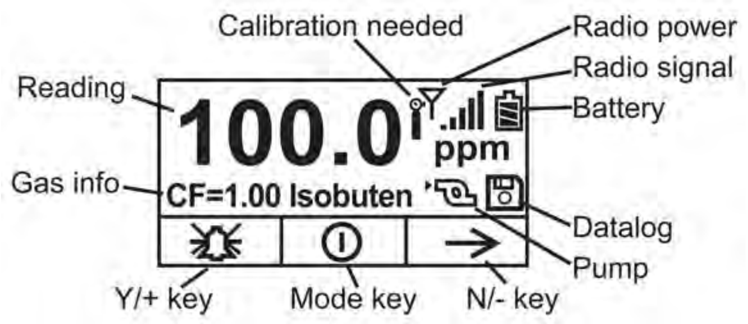
In addition to their labeled functions, the keys labeled Y/+, MODE, and N/- act as "soft keys" that control different parameters and make different selections within the instrument's menus. From menu to menu, each key controls a different parameter or makes a different selection.

Three panes along the bottom of the display are "mapped" to the keys. These change as menus change, but at all times the left pane corresponds to the [Y/+] key, the center pane corresponds to the [MODE] key, and the right pane corresponds to the [N/-] key. Here are three examples of different menus with the relationships of the keys clearly shown:



Display

The display shows the following information:



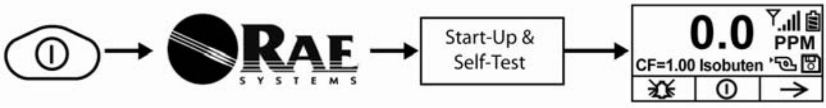
Graph	Graphic representation of concentration plotted over time
Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration needed	Indicates that calibration should be performed
Radio power	Indicates whether radio connection is on or off
Radio signal	Indicates signal strength in 5-bar bargraph
Battery	Indicates battery level in 3 bars
Pump	Indicates that pump is working
Datalog	Indicates whether datalog is on or off
Y/+	Y/+ key's function for this screen
MODE	MODE key's function for this screen
N/-	N/- key's function for this screen

Operating The Instrument

The instrument is designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real-time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment, the instrument is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, you should test the instrument and verify the calibration before the first use. After the instrument is fully charged and calibrated, it is ready for immediate operation.

Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.



The RAE Systems logo should appear first. (If the logo does not appear, there is likely a problem and you should contact your distributor or RAE Systems Technical Support.) The instrument is now operating and performs self tests. If any tests (including sensor and memory tests fail), refer to the Troubleshooting section of this guide.

Once the startup procedure is complete, the instrument shows a numerical reading screen with icons. This indicates that the instrument is fully functional and ready to use.

Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. Once the countdown stops, the instrument is off. Release the Mode key.
3. When you see “Unit off...” release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

Operating The Built-In Flashlight

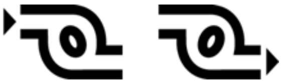
The instrument has a built-in flashlight that helps you point the probe in dark places. Press the flashlight key to turn it on. Press it again to turn it off.

Note: Using the flashlight for extended periods shortens the battery’s operating time before it needs recharging.

Pump Status

IMPORTANT!

During operation, make sure the probe inlet and the gas outlet are free of obstructions. Obstructions can cause premature wear on the pump, false readings, or pump stalling. During normal operation, the pump icon alternately shows inflow and outflow as shown here:



During duty cycling (PID lamp cleaning), the display shows these icons in alternation:

If there is a pump failure or obstruction that disrupts the pump, you will see this icon blinking on and off:

If you see this blinking icon, consult the Troubleshooting section of this guide.

Calibration Status

The instrument displays this icon if it requires calibration:

Calibration is required (and indicated by this icon) if:

- The lamp type has been changed (for example, from 10.6 eV to 9.8 eV).
- The sensor has been replaced.
- It has been 30 days or more since the instrument was last calibrated.
- If you have changed the calibration gas type without recalibrating the instrument.

Operating Modes

Your instrument operates in different modes, depending on the model and its factory default settings. In some cases, you can change modes using a password and using the instrument’s navigation. In other cases, you must use ProRAE Studio software.

The default setting for your instrument is:

User Mode: Basic
Operation Mode: Hygiene

This is outlined in detail on page 74.

The other options, covered later in this guide, are:

User Mode: Advanced (page 78)
Operation Mode: Hygiene

User Mode: Advanced (page 82)
Operation Mode: Search

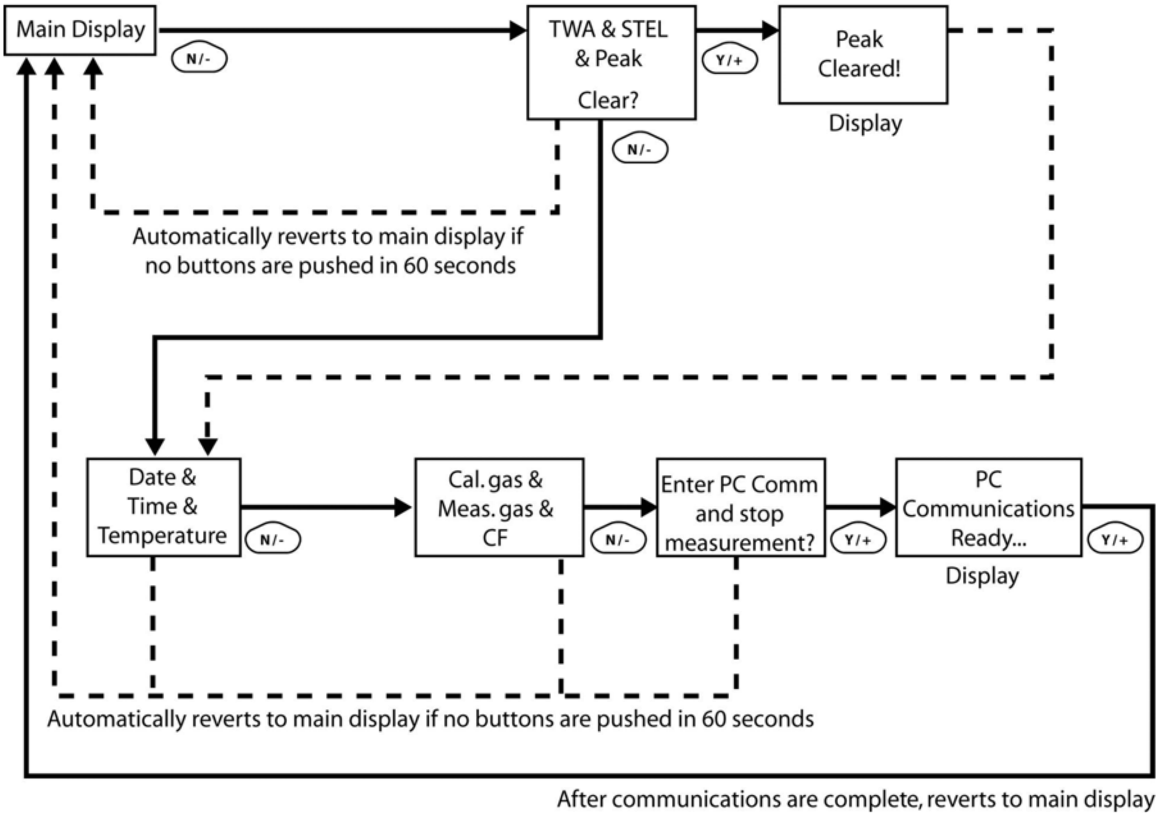
Using ProRAE Studio allows access to other options. In addition, Diagnostic Mode (page 83) is available for service technicians.

Basic User Level/Hygiene Mode (Default Settings)

The instrument is programmed to operate in Basic User Level/Hygiene Mode as its default. This gives you the most commonly needed features while requiring the fewest parameter adjustments.

Pressing [N/-] steps you from one screen to the next, and eventually return to the main display. If you do not press a key within 60 seconds after entering a display, the instrument reverts to its main display.

Note: While viewing any of these screens, you can shut off your instrument by pressing [MODE].



Note: Dashed line indicates automatic progression.

After the instrument is turned on, it runs through the start-up menu. Then the message "**Please apply zero gas…**" is displayed.

At this point, you can perform a zero air (fresh air) calibration. If the ambient air is clean, you can use that. Otherwise, use a cylinder of zero air. Refer to Zero Calibration on page 37 for a more detailed description of zero calibration.

Start zero calibration by pressing Start. You see the message "Zeroing…" followed by a 30-second countdown.

Note: You can press [MODE] to quit, bypassing the zero air calibration.

When zero calibration is complete, you see the message:

Zeroing is done!

Reading = 0.0 ppm

The instrument is now sampling and collecting data.

Note: At the Average & Peak, Date & Time & Temperature, Calibration Gas & Measurement Gas & Correction Factor, and PC Communications screens, the instrument automatically goes to the main display after 60 seconds if you do not push a key to make a selection.

Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition.

In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, or pump stall.

Alarm Signal Summary

Message	Condition	Alarm Signal
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

* Hygiene mode only. In Search mode, the number of beeps per second (1 to 7) depends upon the concentration of the sampled gas. Faster rates indicate higher concentrations.

Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas (Isobutylene)	Cal Span	unit	Low	High	TWA	STEL
MiniRAE 3000	100	ppm	50	100	10	25

Testing The Alarm

You can test the alarm whenever the main (Reading) display is shown. Press [Y/+], and the audible and visible alarms are tested.

Integrated Sampling Pump

The instrument includes an integrated sampling pump. This diaphragm-type pump that provides a 450 to 550 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8" inside diameter to the gas inlet port of the instrument, this pump can pull in air samples from 100' (30 m) away horizontally or vertically.

Note: In Search Mode, the pump turns on when a sample measurement is started, and turns off when the sample is manually stopped.

If liquid or other objects are pulled into the inlet port filter, the instrument detects the obstruction and immediately shuts down the pump. The alarm is activated and a flashing pump icon is displayed.

You should acknowledge the pump shutoff condition by clearing the obstruction and pressing the [Y/+] key while in the main reading display to restart the pump.

Backlight

The LCD display is equipped with an LED backlight to assist in reading the display under poor lighting conditions.

Datalogging

During datalogging, the instrument displays a disk icon to indicate that datalogging is enabled. The instrument stores the measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information is stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down- loaded at a later time to a PC.

Datalogging event

When Datalogging is enabled, measurement readings are being saved. These data are stored in "groups" or "events." A new event is created and stored each time the instrument is turned on and is set to automatic datalogging, or a configuration parameter is changed, or datalogging is interrupted. The maximum time for one event is 24 hours or 28,800 points. If an event exceeds 24 hours, a new event is automatically created. Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits are recorded.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. When transferred to a PC running ProRAE Studio, this data is arranged with a sample number, time, date, gas concentration, and other related information.

Auto/Manual/Snapshot Datalogging

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see page 63 for details).
Snapshot	Datalogs only during snapshot (single-event capture, initiated by pressing [MODE]) sampling. See page 65 for details.

Note: You can only choose one datalog type to be active at a time.

Accessories

The following accessories are included with the instrument:

- An AC Adapter (Battery Charger)
- Alkaline battery adapter
- External Filter
- Organic Vapor Zeroing kit

Hard-case kits also include these accessories:

- Calibration adapter
- Calibration regulator and Flow controller

Standard Kit & Accessories

AC Adapter (Battery Charger)

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Ne charger les batteries que dans emplacements designés non-dangereuses.

A battery charging circuit is built into the instrument cradle. It only needs a regular AC to 12 VDC adapter (wall-mount transformer, part number 500-0114-000) to charge the instrument.

To charge the battery inside the instrument:

1. Power off the instrument.
2. Connect the AC adapter to the DC jack on the instrument's cradle. If the instrument is off, it automatically turns on.
3. While charging, the display message shows "Charging." The Primary LED on the cradle flashes green when charging.
4. When the battery is fully charged, the LED changes to glowing green continuously, and the message "Fully charged" appears on the

display. If there is a charging error, the LED glows red continuously.

A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

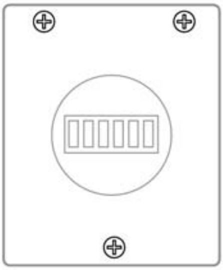
The factory-supplied battery is designed to last for 16 hours of normal operation (no alarm), for a new battery under the optimum circumstances. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), its capacity will be significantly reduced.

Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment in the adapter.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.



To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the instrument by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument. If you try to charge an alkaline batteries installed in the instrument, the instrument's display will say, "Alkaline Battery," indicating that it will not charge the alkaline batteries.

Note: When replacing alkaline batteries, dispose of old ones properly.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

External Filter

The external filter is made of PTFE (Teflon®) membrane with a 0.45 micron pore size to prevent dust or other particles from being sucked into the sensor manifold, which would cause extensive damage to the instrument. It prolongs the operating life of the sensor. To install the external filter, simply connect it to the instrument's inlet tube.

Optional Accessories

Calibration Adapter

The calibration adapter for the instrument is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the instrument and the tubing to the gas regulator on the gas bottle.

Calibration Regulator

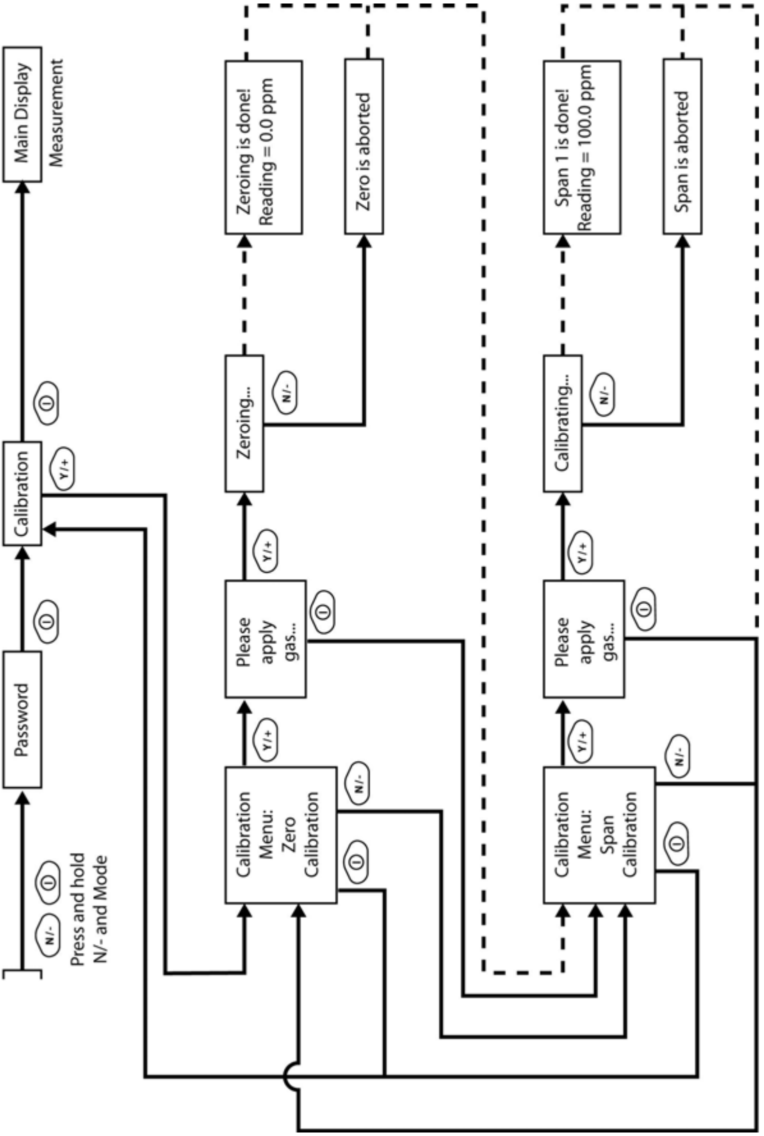
The Calibration Regulator is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the instrument during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a demand-flow regulator or a Tedlar gas bag may be used to match the pump flow precisely.

Organic Vapor Zeroing Kit

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the instrument.

Standard Two-Point Calibration (Zero & Span)

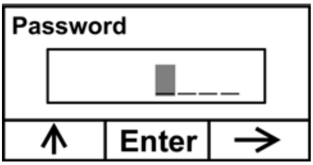
The following diagram shows the instrument’s calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

Entering Calibration

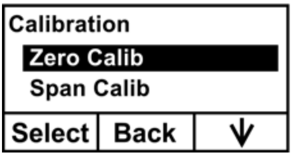
1. Press and hold [MODE] and [N/-] until you see the Password screen.



2. In Basic User Level, you do not need a password to perform calibrations. Instead of inputting a password, enter calibration by pressing [MODE].

   Note: If you inadvertently press [Y/+] and change any of the numbers, simply press [MODE] and you will be directed to the calibration menu.

The Calibration screen is now visible with Zero Calibration highlighted.



These are your options:

- Press [Y/+] to select the highlighted calibration (Zero Calib or Span Calib).
- Press [MODE] to exit calibration and return to the main display and resume measurement.
- Press [N/-] to toggle the highlighted calibration type.

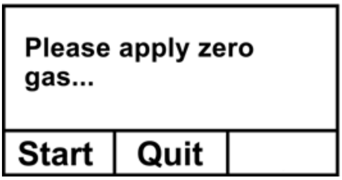
Zero (Fresh Air) Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the instrument to a “fresh” air source such as from a cylinder or Tedlar bag (optional accessory). The “fresh” air is clean, dry air without organic impurities and an oxygen value of 20.9%. If such an air cylinder is not available, any clean ambient air without detectable contaminants or a charcoal filter can be used.

At the Zero Calibration menu, you can proceed to perform a Zero calibration or bypass Zero calibration and perform a Span calibration. You may also go back to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to start calibration.
- Press [MODE] to quit and return to the main calibration display.

If you have pressed [Y/+] to enter Zero calibration, then you will see this message:



Please apply zero gas...

1. Turn on your Zero calibration gas.
2. Press [Y/+] to start calibration.

   Note: At this point, you may press [MODE] if you decide that you do not want to initiate calibration. This will take you directly to the Calibration menu, highlighted for Span calibration.

3. Zero calibration starts a 30-second countdown and displays this message:

   Zeroing...

During the zeroing process, the instrument performs the Zero calibration automatically and does not require any action on your part.

Note: To abort the zeroing process at any time and proceed to Span calibration, press [N/-] at any time while zeroing is being performed. You will see a confirmation message that says "Zero aborted!" and then the Span calibration menu appears.

When Zero calibration is complete, you see this message:

Zeroing is done!
Reading = 0.0 ppm

The instrument will then show the Calibration menu on its display, with Span Calib highlighted.

Span Calibration

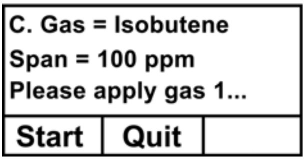
This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the instrument, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

At the Span Calibration menu, you perform a Span calibration. You may also go back to the Zero calibration menu or to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to enter Span calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

If you have pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm). You will also see this message that prompts you:



C. Gas = Isobutene
Span = 100 ppm
Please apply gas 1...

1. Turn on your span calibration gas.
2. Press [Y/+] to initiate calibration.

Note: You may press [MODE] if you decide that you do not want to initiate calibration. This will abort the span calibration and take you directly to the Calibration menu for Zero calibration.

3. Span calibration starts and displays this message:

Calibrating...

During the Span calibration process, there is a 30-second countdown and the instrument performs the Span calibration automatically. It requires no actions on your part.

Note: If you want to abort the Span calibration process, press [N/-] at any time during the process. You will see a confirmation message that says "Span is aborted!" and then the Zero calibration menu appears. You can then proceed to perform a Zero calibration, perform a Span calibration, or exit to the topmost Calibration menu.

When Span calibration is complete, you see a message similar to this (the value is an example only):

Span 1 is done!
Reading = 100.0 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

Exiting Two-Point Calibration In Basic User Level

When you are done performing calibrations, press [MODE], which corresponds with "Back" on the display. You will see the following message:

Updating settings…

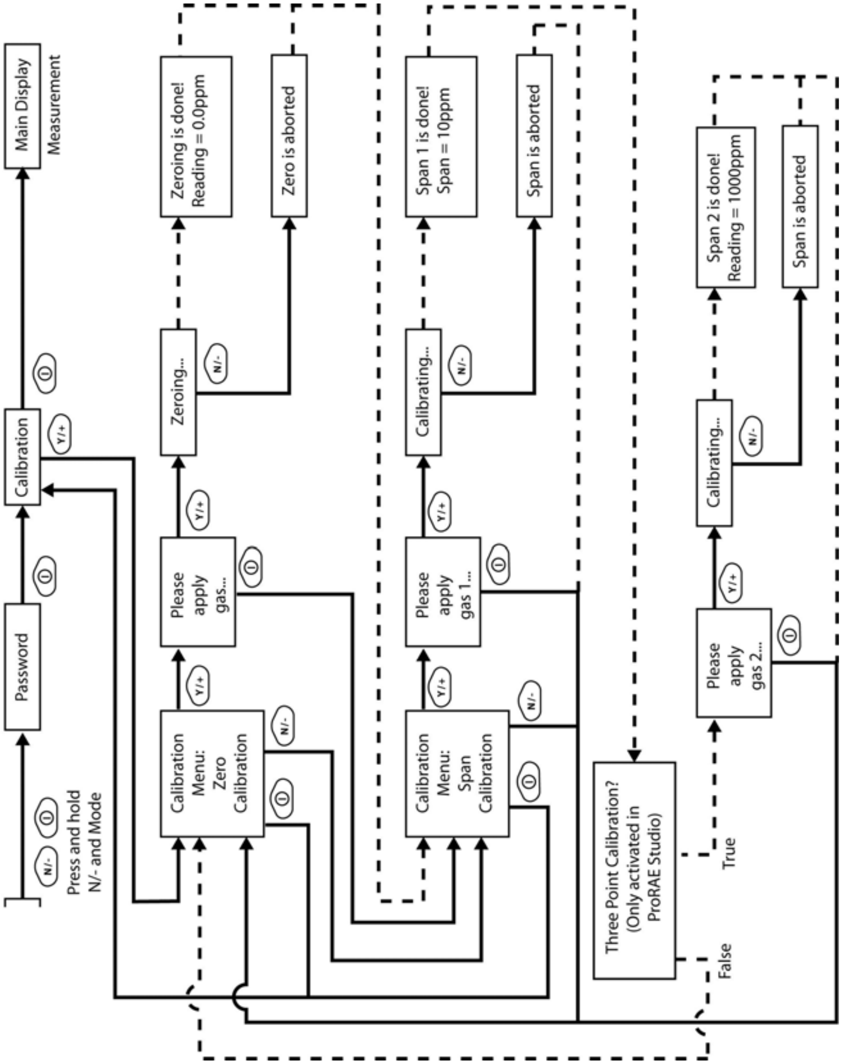
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

Three-Point Calibration

For enhanced accuracy, it is possible to perform a second Span calibration in addition to the Zero and Span calibrations outlined in the previous section. Your instrument first must be set to allow this third calibration. This requires using ProRAE Studio software and a PC, as well as a higher concentration of calibration gas.

Note: Once the third calibration is set, you do not need to use ProRAE Studio to allow future 3-point calibrations. Also, you can only disable 3-point calibration capability by using ProRAE Studio again.

Perform the Zero and Span calibrations. After the first Span calibration (Span 1) is completed, the display a second Span calibration (Span 2) can be performed. The process is identical to the first calibration. As in the Span 1 calibration, you may exit and return to the Zero calibration screen if you choose not to perform this calibration or to abort it.



Note: Dashed line indicates automatic progression.

Span 2 Calibration

A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure.

Note: This gas should be of a higher concentration than the gas used for Span 1 calibration.

Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the instrument, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

At the Span Calibration menu, you perform a Span calibration. You may also go back to the Zero calibration menu or to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to enter Span 2 calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

If you have pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm). You will also see this message that prompts you:

> Please apply gas...

4. Turn on your span calibration gas.
5. Press [Y/+] to initiate calibration.

Note: You may press [MODE] if you decide that you do not want to initiate calibration. This will take you directly to the Calibration menu for Zero calibration.

6. Span calibration starts a 30-second countdown and displays this message:

Calibrating...

During the Span calibration process, the instrument performs the Span calibration automatically and does not require any action on your part.

Note: If you want to abort the Span calibration process, press [N/-] at any time during the process. You will see a confirmation message that says "Span is aborted!" and then the Zero calibration menu will appear. You can then proceed to perform a Zero calibration, perform a Span calibration, or exit to the topmost Calibration menu.

When Span calibration is complete, you will see a message similar to this (the value shown here is for example only):

Span 2 is done!
Reading = 1000 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

Exiting Three-Point Calibration

When you are done performing calibrations, press [MODE], which corresponds with "Back" on the display. You will see the following message:

Updating settings…

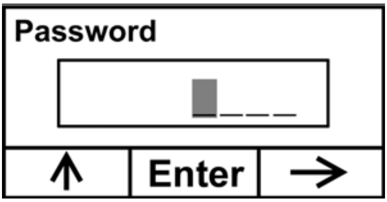
The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

Programming Mode

Programming Mode can be entered from either Hygiene Mode or Search Mode. If the current user mode is Basic, you must provide a 4-digit password to enter.

Entering Programming Mode

1. Press and hold [MODE] and [N/-] until you see the Password screen.



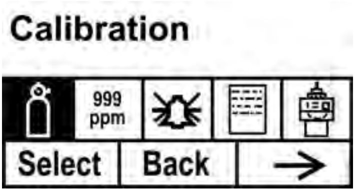
2. Input the 4-digit password:

- Increase the number from 0 through 9 by pressing [Y/+].
- Step from digit to digit using [N/-].
- Press [MODE] when you are done.

If you make a mistake, you can cycle through the digits by pressing [N/-] and then using [Y/+] to change the number in each position.

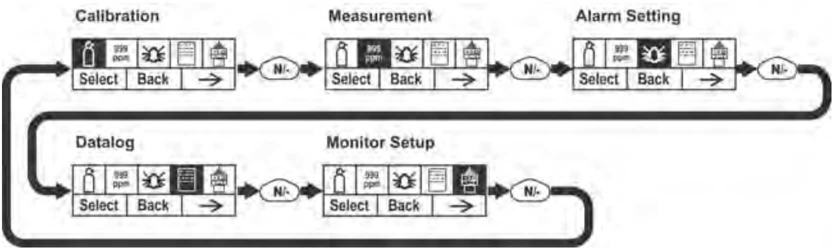
Note: The default password is 0000.

When you have successfully entered Programming Mode, you see this screen:



Note: The password can only be changed by connecting the instrument to a PC running ProRAE Studio software. Follow the instructions in ProRAE Studio to change it.

The Calibration label is shown and its icon is highlighted, but you can press [N/-] to step from one programming menu to the next, with the name of the menu shown at the top of the display and the corresponding icon highlighted. As you repeatedly press [N/-], the selection moves from left to right, and you see these screens:



Note: When you reach Monitor Setup and press [N/-], the menu cycles back to Calibration.

Programming Mode Menus

The Programming Mode allows anyone with the password to change the instrument's settings, calibrate the instrument, modify the sensor configuration, enter user information, etc. Programming Mode has five menus. Each menu includes several sub-menus to perform additional programming functions.

This table shows the menus and sub-menus:

	999 ppm			
Calibration	**Measurement**	**Alarm Setting**	**Datalog**	**Monitor Setup**
Zero Calibration	Meas. Gas	High Alarm	Clear Datalog	Op Mode
Span Calibration	Meas. Unit	Low Alarm	Interval	Site ID
		STEL Alarm	Data Selection	User ID
		TWA Alarm	Datalog Type	User Mode
		Alarm Type		Date
		Buzzer & Light		Time
				Pump Duty Cycle
				Pump Speed
				Temperature Unit
				Language
				Radio Power
				Real Time Protocol
				Power On Zero
				Unit ID
				LCD Contrast

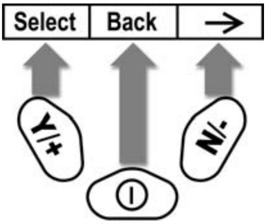
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

Exiting Programming Mode

To exit Programming Mode and return to normal operation, press [MODE] once at any of the programming menu displays. You will see “Updating Settings…” as changes are registered and the mode changes.

Navigating Programming Mode Menus

Navigating through the Programming Mode menus is easy and consistent, using a single interface format of “Select,” “Back” and “Next” at the top level. The three control buttons correspond to these choices as shown:



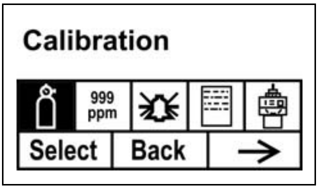
Note: Pressing [MODE] in the Programming Mode’s top level causes the instrument to exit Programming Mode and return to monitoring.

The three keys perform the following functions in Programming Mode:

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Provides a “no” response to a question

Calibration

Two types of calibration are available: Zero (fresh air) and Span.



Select Zero or Span Calibration by pressing [N/+]. Once your choice is highlighted, press [Y/+].

Zero Calibration

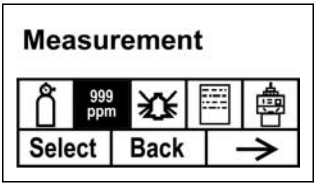
The procedure for performing a zero calibration is covered on page 35.

Span Calibration

The procedure for performing a basic span calibration is covered on page 35.

Measurement

The sub-menus for Measurement are Measurement Gas and Measurement Unit.



Meas. Gas

Measurement gases are organized in four lists:

- My List is a customized list of gases that you create. It contains a maximum of 10 gases and can only be built in ProRAE Studio on a PC and transferred to the instrument. **Note:** The first gas in the list is always isobutylene (it cannot be removed from the list).
- Last Ten is a list of the last ten gases used by your instrument. The list is built automatically and is only updated if the gas selected from Custom Gases or Library is not already in the Last Ten. This ensures that there is no repetition.
- Gas Library is a library that consists of all the gases found in RAE Systems' Technical Note TN-106 (available online at www.raesystems.com).
- Custom Gases are gases with user-modified parameters. Using ProRAE Studio, all parameters defining a gas can be modified, including the name, span value(s), correction factor, and default alarm limits.

1. Scroll through each list by pressing [N/-].
2. Press [Y/+] to select one (My List, Last Ten, Gas Library, or Custom Gases).

3. Once you are in one of the categories, press [N/-] to scroll through its list of options and [Y/+] to select one. (If you press [MODE], you exit to the next submenu.)
4. Press [Y/+] to save your choice or [N/-] to undo your selection.

Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

Meas. Unit

Standard available measurement units include:

Abbreviation	**Unit**	**MiniRAE 3000**
ppm	parts per million	Yes
ppb	parts per billion	
mg/m3	milligrams per cubic meter	Yes
ug/m3	micrograms per cubic meter	

- Scroll through the list by pressing [N/-].
- Select by pressing [Y/+].
- Save your selection by pressing [Y/+] or undo your selection by pressing [N/-].

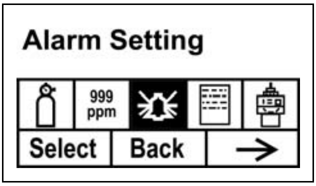
Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

Alarm Setting

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings: Low, High, TWA and STEL). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn of the alarm condition.

An alarm signal summary is shown on page 27.

In this menu, you can change the High and Low alarm limits, the STEL limit, and the TWA. Press [Y/+] to to enter the Alarm Setting menu. **Note:** All settings are shown in ppb (parts per billion), or µg/m^3 (micrograms per cubic meter), depending on your setting.



1. Scroll through the Alarm Limit sub-menu using the [N/-] key until the display shows the desired limit to be changed (High Alarm, Low Alarm, STEL Alarm, and TWA Alarm)
2. Press [Y/+] to select one of the alarm types. The display shows a flashing cursor on the left-most digit of the previously stored alarm limit.
3. Press [Y/+] to increase each digit's value.
4. Press [N/-] to advance to the next digit.
5. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

Press [MODE] when you are done.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

When all alarm types have been changed or bypassed, press [MODE] to exit to the Programming Menu.

High Alarm

You can change the High Alarm limit value. The value is typically set by the instrument to match the value for the current calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the High Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.
When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

Press [Y/+] to save the changes.
Press [N/-] to undo the changes and revert to the previous settings.

Low Alarm

You can change the Low Alarm limit value. The value is typically set by the instrument to match the value for the current calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the Low Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

STEL Alarm

You can change the STEL Alarm limit value. The value is typically set by the instrument to match the value for the calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the STEL Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

TWA Alarm

You can change the TWA (time-weighted average) Alarm limit value. The value is typically set by the instrument to match the value for the calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the TWA Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices:

- Save
- Undo

You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Alarm Type

There are two selectable alarm types:

Latched	When the alarm is triggered, you can manually stop the alarm. The latched setting only controls alarms for High Alarm, Low Alarm, STEL Alarm, and TWA alarm. **Note:** To clear an alarm when the instrument is set to “Latched,” press [Y/+] when the main (Reading) display is shown.
Automatic Reset	When the alarm condition is no longer present, the alarm stops and resets itself.

1. Press **[N/-]** to step from one alarm type to the other.
2. Press **[Y/+]** to select an alarm type.

When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Buzzer & Light

The buzzer and light alarms can be programmed to be on or off individually or in combination. Your choices are:

- Both on
- Light only
- Buzzer only
- Both off

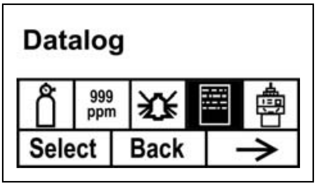
1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates your selection).
3. When you have completed your selections, press [MODE].

   You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Datalog

The instrument calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.



1. Scroll through the Datalog sub-menu using the [N/-] key until the display shows the desired parameter to be changed:

   Clear Datalog
   Interval
   Data Selection
   Datalog Type

2. Press [Y/+] to make your selection. Exit by pressing [MODE] for Back.

Clear Datalog

This erases all the data stored in the datalog.

Note: Once the datalog is cleared, the data cannot be recovered.

Press [Y/+] to clear the datalog. The display asks, "Are you sure?"

- Press [Y/+] if you want to clear the datalog. When it has been cleared, the display shows "Datalog Cleared!"
- Press [N/-] if you do not want to clear the datalog.

The display changes, and you are taken to the next sub-menu, Interval.

Interval

Intervals are shown in seconds. The default value is 60 seconds. The maximum interval is 3600 seconds.

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Data Selection

Data Selection allows you to select which types of data are stored and made available when you offload your datalog to a computer via ProRAE Studio software.

You can choose any or all of three types of data (you must choose at least one):

- Average
- Maximum
- Minimum

1. Press [N/-] to step from one option to the next. The highlighter indicates your choice.
2. Press [Y/+] to toggle your selection on or off (the check box indicates "on" with an "X").
3. When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Datalog Type

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument’s datalogging is manually started (see below for details).
Snapshot	Datalogs only during single-event capture sampling.

Note: You can only choose one datalog type to be active at a time.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates “on”).
3. When you have completed your selection, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.

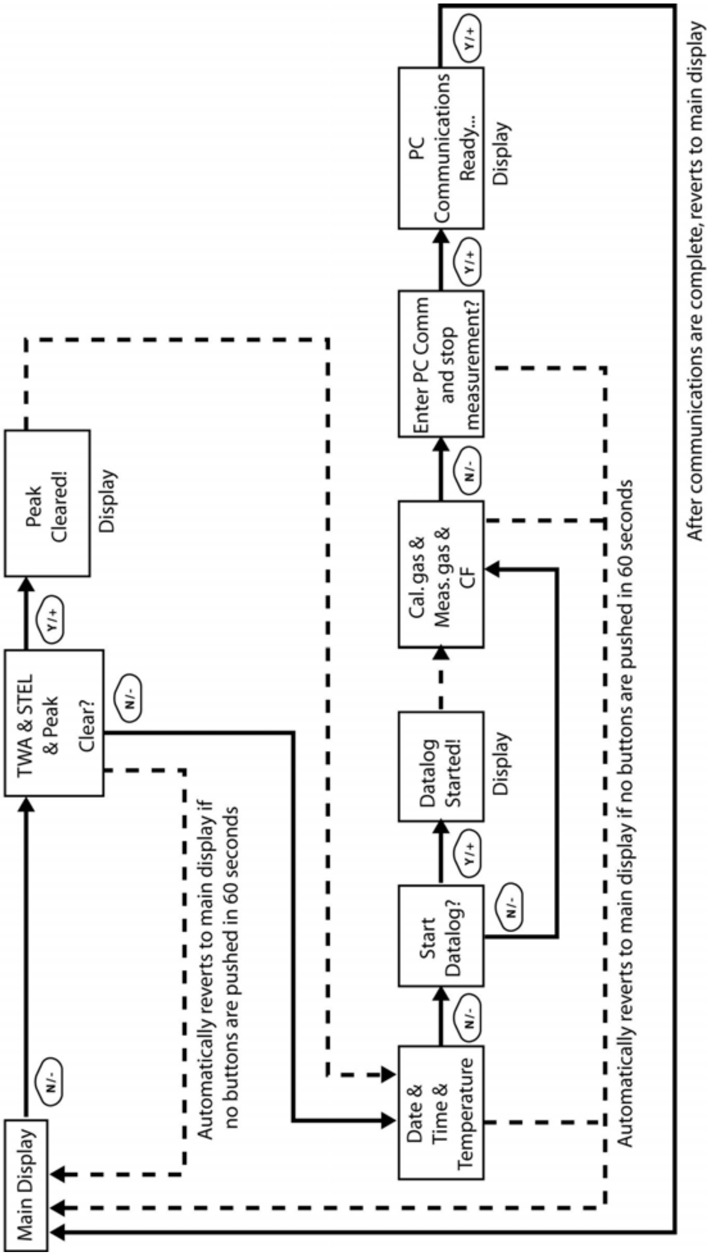
Press [N/-] to undo the changes and revert to the previous settings.

Manual Datalog

When the instrument is set to Manual Datalog, you turn datalogging on and off by stepping through the displays from the Main Display, and then pressing the keys to select datalog on/off functions.

- When you reach the screen that says “Start Datalog?” press [Y/+] to start it. You see “Datalog Started,” confirming that datalogging is now on.

When you reach the screen that says “Stop Datalog?” press [Y/+] to stop it. You see “Datalog Stopped,” confirming that datalogging is now off.



Note: Dashed line indicates automatic progression.

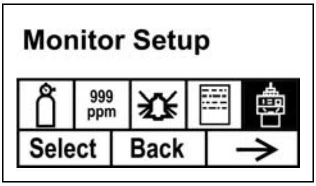
Snapshot Datalog

When the instrument is in Snapshot datalogging mode, it captures a single "snapshot" of the data at the moment of your choosing. Whenever the instrument is on and it is set to Snapshot, all you have to do is press [MODE] each time you want to capture a snapshot of the data at that instant.

When you send the data to a computer using ProRAE Studio, the data snapshots are uniquely identified by time and other parameters.

Monitor Setup

Many settings can be accessed in this menu, including setting the date and time and adjusting the pump's on/off duty cycle.



Op Mode

Under Monitor Setup is "Op Mode."

Press [Y/+] to select.

You see two options (one is highlighted):

Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

1. Select Hygiene or Search by pressing [N/-]. The highlighting changes from one to the other each time you press [N/-].
2. Press [Y/+] to select that mode for the instrument.
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

Site ID

Enter an 8-digit alphanumeric/character Site ID in the programming mode. This Site ID is included in the datalog report.

1. Press [Y/+] and the display shows the current site ID. Example: "RAE00001." Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).
   Note: The last four digits must be numerals.
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

   Repeat this process until all eight digits of the new site ID are entered.

Press [MODE] to exit.

If there is any change to the existing site ID, the display shows "Save?" Press [Y/+] to accept the new site ID. Press [N/-] to discard the change and move to the next sub-menu.

User ID

Enter an 8-digit alphanumeric User ID in the programming mode. This User ID is included in the datalog report.

1. Press [Y/+] and the display shows the current User ID. Example: “RAE00001.” Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

   Repeat this process until all eight digits of the new User ID are entered.

Press [MODE] to exit.

If there is any change to the existing User ID, the display shows “Save” Press [Y/+] to accept the new site ID. Press [N/-] to discard (undo) the change and move to the next sub-menu.

User Mode

The instrument has two user modes:

Basic Basic users can only see and use a basic set of functions.
Advanced Advanced users can see all screens and perform all available functions.

Note: The default value for User Mode is Basic.

To change the User Mode:

1. Press [N/-] to step from one option to the next. The highlighting changes each time you press [N/-].
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
4. Press [Y/+] to accept the new User Mode. Press [N/-] to discard the change and move to the next sub-menu.

Date

The Date is expressed as Month/Day/Year, with two digits for each.

1. Press [Y/+] and the display shows the current date. Note that the left-most digit flashes to indicate it is selected.
2. Press [Y/+] to step through all 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

   Repeat this process until all six digits of the new date are entered.

Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

Time

The Time is expressed as Hours/Minutes/Seconds, with two digits for each. The time is in 24-hour (military) format.

1. Press [Y/+] and the display shows the current time. Note that the left-most digit flashes to indicate it is selected.
2. Press [Y/+] to step through all 10 numerals (0 to 9).

3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

   Repeat this process until all six digits of the new time are entered.

Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

Duty Cycle

The pump's duty cycle is the ratio of its on time to off time. The duty cycle ranges from 50% to 100% (always on), and the period is 10 seconds. Therefore, a duty cycle of 60% means that the pump is on for 6 seconds and off for four seconds. Duty cycling is employed by the instrument to clean the PID. A lower duty cycle has a greater effect on keeping the PID clean than a higher duty cycle.

Important! Pump duty cycling is interrupted when the instrument senses a gas. The pump's duty cycle is disabled when the measurement is greater than the 2ppm threshold and is re-enabled when the reading falls below 90% of the threshold (1.8 ppm).

1. Press [Y/+] to increase the value.
2. When you have completed your selection, press [MODE].
   - Press [Y/+] to save the new duty cycle value.
   - Press [N/-] to undo the change and move to the next sub-menu.

Temperature Unit

The temperature display can be switched between Fahrenheit and Celsius units.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the new temperature unit.
    - Press [N/-] to undo the change and move to the next sub-menu.

Pump Speed

The pump can operate at two speeds, high and low. Running at low speed is quieter and conserves a small amount of power. There is almost no difference in sampling accuracy.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the new temperature unit.
    - Press [N/-] to undo the change and move to the next sub-menu.

Language

English is the default language, but other languages can be selected for the instrument.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save your new language choice.
    - Press [N/-] to undo it and return to the previous language selection.

Radio Power

The radio connection can be turned on or off.

1. Press [N/-] to step from one option to the next (on or off).
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates that the option is selected).
3. When you have completed your selection, press [MODE].

    - Press [Y/+] to accept the new radio setting (on or off).
    - Press [N/-] to discard the change and move to the next sub-menu.

Real Time Protocol

Real Time Protocol is the setting for data transmission.

The choices are:

P2M (cable)	Point to multipoint. Data is transferred from the instrument to multiple locations using a wired connection. Default data rate: 19200 bps.
P2P (cable)	Point to point. Data is transferred only between the instrument and one other location, such as a computer. Default data rate: 9600 bps.
P2M (wireless)	Point to multipoint, wireless. Data is transferred wirelessly and can be received by multiple receivers.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the new real-time communications protocol.
    - Press [N/-] to undo the change and move to the next sub-menu.

Power On Zero

When Power On Zero is on, the instrument performs a zero calibration when it is turned on.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the change.
    - Press [N/-] to discard the change and move to the next sub-menu.

Unit ID

This three-digit number keeps data separated by instrument when more than one instrument is used in a network. If multiple sensing units are attempting to communicate with the same Host, then the units must all have a different Unit ID.

1. Press [Y/+] to step through all 10 numerals (0 to 9). If you pass the numeral you want, keep pressing [Y/+]. After it counts up to 9, it starts counting up from 0 again.
2. Press [N/-] to advance to the next digit. The next digit to the right flashes.

Repeat this process until all three digits of the Unit ID are entered.

3. Press [MODE] when you are done.
   - Press [Y/+] to save the change.
   - Press [N/-] to discard the change and move to the next sub-menu.

LCD Contrast

The display's contrast can be increased or decreased from its default setting. You may not need to ever change the default setting, but sometimes you can optimize the display to suit extreme temperature and ambient brightness/darkness conditions.

- The minimum value is 20.
- The maximum value is 60.

1. Press [Y/+] to increase the value or [N/-] to decrease the value.
2. Press [MODE] to save your selection.
   - Press [Y/+] to save your new contrast value.
   - Press [N/-] to undo it and return to the previous value.

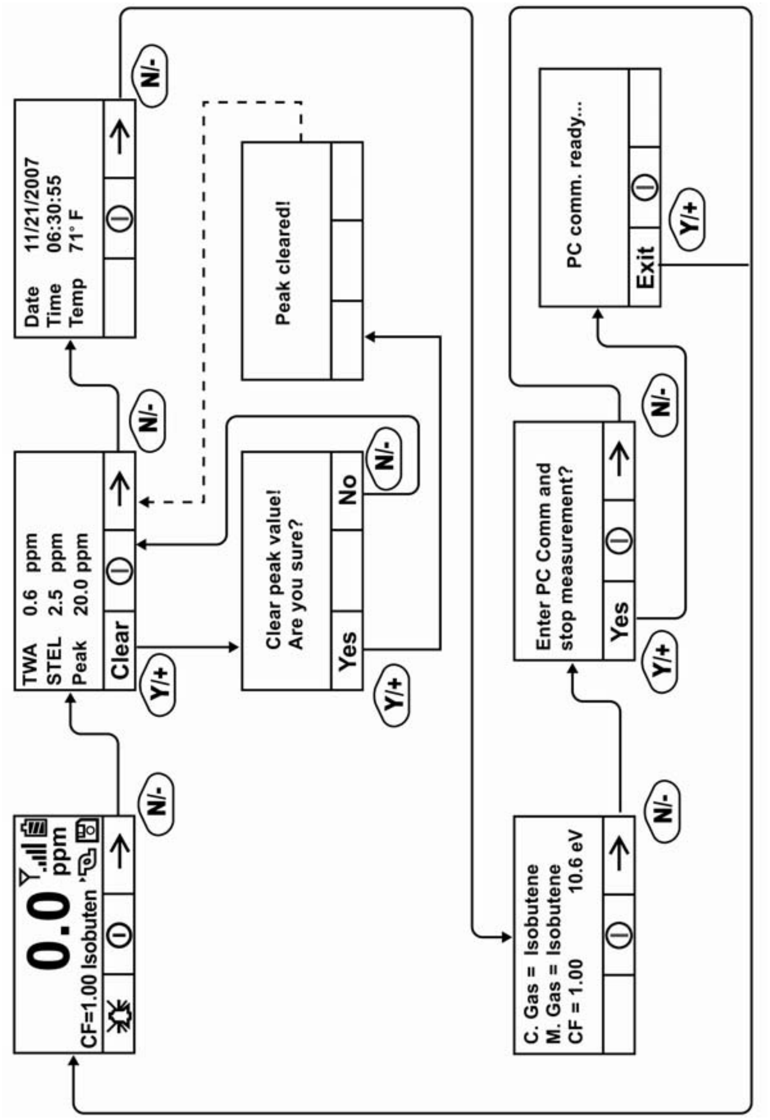
Hygiene Mode

The instrument usually operates in Hygiene Mode, which provides basic functionality. However, it is possible to operate it in a second mode called Search Mode. Here are the primary differences:

Hygiene Mode:	Automatic measurements, continuously running and datalogging, and calculates additional exposure values.
Search Mode:	Manual start/stop of measurements and display of certain exposure values.

Basic User Level & Hygiene Mode

The default setting is navigated in the following way:



Note: Dashed line indicates automatic progression.

Pressing [N/-] steps you from screen to screen. Options include clearing the Peak value and turning on the instrument's PC Communications for data transfer to a PC.

Entering Search Mode From Hygiene Mode

In order to change the instrument's operational mode from Hygiene Mode to Search Mode, you must enter the password-protected Programming Mode:

1. Hold [MODE] and [N/-] until you see the password screen.
2. Use [Y/+] to increment to the number you want for the first digit. (If you pass by the desired number, press [Y/+] until it cycles through to 0 again. Then press [Y/+] until you reach the desired number.)
3. Press [N/-] to advance to the next digit.
4. Again press [Y/+] to increment the number.
5. Press [N/-] to advance to the next digit.

Continue the process until all four numbers of the password have been input. Then press [MODE] to proceed.

The screen changes to icons with the label "Calibration."

1. Press [N/-] to advance to "Monitor Setup."
2. Press [Y/+] to select Monitor Setup.

Under Monitor Setup, you will see "Op Mode."

Press [Y/+] to select.

You will see:

Hygiene
Search

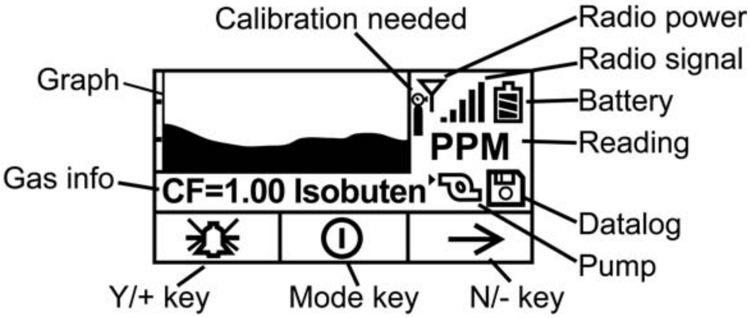
The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

1. Select Hygiene or Search by pressing [N/-].
2. Press [Y/+] to place the instrument into the selected mode.

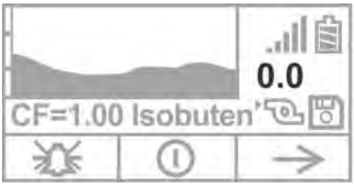
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

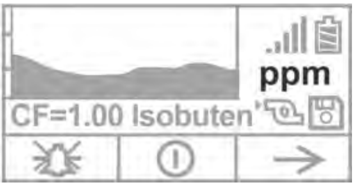
Optional Graphic Screen In Search Mode

Using ProRAE Studio, you can set your instrument to show a graphic display instead of a numeric display of ongoing data. Consult your ProRAE Studio disc for information.



During sampling, the display's readings are shown numerically, plus the graph tracks the highest readings over time. The numeric reading alternates between the value and the measurement units, as well:





Advanced User Level (Hygiene Mode Or Search Mode)

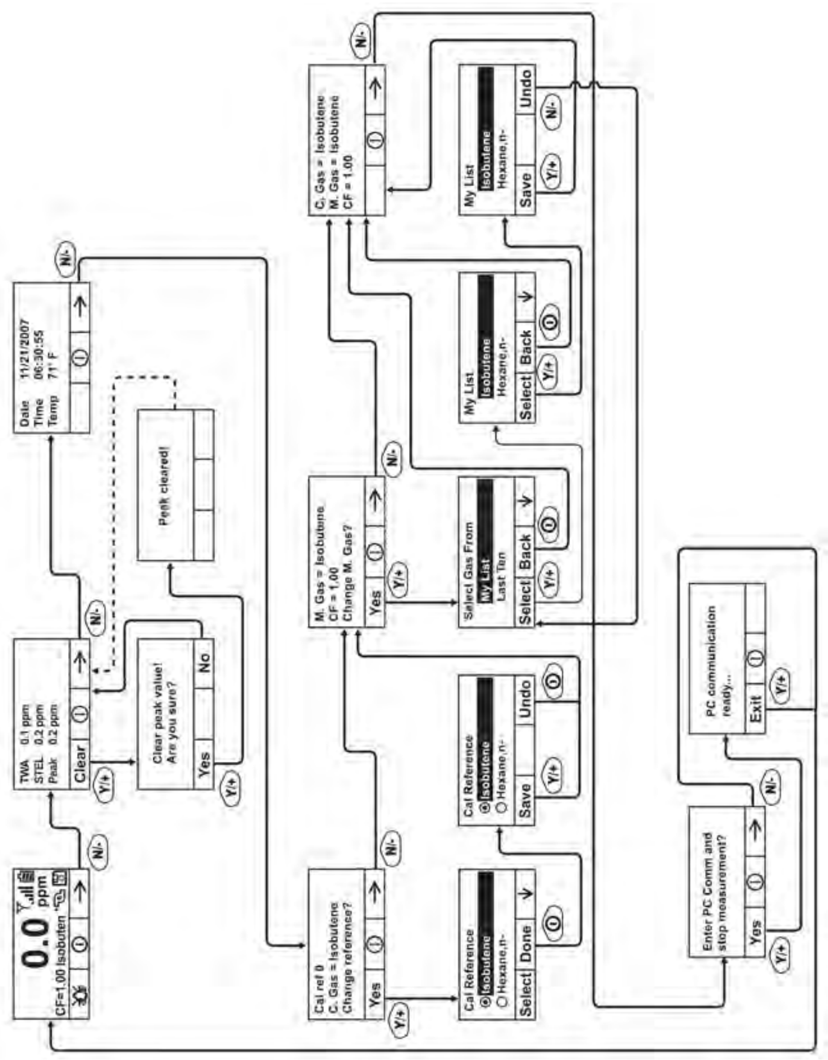
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

Advanced User Level & Hygiene Mode

With the instrument in Operation Mode: Hygiene Mode, enter User Mode: Advanced User Level (refer to the section called Monitor Mode for instructions).

Once you are in Advanced User Level and Hygiene Mode together, you can change the calibration reference and measurement gas, in addition to performing normal monitoring functions.

Pressing [N/-] progresses through the screens, while pressing [Y/+] selects options. Pressing [MODE] makes menu choices when it is shown for “Done” or “Back.” Pressing and holding [Mode] whenever the circle with a vertical line in the middle is shown activates the countdown to shutoff.

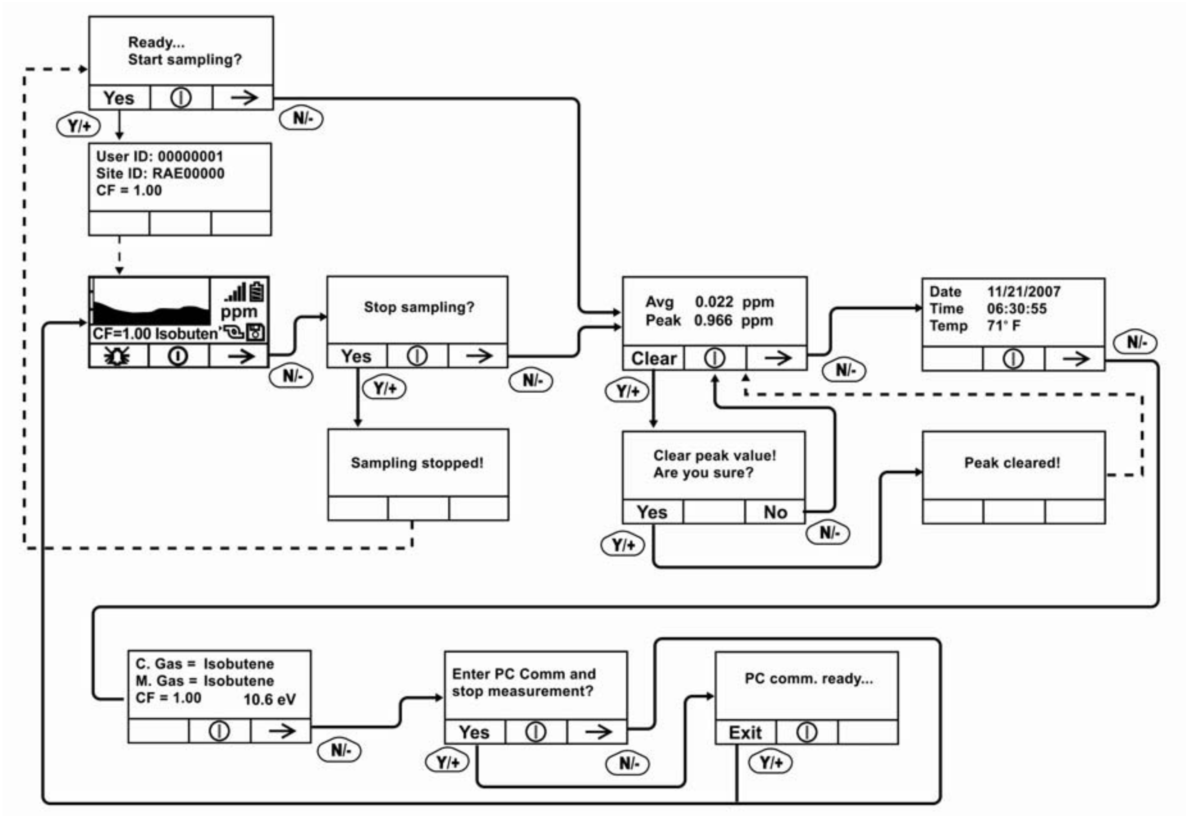


Note: Dashed line indicates automatic progression.

Basic User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Basic User Level (refer to the section called User Mode for instructions).

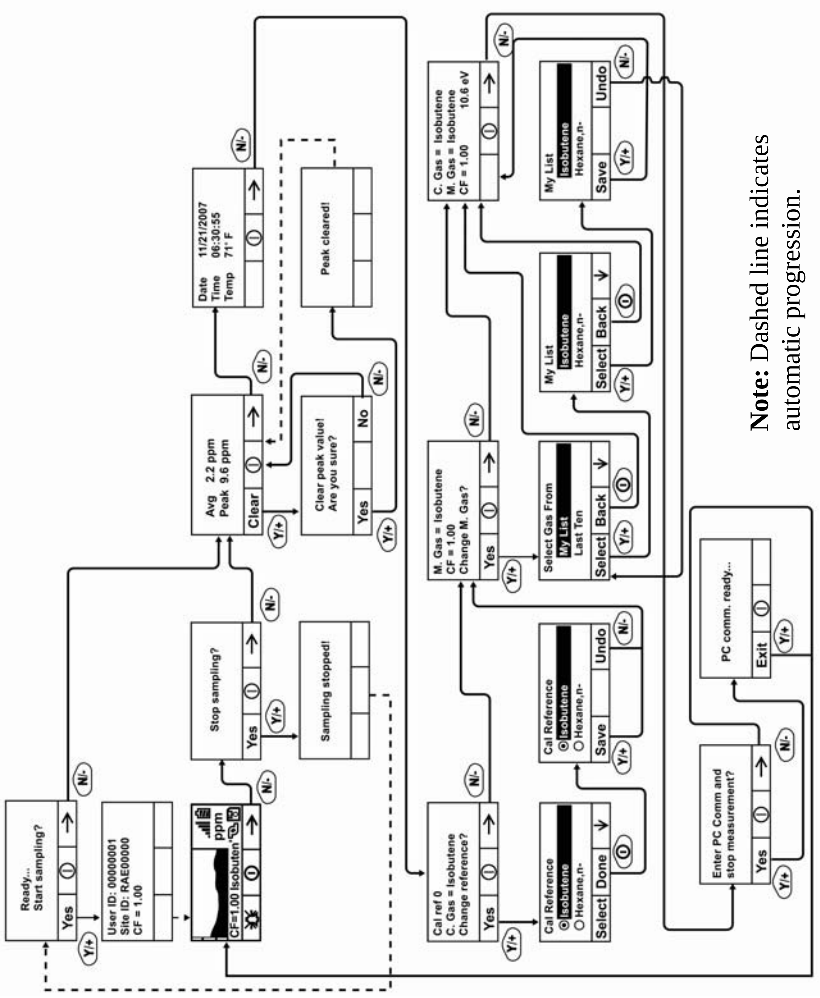
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, "Ready…Start sampling?" press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see a new screen that says, "Stop sampling?" Press [Y/+] to stop sampling. Press [N/-] if you want sampling to continue.



Note: Dashed line indicates automatic progression.

Advanced User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Advanced User Level (refer to the section called Monitor Mode for instructions). Operation is similar to Basic User Level & Sampling Mode, but now allows you to change calibration and measurement reference gases. Refer to the section on measurement gases on page 52 for more details.



Note: Dashed line indicates automatic progression.

Diagnostic Mode

IMPORTANT! Diagnostic Mode is designed for servicing and manufacturing, and therefore is not intended for everyday use, even by advanced users. It provides raw data from sensors and about settings, but only allows adjustment of pump stall parameters, which should only be changed by qualified personnel.

Note: If the instrument is turned on in Diagnostic Mode and you switch to User Mode, datalog data remains in raw count form. To change to standard readings, you must restart the instrument.

Entering Diagnostic Mode

Note: To enter Diagnostic Mode, you must begin with the instrument turned off.

Press and hold [Y/+] and [MODE] until the instrument starts.

The instrument goes through a brief startup, and then displays raw data for the PID sensor. These numbers are raw sensor readings without calibration. The instrument is now in Diagnostic Mode.

Note: In Diagnostic Mode, the pump and lamp are normally on.

You can enter Programming Mode and calibrate the instrument as usual by pressing both [MODE] and [N/-] for three seconds.

You can enter Monitoring Mode by pressing [MODE] and [Y/+] together for three seconds.

Once the instrument is started up in Diagnostic Mode, you can switch between Diagnostic Mode and Monitoring Mode by pressing and holding [MODE] and [Y/+] simultaneously for two seconds.

In Diagnostic mode, you can step through parameter screens by pressing [MODE].

Adjusting The Pump Stall Threshold

If the gas inlet is blocked but the pump does not shut down, or the pump shuts down too easily with a slight blockage, the pump stall threshold value may be set too high or too low.

Use the following steps to adjust the pump stall threshold:

Pump High

In Diagnostic Mode, press the [MODE] key until "Pump High" is displayed. The display shows the maximum, minimum, and stall values for the pump at its high speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

Pump Low

In Diagnostic Mode, press the [MODE] key until "Pump Low" is displayed. The display shows the maximum, minimum, and stall values for the pump at its low speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

Exiting Diagnostic Mode

You can exit Diagnostic Mode and go directly to Programming Mode or Monitor Mode as outlined above, or you can exit Diagnostic Mode completely.

To exit Diagnostic Mode so that it cannot be re-entered without a restart:

Shut down the instrument. When it is off, restart it by holding the [MODE] key. Diagnostic Mode cannot be entered until the instrument is restarted as outlined in "Entering Diagnostic Mode."

Transferring Data To & From A Computer

Once you have connected your instrument cradle to the PC, you can can transfer data, including a download of the datalog to the computer and updates of firmware to the instrument (should this ever be necessary).

Downloading The Datalog To A PC

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio on your PC.
4. From ProRAE Studio, select "Operation" and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. To receive the datalog in the PC, select "Downlog Datalog."
7. When you see "Unit Information," click OK.

During the data transfer, the display shows a progress bar.

When the transfer is done, you will see a screen with the datalog information. You can now export this datalog for other use or printing.

Uploading Firmware To The instrument From A PC

Uploading new firmware to your instrument requires connecting the instrument and PC. Follow these steps to make the connection:

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start RAEProgrammer 7000 on your PC.
4. From RAEProgrammer 7000, select "Operation" and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. Select Operation → Download Firmware.

Once communication is established, follow the instructions that accompany RAEProgrammer 7000 and the firmware to upload the new firmware to your instrument.

Note: Check for the latest updates to ProRAEProgrammer 7000 at www.raesystems.com.

Maintenance

The major maintenance items of the instrument are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

Note: Maintenance should be performed by qualified personnel only.

NOTE: The printed circuit board of the instrument is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the instrument. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

Battery Charging & Replacement

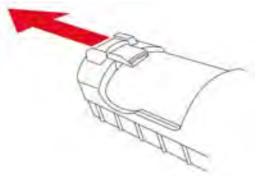
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

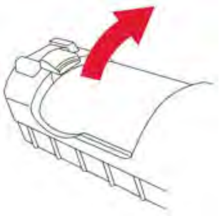
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous.

Replacing The Li-ion Battery

1. Turn off the instrument.
2. Located on the rear of the instrument is a battery tab. Slide it down to unlock the battery.



3. Remove the battery pack from the battery compartment by tilting it out.



4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment.
5. Slide the capture tab back up to its locked position.

Replacing The Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.

To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the battery compartment by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument’s internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument.

Note: When replacing alkaline batteries, dispose of old ones properly.

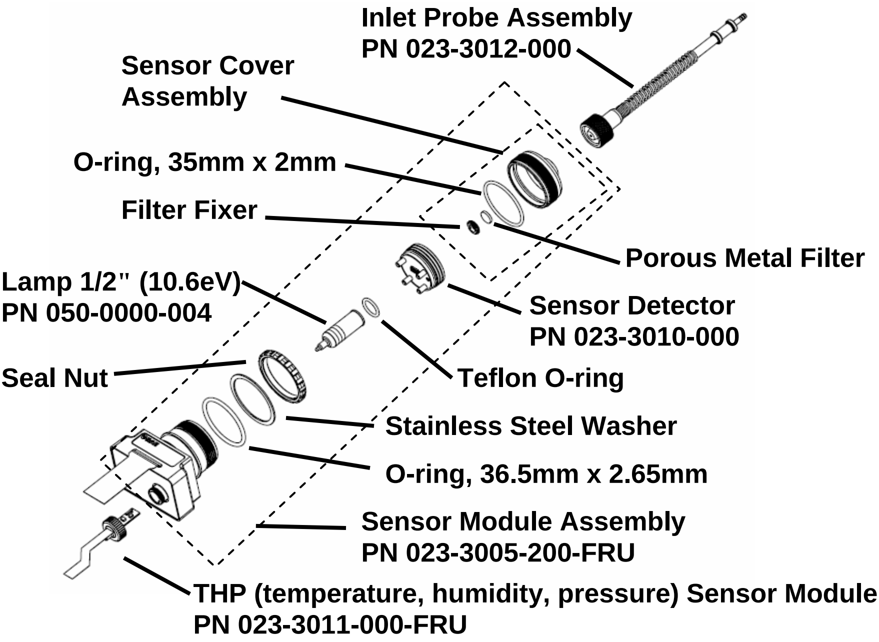
WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Sensor Components

Note: The cleaning procedure is not normally needed. Clean the PID sensor module, the lamp and the lamp housing only if:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A liquid has been sucked into the unit and damaged the unit.

Use of the external filter helps to prevent contamination of the sensor.

To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull it straight out. A slight, gentle rocking motion helps release the sensor.

Cleaning The PID Sensor

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.
Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode "fingers" should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

Cleaning The Lamp Housing Or Changing The Lamp

If the lamp does not turn on, the instrument will display an error message to indicate replacement of the lamp may be required.

1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

   CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.

3. Reinstall the PID sensor module.

4. Tighten the Lamp Housing Cap.

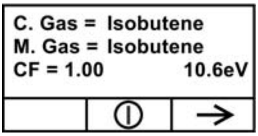
Determining The Lamp Type

The monitor can accommodate three lamp values: 10.6eV (standard), 9.8eV, and 11.7eV. The monitor automatically reads a marking on the side of the lamp to set the proper Correction Factor. There are two ways to determine the lamp type:

Remove the lamp and look for markings (bars) on the side:

- No bars: 10.6eV
- 1 bar: 11.7eV
- 2 bars: 9.8eV

Also, when the monitor is running, the lamp type is shown along with the calibration and measurement gas and Correction Factor:



C. Gas = Isobutene
M. Gas = Isobutene
CF = 1.00 10.6eV

Note: This screen can be accessed from the reading screen by pressing [N/-] four times.

Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

If the pump is not working properly, refer the instrument to qualified service personnel for further testing and, if necessary, pump repair or replacement.

Cleaning The Instrument

Occasional cleaning with a soft cloth is recommended. Do not use detergents or chemicals.

Visually inspect the contacts at the base of the instrument, on the battery, and on the charging cradle to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Never use solvents or cleaners.

Ordering Replacement Parts

If you need replacement parts, contact your local RAE Systems distributor. A list is available online:

http://www.raesystems.com

In the U.S., you can order sensors, replacement batteries, and other accessories online at:

http://istore.raesystems.com/

Special Servicing Note

If the instrument needs to be serviced, contact either:

1. The RAE Systems distributor from whom the instrument was purchased; they will return the instrument on your behalf.

   or

2. The RAE Systems Technical Service Department. Before returning the instrument for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the instrument is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.

Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

Technical Support

To contact RAE Systems Technical Support Team:

Monday through Friday, 7:00AM to 5:00PM Pacific (US) Time
Phone (toll-free): +1 888-723-4800
Phone: +1 408-952-8461
Email: tech@raesystems.com

Life-critical after-hours support is available:

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Controlled Part of Manual

Intrinsic Safety:
US and Canada: Class I, Division 1, Groups A,B,C,D T4

Europe: ATEX (0575 Ex II 2G Ex ia IIC/IIB T4 Gb)
KEMA 07 ATEX 0127
Complies with EN60079-0:2009, EN60079-11:2007
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0:2007, IEC 60079-11:2006

Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)

Basic Operation

Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.

The instrument is now operating and performs self tests. Once the self tests are complete, the display shows a graph or numerical gas reading. This indicates that the instrument is fully functional and ready to use.

Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. When you see "Unit off..." release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition.

In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, pump stall, or when the datalog memory is full.

Alarm Signal Summary

Message	Condition	Alarm Signal
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display

Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas (Isobutylene)	**Cal Span**	**unit**	**Low**	**High**	**TWA**	**STEL**
ppbRAE 3000	10	ppm	10	25	10	25
MiniRAE 3000	100	ppm	50	100	10	25
MiniRAE Lite	100	ppm	50	100	10	25
UltraRAE 3000	100	ppm	50	100	10	25

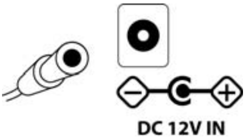
Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion/NiMH battery is charged by placing the instrument in its cradle. Contacts on the bottom of the instrument meet the cradle's contacts, transferring power without other connections.

Note: Before setting the instrument into its charging cradle, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter's barrel connector into the instrument's cradle.



2. Plug the AC/DC adapter into the wall outlet.
3. Place the instrument into the cradle, press down, and lean it back. It locks in place and the LED in the cradle glows.

Note: To release the instrument, press down and tilt the top out of the cradle and lift up.

The instrument begins charging automatically. The LED on the front of the cradle marked "Primary" blinks during charging. During charging, the diagonal lines in the battery icon on the instrument's display are animated and you see the message "Charging..."

When the instrument's battery is fully charged, the battery icon is no longer animated and shows a full battery. The message "Fully charged!" is shown and the Primary LED on the cradle glows continuously green.

Note: A spare Li-ion battery (059-3051-000) or NiMH(059-3054-000) can be charged by placing it directly in the charging port on the back of the cradle. It can be charged at the same time as the instrument. Press the battery in place, sliding it slightly toward the front of the cradle. This locks it in the cradle. To release the battery, slide it forward again and tilt it up.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. **Remove and replace batteries only in areas known to be non-hazardous.**

Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the battery icon blinks once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion, NiMH, or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in an area known to be non-hazardous.

Replacing Rechargeable Li-Ion or NiMH Battery

Caution: Turn off the instrument before removing or replacing the battery.

Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500).

Do not mix old and new batteries or different type batteries.

Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.

Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
“Lamp” message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

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Rev. C
August 2010
P/N 059-4020-000

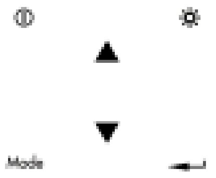
FIELD OPERATION GUIDE
YSI 550 DO INSTRUMENT

TURNING THE INSTRUMENT ON

The YSI 550 DO keypad consists of six keys. There are four function keys, and one up and one down arrow keys. The top left key that has a green circle and line is the ON/OFF key. The top right key is the back light. The bottom left is the Mode key, and the bottom right is the Enter key.

Turn the instrument on by pressing and releasing the **ON/OFF** button on the front of the instrument.

NOTE: Since the probe has not yet been prepared, the data on the display will be inaccurate.



The light key is at the top right of the keypad. Pushing the **LIGHT** key will turn on or off the back light. The light will power off automatically after two minutes of non-use.

CHANGING THE TEMPERATURE UNITS

The YSI 550 DO Instrument can display the temperature units in either Fahrenheit or Celsius. To change the units that are displayed, turn the instrument on. Pressing both the down arrow keys and the mode key at the same time will switch the units between C or F.

CHOOSING THE RIGHT MEMBRANE

The YSI 5906 Standard Membrane Kit is supplied with the YSI 550 DO Instrument. This kit contains six cap membranes and a bottle of electrolyte solution. YSI recommends the 5906 membranes for all applications.

MEMBRANE CAP INSTALLATION

To install a new membrane cap on your YSI 550 dissolved oxygen probe:

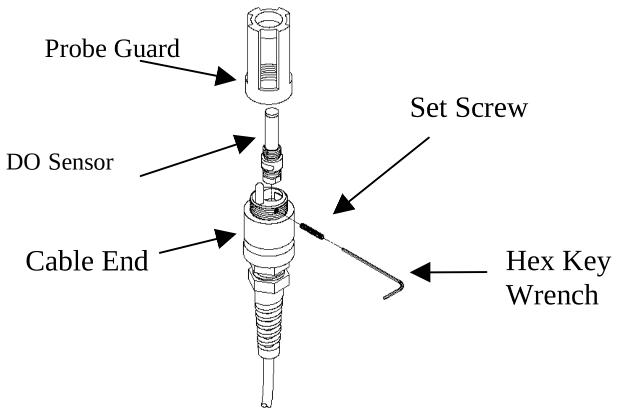
Unscrew and remove the probe sensor guard.

1. Unscrew and remove the old membrane cap.
2. Thoroughly rinse the sensor tip with distilled or DI water.
3. xPrepare the electrolyte according to the directions on the solution bottle.Hold the membrane cap and fill it at least 1/2 full with the electrolyte solution.
4. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
5. Screw the probe sensor guard on moderately tight.

CAUTION: **Do not touch the membrane surface.**

HOW TO REPLACE THE DO PROBE TIP

In the YSI 559 dissolved oxygen module replacement kit YSI supplies a YSI 559 DO Sensor, a YSI 5906 membrane kit, the set screw that holds the sensor in place, a hex key wrench to help install the probe, and an instruction sheet.



1. Remove probe guard.

2. **IMPORTANT:** Thoroughly dry the sensor so that no water enters the probe port when the sensor is removed.

3. Insert the long end of the hex key wrench into the small hole in the side of the DO sensor module. Turn the wrench counter clockwise and remove the screw. (You do not have to remove the screw all the way to release the sensor.)

4. Pull the DO sensor out of the module. The DO sensor is keyed, or has a flat side, so that it can not be removed improperly.

5. Insert the new probe. Make sure that the inside of the module, and the o-ring of the sensor are clean, with no contaminants, such as grease, dirt, or hair. The DO sensor is keyed, or has a flat side, so that it can not be installed improperly.

6a. **IF you did not remove the screw all the way in Step 3:** Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out on either side of the DO sensor module.

6b. **IF you removed the screw all the way in Step 3:** Insert the set screw into the small hole in the side of the DO sensor module, and turn clockwise to rethread.

7. The YSI 559 DO module is shipped dry. **Before using the YSI 550 with a new YSI 559 sensor, the protective membrane on the probe tip must be removed, the membrane cap must be filled with electrolyte solution and a new membrane must be installed.** Follow the instructions below to install the electrolyte solution and membrane.

8. Insert the new probe. Make sure that the inside of the module, and the o-ring of the sensor are clean, with no contaminants, such as grease, dirt, or hair. The DO sensor is keyed, or has a flat side, so that it can not be installed improperly.

CAUTION: Make sure that you do not cross-thread the screw. Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out on either side of the cable end. The probe guard will not thread on properly and damage may result if the screw is allowed to stick out on either side of the cable end.

THE CALIBRATION PROCESS

Before you calibrate the YSI 550 DO Instrument complete the procedures discussed **in Section 2, Preparing the YSI 550** and **Section 3, Preparing the Probe**.

Note: While testing to EN-61000-4-6, Conducted RF Immunity, per Table A.1 of EN61326, Electrical Equipment for Measurement, Control and Laboratory Use, the YSI 550 exhibited an ERROR 8 message from 8.6 MHz 22.8 MHz at induced RF voltages of 3-Volts to 1-Volt RMS on the 25-foot probe cable. If you observe this interference please relocate the probe-cable away from heavy industrial equipment power and control cables or communications equipment cables which may be causing the interference.

To accurately calibrate the YSI 550, you will need to know the following information:

- ➢ The approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has a salinity of approximately 35 parts per thousand (ppt). If you are uncertain what the salinity of the sample water, use a YSI 30 Salinity-Conductivity-Temperature instrument to determine salinity.

- ➢ IF you are going to calibrate in % saturation mode, you need to know the approximate altitude of the region where you are located.

1. Ensure that the sponge inside the instrument's calibration chamber is moist. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required after turning the instrument on).

3. To enter the calibration menu, use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time.

TO CALIBRATE IN MG/L:

To switch between mg/L and percent saturation to be displayed as the oxygen readings units, press the Mode key. Either a “mg/L” or “%” will be displayed on the right side of the screen.

4. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. The YSI 550 DO instrument should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current DO reading (before calibration) should be on the main display.

5. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. You can enter any number from 0 to 40 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the LCD (zero for fresh water), press the **ENTER** key. The instrument will return to normal operation.

Once the calibration process is complete, the only keys that will remain operational are the **MODE** key, the **LIGHT** key and the **ON/OFF** key. You can move back and forth from reading dissolved oxygen in the mg/L mode or the % air saturation mode by pressing the **MODE** key. If you are working in a dark area and have difficulty reading the LCD, press the **LIGHT** key to activate the back-light of the YSI 550. The **ON/OFF** key turns the instrument on or off.

For best results:

- Each time the YSI 550 DO Instrument is turned off, re-calibrate before taking measurements.
- Calibrate at a temperature within ±10°C of the sample temperature.

TO CALIBRATE IN % SATURATION:

To switch between mg/L and percent saturation to be displayed as the oxygen readings units, press the Mode key. Either a “mg/L” or “%” will be displayed on the right side of the screen.

4. IF you are calibrating in % saturation mode, the LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude.

EXAMPLE: Entering the number 12 here indicates 1200 feet.

6. When the proper altitude appears on the LCD, press the **ENTER** key. The YSI 550 DO Instrument should now display **CAL** in the lower left of the display, the calibration value should be displayed in the lower right of the display and the current DO reading (before calibration) should be on the main display.

7. Make sure that the DO reading (large display) is stable, then press the **ENTER** button. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. You can enter any number from 0 to 40 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the LCD (zero for fresh water), press the **ENTER** key. The instrument will return to normal operation.

Once the calibration process is complete, the only keys that will remain operational are the **MODE** key, the **LIGHT** key and the **ON/OFF** key. You can move back and forth from reading dissolved oxygen in the mg/L mode or the % air saturation mode by pressing the **MODE** key. If you are working in a dark area and have difficulty reading the LCD, press and hold the **LIGHT** key to activate the back-light of the YSI 550. The **ON/OFF** key turns the instrument on or off.

For best results:

- Each time the YSI 550 DO Instrument is turned off, re-calibrate before taking measurements.
- Calibrate at a temperature within ±10°C of the sample temperature.

CONVERSION CHART

To Convert From	To	Equation
Feet	Meter	Multiply by 0.3048
Meter	Feet	Multiply by 3.2808399
Degrees Celsius	Degrees Fahrenheit	(°C × 9/5) + 32
Degrees Fahrenheit	Degrees Celsius	(°F - 32) × 5/9
Milligrams per liter (mg/L)	Parts per million (ppm)	Multiply by 1

YSI *incorporated*

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Item #655127
Drawing #A655127
Revision A
March 2000

YSI Environmental

Pure
Data for a
Healthy
Planet.™

YSI 550A
Dissolved Oxygen Instrument

Operations
Manual

CONTENTS

GENERAL DESCRIPTION

The YSI 550A Handheld Dissolved Oxygen Instrument is a rugged, microprocessor based, digital instrument with a field-replaceable YSI dissolved oxygen probe. The YSI 550A DO Instrument is impact-resistant and waterproof.

The YSI 550A DO Instrument is designed for field use and is available with cable lengths of 12, 25, 50, or 100 feet (3.5, 7.5, 15, 30.5 meters). The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The large Liquid Crystal Display (LCD) is easy to read and is equipped with a backlight for use in dark or poorly lighted areas.

The YSI 550A DO Instrument can be easily calibrated with the press of a few keys. Additionally, the instrument's microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the function of the instrument circuitry and the quality of the readings you obtain.

The system displays temperature in either ^{o}C or ^{o}F and dissolved oxygen in either mg/L (milligrams per liter) or % air saturation. The system requires only a single calibration regardless of which dissolved oxygen display is used, and will calibrate in either mode. Salinity compensation values can be changed at any time without performing a new calibration.

A detachable calibration chamber is mounted to the back of the instrument. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration. This chamber is also designed for transporting and storing the probe. When the probe is stored in the chamber, the moist environment will prolong effective membrane performance and probe life.

The YSI 550A DO Instrument is powered by 4 C-size alkaline batteries. A new set of alkaline batteries will provide approximately 2000 hours of continuous operation. If the backlight is used often, batteries will be depleted faster.

The YSI 550A case is waterproof with an IP-67 rating. The instrument is 100% corrosion proof and can be operated in a wet environment without damage to the instrument.

INITIAL INSPECTION

When you unpack your new YSI 550A DO Handheld Instrument for the first time, check the packing list to make sure you have received everything. If there is anything missing or damaged, call the dealer from whom you purchased the YSI 550A. If you do not know which authorized dealer sold the system to you, call YSI Customer Service at 800-897-4151 or 937-767-7241.

WARRANTY REGISTRATION

Please complete the Product Registration on the YSI website at www.ysi.com. If you are not online, you may complete the Warranty Card included with your instrument and return it to YSI Incorporated. Your purchase of this quality instrument will then be recorded in YSI's customer database. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI 550A DO Instrument should ever need repair.

WARRANTY

The YSI 550A DO Instrument is warranted for three years from date of purchase by the end user against defects in materials and workmanship. YSI 550A DO probes and cables are warranted for one year from date of purchase by the end user against defects in material and workmanship. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

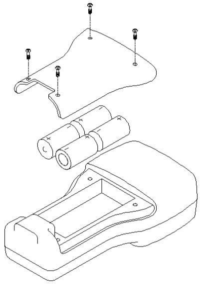
THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

FEATURES OF THE YSI 550A

KEYPAD

⏻	Powers the unit on or off. The instrument will activate all segments of the display for a few seconds, and then will show a self-test procedure for several more seconds. During this power on self-test sequence, it is normal to error messages appear and disappear. If the instrument were to detect a problem, a **continuous** error message would be displayed.
☼	Turns the display backlight on or off. The light will turn off automatically after two minutes of non-use.
Mode	During DO calibration it allows the user to select between % and mg/L. After selection, it may be pressed several times to exit back to measurement mode without completing the calibration. During measurement, it switches the instrument display between DO %, DO mg/L, and salinity calibration.
▲ and ▼	Increases or decreases the value during calibrations.
▼ and **Mode**	Press at the same time to switch the temperature units between Fahrenheit (F) and Celsius (C).
▲ and **Mode**	Press at the same time to increase or decrease the resolution of the instrument in mg/L or % measurement mode.

BATTERIES



The YSI 550A DO Instrument is powered by 4 C-size alkaline batteries. A new set of alkaline batteries will provide approximately 2000 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message. When the message first appears, the instrument will have approximately 50 hours of life left, provided the back light is not used.

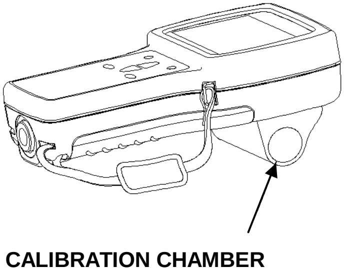
INSTRUMENT CASE

The waterproof instrument case is sealed at the factory and is not to be opened, except by authorized service technicians.

Caution: Do not attempt to separate the two halves of the instrument case as this may damage the instrument, break the waterproof seal, and will void the manufacturer's warranty.

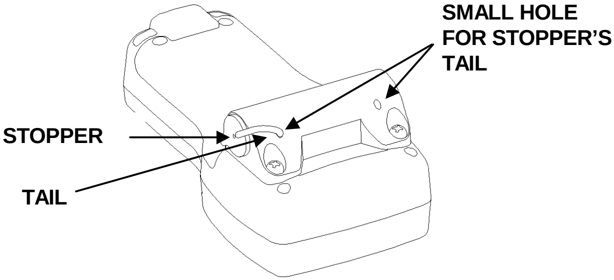
CALIBRATION/STORAGE CHAMBER

The YSI 550A DO Instrument has a convenient calibration/storage chamber that can be attached to the instrument's back. The calibration chamber can be used from either side of the instrument, by moving the rubber stopper to either end.



If you look into the chamber, you should notice a small round sponge in the bottom. Carefully put 3 to 6 drops of clean water into the sponge. Turn the instrument over and allow any excess water to drain out of the chamber. The wet sponge creates a 100% water saturated air environment for the probe. This environment is ideal for dissolved oxygen calibration and for storage of the probe during transport and non-use.

The YSI 550A DO Instrument's storage chamber can be conveniently used from either side of the instrument.



1. Remove the chamber from the instrument by unscrewing the two screws.
2. Remove the rubber stopper from the chamber by pulling the "tail" free of the small hole on the chamber.
3. Re-attached the rubber stopper to the storage chamber by threading the "tail" through the opposite small hole on the chamber.
4. Re-attached the storage chamber to the instrument using the two screws.

HAND STRAP

The hand strap is designed to allow comfortable operation of the YSI 550A DO Instrument with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be dropped or bumped from your hand. The hand strap can be conveniently used from either side of the instrument.

To switch the hand strap from one side to the other:
1. Pull the two velcro strips apart.
2. Pull the strap free of the upper and lower hooks.
3. Feed the strap through the hooks on the other side of the instrument.
4. Adjust the strap length so that your hand is snugly held in place.
5. Press the two velcro strips back together.

PRINCIPLES OF OPERATION

The sensor consists of a silver body as the anode and a circular gold cathode embedded in the end. In operation, this end of the sensor is filled with a solution of electrolyte containing a small amount of surfactant to improve wetting action.

A thin semi-permeable membrane, stretched over the sensor, isolates the electrodes from the environment, while allowing gases to enter. When a polarizing voltage is applied to the sensor electrodes oxygen that has passed through the membrane reacts at the cathode causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the partial pressure of oxygen outside the membrane. As the oxygen partial pressure varies, so does the oxygen diffusion through the membrane. This causes the probe current to change proportionally.

PREPARING THE PROBE

MEMBRANE CAP INSTALLATION

The YSI 550A DO probe is shipped with a dry, protective membrane. Before using the instrument for the first time, remove the protective cap and replace it with a new one following these instructions:

1. Remove the probe sensor guard to access the probe tip.
2. Unscrew and remove the old membrane cap and discard.
3. Thoroughly rinse the sensor tip with distilled or DI water.
4. Fill a new membrane cap with O_2 probe solution that has been prepared according to the directions on the bottle. Be very careful not to touch the membrane surface. Lightly tap the side of the membrane cap to release bubbles that may be trapped.
5. Thread the membrane cap onto the probe. It is normal for a small amount of electrolyte to overflow.
6. Replace the probe sensor guard.

MEMBRANE MAINTENANCE

Additional membrane changes will be required over time. The average replacement interval is 4 to 8 weeks, although they may last longer if kept clean. To clean the membrane, use a lint-free cloth, such as a Kimwipe, and rubbing alcohol to gently remove the contamination. In harsh environments, such as wastewater, membrane replacements may be required every 2 to 4 weeks.

DISSOLVED OXYGEN CALIBRATION

Dissolved oxygen calibration must be done in an environment with known oxygen content. The YSI 550A DO Instrument can be calibrated in either mg/L or % saturation. Sections below include instructions on how to calibrate in either mode.

BEFORE YOU CALIBRATE

To accurately calibrate the YSI 550A, you will need to know the following information:

- The approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has a salinity of approximately 35 parts per thousand (ppt). If you are uncertain what the salinity of the sample water is, use a YSI 30 Salinity-Conductivity-Temperature instrument to determine a salinity value.

- For calibration in % saturation mode, the approximate altitude (in feet) of the region where you are located is required. This information can be obtained over the internet or from a local airport or weather station. To convert from meters to feet, divide by 0.3048.

For best results:

- Check calibration with each use and recalibrate as necessary to prevent drift. Dissolved oxygen readings are only as good as the calibration.

- Calibrate at a temperature within ±10°C of the sample temperature.

CALIBRATION IN % SATURATION

1. Ensure that the sponge inside the instrument's calibration chamber is moist. Insert the probe into the calibration chamber.

2. Turn the instrument on. Allow it to warm up and readings to stabilize for about 15-20 minutes.

3. Press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time to enter the calibration menu.

4. Press the **Mode** key until “%” is displayed on the right side of the screen for oxygen units. Press **ENTER**.

5. The LCD will prompt you to enter the local altitude in hundreds of feet. Use the arrow keys to increase or decrease the altitude. When the proper altitude appears on the LCD, press the **ENTER** key.
   EXAMPLE: Entering the number 12 here indicates 1200 feet.

6. **CAL** will now display in the lower left corner of the screen, the calibration value in the lower right corner and the current DO reading (before calibration) will be the main display. Once the current DO reading is stable, press the **ENTER** button.

7. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. You can enter any number from 0 to 70 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the LCD, press the **ENTER** key. The instrument will return to normal operation.

CALIBRATION IN MG/L

1. Turn the instrument on. Allow it to warm up and readings to stabilize for about 15-20 minutes.

2. Place the probe in a solution with a known mg/L reading. Continuously stir or move the probe through the sample at a rate of at least 1/2 foot per second (16cm per second) during the entire calibration process.

3. Press and release both the **UP ARROW** and **DOWN ARROW** keys at the same time to enter the calibration menu.

4. Press the **Mode** key until “mg/L” is displayed on the right side of the screen for oxygen units. Press **ENTER**.

5. **CAL** will now display in the lower left corner of the screen and the current DO reading (before calibration) will be on the main display. Once the current DO reading is stable, use the up and down arrow keys to select the mg/L value of the known solution, then press the **ENTER** button.

6. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. Enter any number from 0 to 70 parts per thousand (PPT) of salinity. Use the arrow keys to increase or decrease the salinity setting. When the correct salinity appears on the, press the **ENTER** key. The instrument will return to normal operation.

SALINITY COMPENSATION CALIBRATION

1. Press the **Mode** key until salinity calibration is displayed on the screen.
2. Use the **UP ARROW** and **DOWN ARROW** keys to adjust the salinity value to that of the samples you will be measuring, 0-70 ppt.
3. Press the **ENTER** key to save the calibration.
4. Press **Mode** to return to dissolved oxygen measurement

PROBE OPERATION

NOTE: The YSI 550A DO Instrument should not be used in a purpose other than that specified by YSI Incorporated. See **Warranty** for details.

STIRRING

It is important to recognize that a very small amount of oxygen dissolved in the sample is consumed during probe operation. It is therefore essential that the sample be continuously stirred at the sensor tip. If stagnation occurs, measurements will appear artificially low.

Stirring may be accomplished by mechanically moving the sample around the probe tip, or by moving the probe through the sample. The YSI Model 550A has a flow dependence of <25%. The rate of stirring required is 1/2 foot per second (16cm per second).

MEASUREMENT PROCEDURE

1. Insert the probe into the sample to be measured.
2. Continuously stir or move the probe through the sample.
3. Allow temperature and dissolved oxygen readings to stabilize.
4. Observe/Record readings.
5. If possible, rinse the probe with clean water after each use.

PRECAUTIONS

1. Membranes last longer if properly installed and regularly maintained. Erratic readings can result from loose, wrinkled, damaged, or fouled membranes, large (more than 1/8" diameter) air bubbles in the electrolyte reservoir, or membrane coating by oxygen consuming (e.g. bacteria) or oxygen producing (e.g. algae) organisms. If unstable readings or membrane damage occurs, replace both the membrane cap and electrolyte solution.

2. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the probe.

3. Avoid substances such as acids, caustics, and strong solvents, which may damage probe materials. Probe materials include the PE membrane, acrylic plastic, EPR rubber, stainless steel, epoxy, polyetherimide and the PVC cable covering.

4. Always store the probe in the calibration/storage chamber with the moistened sponge.

PROBE ELECTRODE MAINTENANCE

SILVER ANODE

After extended use, a thick layer of AgCl builds up on the silver anode reducing the sensitivity of the sensor. The anode must be cleaned to remove this layer and restore proper performance. The cleaning can be chemical or mechanical:

- **Chemical cleaning:** Remove the membrane cap and rinse the electrodes deionized or distilled water. Soak the entire anode section in a 14% ammonium hydroxide solution for 2 to 3 minutes (or a 3% solution may be used and soaked overnight for 8-12 hours). Rinse heavily in cool tap water followed by a thorough rinsing with distilled or deionized water. The anode should then be thoroughly wiped with a wet paper towel to remove the residual layer from the anode.

  Warning: Chemical cleaning should be performed on an as-needed basis, and no more often than once a year (or once per six months in wastewater environments). When readings appear unstable or the instrument will not calibrate, first attempt a membrane change and recalibrate. If a new membrane does not resolve the problem, then proceed with the chemical cleaning.

- **Mechanical cleaning:** Sand off the dark layer from the silver anode with 400 grit wet/dry sandpaper. Wrap the wet sandpaper around the anode and twist the probe. Rinse the anode with clean water after sanding, and wipe thoroughly with a wet paper towel.

GOLD CATHODE

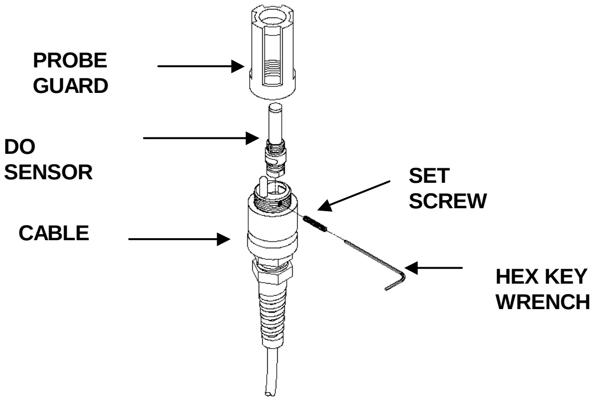
For correct probe operation, the gold cathode must be textured properly. It can become tarnished or plated with silver after extended use. The gold cathode can be cleaned by using the YSI 5238 Probe Reconditioning Kit or 400 grit wet/dry sandpaper. Never use chemicals or abrasives not recommended or supplied by YSI.

Using the sanding paper provided in the YSI 5238 Probe Reconditioning Kit, wet sand the gold with a twisting motion about 3 times or until all silver deposits are removed and the gold appears to have a matte finish. If the cathode remains tarnished, return the probe for service. Wipe the gold cathode thoroughly with a wet paper towel before putting on a new membrane cap.

REPLACEMENT OF THE DO ELECTRODES

Should replacement of the DO Electrodes be required, the user may purchase a YSI 559 Replaceable DO Module Kit. The kit includes an instruction sheet, DO sensor module, set screw, and hex key wrench.

1. Remove probe guard.
2. **IMPORTANT:** Thoroughly dry the sensor so that no water enters the probe port when the sensor is removed.
3. Insert the long end of the hex key wrench into the small hole in the side of the DO sensor. Turn the wrench counter clockwise until the sensor is released.
4. Pull the DO sensor out of the probe. The DO sensor is keyed, or has a flat side, so that it can not be removed or inserted improperly.



5. Make sure that the inside of the connector and the o-ring of the sensor are clean and dry, with no contaminants, such as grease, dirt, or hair. Insert the new sensor.
6. Use the hex key wrench to tighten the screw, making sure that the screw does not stick out on either side of the DO sensor module. Also, if the hex screw was removed completely, make sure that it is not cross-threaded when replaced.
7. The YSI 559 DO module is shipped with a dry, protective membrane. Before using for the first time, remove the protective cap and replace it with a new one following the instructions for **Membrane Cap Installation**.

ACCESSORIES/REPLACEMENT PARTS

The following parts and accessories are available from YSI or any YSI Authorized Dealer.

YSI Model Number	Description
5908	Membrane Kit, 1.25 mil PE, 6 caps and bottle of electrolyte solution
559	Replaceable DO Module
5238	Probe Reconditioning Kit, 10 sanding discs (400 grit) and sanding tool
5065	Form-Fitted Cover with Shoulder Strap
614	Ultra Clamp, C-Clamp Mount
4654	Tripod
5085	Hands Free Harness
5050	Small, Hard-sided Carrying Case, Foam-lined
5060	Small, Soft-sided Carrying Case, Precut Foam Interior
5080	Small, Hard-sided, Pelican Carrying Case, Precut Foam Interior

SPECIFICATIONS

Display	Resolution	Range	Accuracy
Dissolved O_2 mg/L	0.01 mg/L or 0.1 mg/L, user selectable	0 to 20 mg/L	± 0.3 mg/L or ± 2% of reading, whichever is greater
		20 to 50 mg/L	± 6% of reading
Dissolved O_2 %	0.1% or 1%, user selectable	0 to 200%	± 2% air sat or ± 2% of reading, whichever is greater
		200 to 500%	± 6% of reading
Temperature ºC	0.1 ºC	-5 to +45 ºC	± 0.3 ºC
Temperature ºF	0.1 ºF	23 to 113 ºF	± 0.6 ºF

Medium:	Fresh, sea or polluted water
Dissolved Oxygen Sensor:	Steady-state polarographic
Dissolved Oxygen Probe:	Field-replaceable module
Dissolved Oxygen Response Time:	95% of end value in 9 seconds
Temperature Units:	Celsius or Fahrenheit, user selectable
Parameter Compensation:	Automatic temperature compensation for dissolved oxygen Automatic salinity compensation (0-70 ppt) for dissolved oxygen Altitude compensation for dissolved oxygen percent calibration
Size:	4.7 in. width; 9 in. length (11.9 cm x 22.9 cm)
Weight with Batteries:	2 lb. (0.91 kg)
Power:	4 alkaline C-cells
Battery life:	Over 2000 hours at 25°C (77ºF)
Cables:	12, 25, 50, and 100-foot lengths (3.5, 7.5, 15, 30.5 meter lengths)
Other Features:	Waterproof to IP-67 High-impact resistance Push-button calibration Built-in calibration chamber Large back-lit display Low battery indicator on display Manual salinity input CE-compliance

TROUBLESHOOTING

NOTE: An error displayed briefly during the first few seconds after turning the instrument on does NOT indicate a problem.

SYMPTOM	POSSIBLE SOLUTION
1. Instrument will not turn on, LCD displays "LO BAT", or Main display flashes “OFF”	A. Low battery voltage, replace batteries B. Batteries installed incorrectly, check battery polarity C. Return system for service
2. Instrument will not calibrate.	A. Replace membrane and electrolyte B. Clean probe electrodes C. Return system for service
3. Instrument "locks up".	A. Remove batteries, wait 15 seconds for reset, replace batteries B. Replace batteries C. Return system for service
4. Instrument readings are inaccurate.	A. Verify calibration altitude and salinity settings are correct and recalibrate. B. Probe may not have been in 100% water saturated air during calibration procedure. Moisten sponge in calibration chamber and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
5. Main display reads “Over” or “Undr”.	A. Sample O_2 concentration is more than 60 mg/L or 500%, or less than –0.02 mg/L or -0.3%. B. Verify calibration altitude and salinity settings are correct and recalibrate. C. Replace membrane and electrolyte. Recalibrate. D. Clean probe electrodes. E. Return system for service.
6. Main display reads “Over” or “Undr” during calibration.	A. Replace membrane and electrolyte. Recalibrate. B. Clean probe electrodes. C. Return system for service.

SYMPTOM	POSSIBLE SOLUTION
7. Secondary display reads "Ovr" or “Undr”.	A. Sample temperature is less than -5º C (23ºF) or more than +45ºC (122ºF). Increase or decrease the sample temperature to bring within the allowable range. B. Return system for service.
8. Main display reads “Err” and Secondary display reads “RO”, “RA”, or “AdC”.	A. Return system for service
9. Main display reads “Err” or burn” and Secondary display reads “EEP”	A. Return system for service

CONTACT INFORMATION

YSI offers a wide range of customer assistance and technical support functions to ensure that you have the information required to use our products. Contact YSI Environmental if you need assistance or have questions regarding any YSI Environmental Product. Business hours are Monday through Friday, 8AM to 5PM ET.

YSI Environmental Incorporated
1725 Brannum Lane
Yellow Springs, OH 45387
Toll Free: 800-897-4151
Phone: 937 767-7241
Fax: 937 767-1058
E-Mail: environmental@ysi.com
www.ysi.com/environmental

REQUIRED NOTICE

The Federal Communications Commission defines this product as a computing device and requires the following notice:

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- re-orient the receiving antenna
- relocate the YSI Instrument with respect to the receiver
- move the YSI Instrument away from the receiver
- plug the YSI Instrument into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 0004-000-00345-4.

Note: While testing to EN-61000-4-6, Conducted RF Immunity, per Table A.1 of EN61326, Electrical Equipment for Measurement, Control and Laboratory Use, the YSI 550A exhibited an ERROR 8 message from 8.6 MHz 22.8 MHz at induced RF voltages of 3-Volts to 1-Volt RMS on the 25-foot probe cable. If you observe this interference please relocate the probe-cable away from heavy industrial equipment power and control cables or communications equipment cables which may be causing the interference.

APPENDIX G – HEALTH AND SAFETY PLAN

APPENDIX H

SITE MANAGEMENT FORMS

Summary of Green Remediation Metrics for Site Management

Site Name: ___________________________________Site Code: ______________________
Address: _____________________________________City: ___________________________
State: ______________ Zip Code: __________County: _________________________

Initial Report Period (Start Date of period covered by the Initial Report submittal)
Start Date: ______________________

Current Reporting Period
Reporting Period From: ________________________To: ____________________________

Contact Information
Preparer’s Name: _____________________________ Phone No.: _____________________
Preparer’s Affiliation: ______________________________________

I. Energy Usage: Quantify the amount of energy used directly on-site and the portion of that derived from renewable energy sources.

	Current Reporting Period	**Total to Date**
Fuel Type 1 (e.g. natural gas (cf))		
Fuel Type 2 (e.g. fuel oil, propane (gals))		
Electricity (kWh)		
Of that Electric usage, provide quantity:		
Derived from renewable sources (e.g. solar, wind)		
Other energy sources (e.g. geothermal, solar thermal (Btu))		

Provide a description of all energy usage reduction programs for the site in the space provided on Page 3.

II. Solid Waste Generation: Quantify the management of solid waste generated on-site.

	Current Reporting Period (tons)	**Total to Date (tons)**
Total waste generated on-site		
Operation, maintenance, and monitoring-generated waste		
Of that total amount, provide quantity:		
Transported off-site to landfills		
Transported off-site to other disposal facilities		
Transported off-site for recycling/reuse		
Reused on-site		

Provide a description of any implemented waste reduction programs for the site in the space provided on Page 3.

III. Transportation/Shipping: Quantify the distances travelled for delivery of supplies, shipping of laboratory samples, and the removal of waste.

	Current Reporting Period (miles)	**Total to Date (miles)**
Standby Engineer/Contractor		
Laboratory Courier/Delivery Service		
Waste Removal/Hauling		

Provide a description of all mileage reduction programs for the site in the space provided on Page 3. Include specifically any local vendor/services utilized that are within 50 miles of the site.

IV. Water Usage: Quantify the volume of water used on-site from various sources.

	Current Reporting Period (gallons)	**Total to Date (gallons)**
Total quantity of water used on-site		
Of that total amount, provide quantity:		
Public potable water supply usage		
Surface water usage		
On-site groundwater usage		
Collected or diverted storm water usage		

Provide a description of any implemented water consumption reduction programs for the site in the space provided on Page 3.

V. Land Use and Ecosystems: Quantify the amount of land and/or ecosystems disturbed and the area of land and/or ecosystems restored to a pre-development condition (i.e. Green Infrastructure).

	Current Reporting Period (acres)	**Total to Date (acres)**
Land disturbed		
Land restored		

Provide a description of any implemented land restoration/green infrastructure programs for the site in the space provided on Page 3.

Description of green remediation programs reported above (Attach additional sheets if needed)
Energy Usage:
Waste Generation:
Transportation/Shipping:
Water usage:
Land Use and Ecosystems:
Other:

CERTIFICATION BY CONTRACTOR

I, ____________________________ (**Name**) do hereby certify that I am ______________________ (**Title**) of the Company/Corporation herein referenced and contractor for the work described in the foregoing application for payment. According to my knowledge and belief, all items and amounts shown on the face of this application for payment are correct, all work has been performed and/or materials supplied, the foregoing is a true and correct statement of the contract account up to and including that last day of the period covered by this application.

____

Date **Contractor**

APPENDIX I

REMEDIAL SYSTEM OPTIMIZATION TABLE OF CONTENTS

REMEDIAL SYSTEM OPTIMIZATION FOR [Site Name]

TABLE OF CONTENTS

Arcadis CE, Inc.

855 Route 146

Suite 210

Clifton Park, New York 12065

Tel 518 250 7300

Fax 518 250 7301

www.arcadis.com

4.3 RECOMMENDATIONS TO REDUCE COSTS

4.3.1 Supply Management

4.3.2 Process Improvements or Changes

4.3.3 Optimize Monitoring Program

4.3.4 Maintenance and Repairs

4.4 RECOMMENDATIONS FOR IMPLEMENTATION