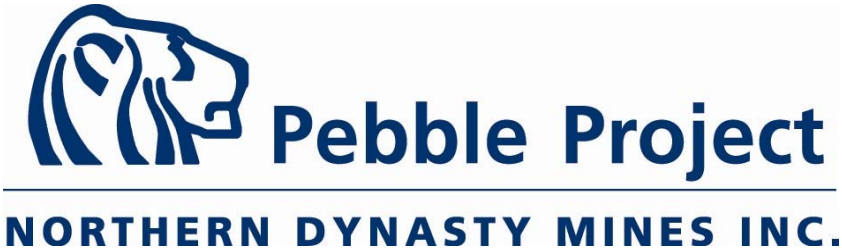


# DRAFT ENVIRONMENTAL BASELINE STUDIES

## FIELD SAMPLING PLAN

## CHAPTER 12. MARINE

**NOVEMBER 2005**

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# Acronyms

ADF&G.....Alaska Department of Fish and Game
ADOT&PF.....Alaska Department of Transportation and Public Facilities
BEESC.....Bristol Environmental and Engineering Services Corporation
CAS..... Columbia Analytical Services, Inc.
cm.....centimeter
COC .....Chain-of-Custody
CORI.....Coastal & Oceans Resources Inc.
DI .....Deionized
FSP.....Field Sampling Plan
GIS .....Geographic Information System
GPS .....Global Positioning System
IIE .....Iniskin/Iliamna Estuary
m ..... meter
mm .....millimeter
NCA .....North Creek Analytical, Inc.
NDM ..... Northern Dynasty Mines Inc.
NEPA .....National Environmental Policy Act
NOAA .....National Oceanic and Atmospheric Administration
OCSEAP .....Outer Continental Shelf Environmental Assessment Program
Pentec.....Pentec Environmental
PN&D .....Peratrovich, Nottingham & Drage, Inc.
QAPP ..... Quality Assurance Project Plan
QA/QC .....Quality Assurance/Quality Control
SGS .....SGS Environmental Services, Inc.
Shaw.....Shaw Environmental, Inc.
TKN .....Total Kjedahl nitrogen
TL.....Total length
TOC.....Total organic carbon
UAF..... University of Alaska Fairbanks
USACE .....U.S. Army Corps of Engineers

# 1.0 Introduction

This Field Sampling Plan (FSP) presents protocols for collection of marine sediment and fish tissue samples to be collected during the 2005 Marine Studies Program for the Pebble Project. The Pebble Project is a proposed open pit mine being considered to recover gold, copper, molybdenum, and other metals from a deposit located near Iliamna, Alaska. Northern Dynasty Mines Inc. (NDM), the project sponsor, has commenced extensive study programs to collect the engineering, environmental, and socioeconomic data necessary for a bankable feasibility study and for applications for state and federal permits. The *Pebble Project, Draft Environmental Baseline Studies, Proposed 2005 Study Plan* (NDM, 2005a) provides a comprehensive description of the environmental studies being conducted in the onshore and offshore environments.

The Marine Studies Program will be conducted in Iniskin and Iliamna Bays (Figure 1-1) which comprise one of several estuarine complexes and embayments along the west side of lower Cook Inlet. The objective of the 2005 Marine Studies is to further characterize the fauna, flora, and habitat conditions in marine areas that could be affected by development of a port and related activities in the Iniskin Iliamna estuary (IIE). The intent of this study is to raise the information base to a level adequate to evaluate potential impacts of the project for compliance with the National Environmental Policy Act (NEPA) and to support other permitting activities. The 2005 study will build on historic information, including the results of the 2004 marine reconnaissance survey.

The field sampling effort in 2005 will be focused on intertidal and near-shore areas near the preferred potential port site (Port Site 1), and along shorelines that could be affected by the road route under consideration at this time. Figure 1-1 shows key features in the IIE considered for design of the reconnaissance study. Key assumptions include:

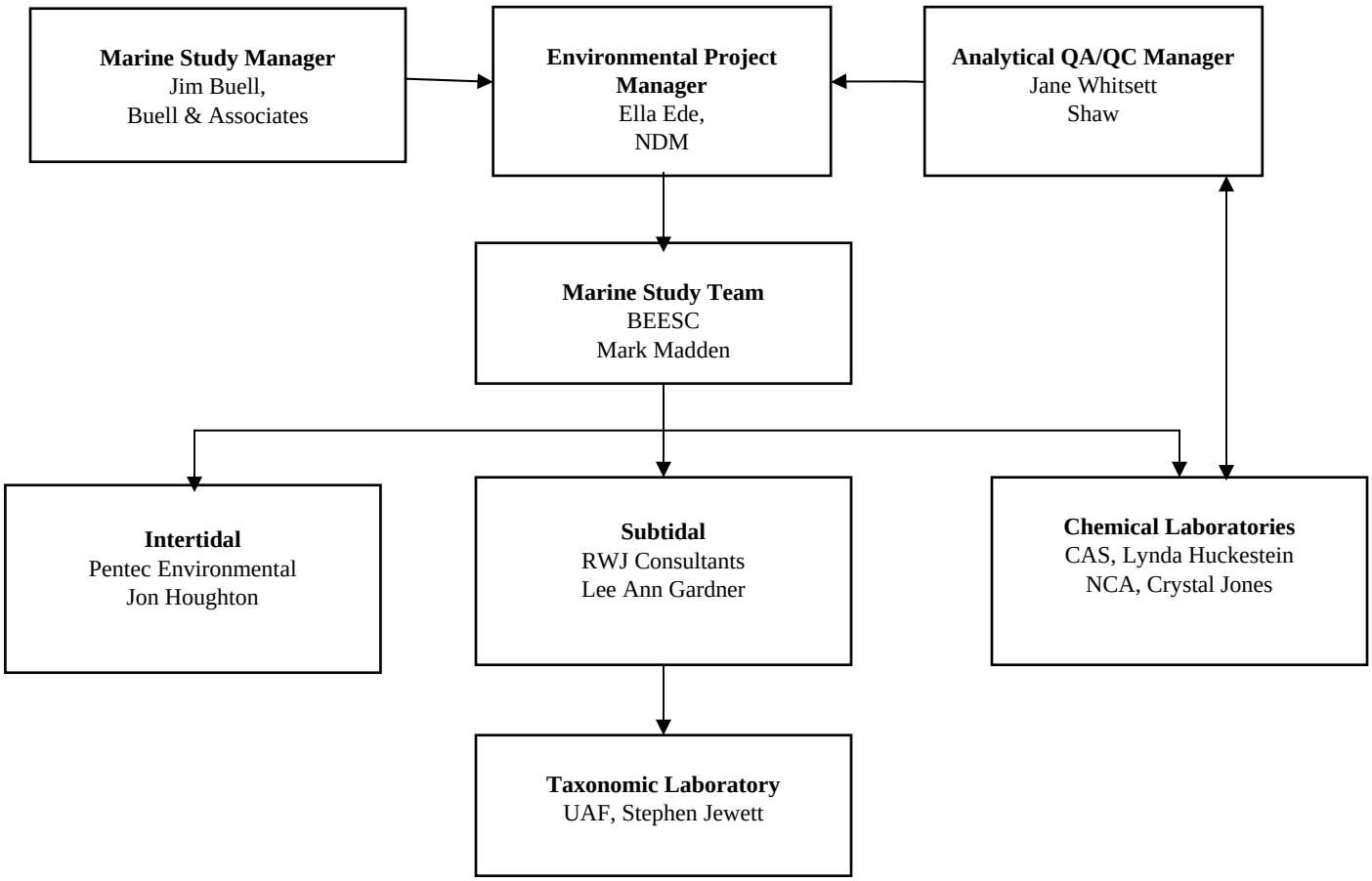
- A port facility to be constructed at or near the proposed Port Site 1, as identified in the Alaska Department of Transportation and Public Facilities (ADOT&PF) *Iliamna Regional Transportation Corridor Analysis* (PN&D, 2004). Upland port facilities would be located immediately adjacent to Port Site 1.
- A road will connect the port facilities to the mine. This study will focus on road development east of Williamsport to Port Site 1. The ADOT&PF preferred route Crosses Iliamna Bay near Williamsport, then runs along the eastern shore of Iliamna Bay, rounding North Head and Knoll Head. An alternate route (not shown on Figure 1-1) which crosses Iliamna Bay near Williamsport, then continues inland, down the ‘Y’ Valley to Knoll Head is also under consideration.

# 2.0 Organization and Responsibilities

## 2.1 Project Organization

NDM has selected Bristol Environmental and Engineering Services Corporation (BEESC) and its team of subcontractors to conduct the marine studies. This team will collect all field samples for laboratory analyses. Shaw Environmental, Inc. (Shaw) will provide analytical quality assurance and quality control (QA/QC) management for the project in accordance with the Quality Assurance Project Plan ([QAPP] NDM 2005b). Key personnel and their roles are identified in the organizational chart (Figure 2-1) and are described in Table 2-1. Table 2-2 summarizes the primary and QA analytical laboratories for the marine studies. Table 2-3 provides complete contact information for the analytical laboratories.

**Figure 2-1**
**Pebble Project Marine Studies Organization Chart**



## 2.2 Project Responsibilities

Project responsibilities for the Pebble Project marine studies are described in Table 2-1.

**Table 2-1**

**Summary of Pebble Project Marine Studies Key Personnel and Roles**

| Personnel | Responsibilities |
|---|---|
| **NORTHERN DYNASTY MINES INC.** | |
| Bruce Jenkins, Chief Operating Officer | Responsible for development and execution of overall project scope and schedule. |
| Ella Ede, Environmental Project Manager | Provides oversight of project team, deliverables, and schedule. |
| Jim Buell, Buell & Associates, Marine Studies Manager | Responsible for oversight of sample collection and laboratory analyses associated with the marine studies at the proposed project port site as well as marine areas potentially impacted by the project. |
| **SHAW ENVIRONMENTAL, INC.** | |
| Jane Whitsett, Analytical QA/QC Manager | Responsible for preparation of QAPP and review of laboratory data and deliverables to ensure technical and quality requirements stipulated by regulatory agencies and NDM are met. |
| **FIELD TEAM** | |
| **BEESC,** Mark Madden, Marine Studies Project Manager | Provides oversight of marine studies field team, deliverables, vessel support, field work/collections, and schedule. |
| Jon Houghton, Intertidal Task Manager (**Pentec**) | Responsible for collection of data and samples in intertidal habitat, field documentation, and coordination of intertidal study team. |
| J. Starkes, Fishery Biologist (**Pentec**)<br>S. Lindstrom, Algaogist (**Sandra Lindstrom**)<br>D. Lees, Marine Biologist (**Littoral Ecological & Environmental Services**)<br>L. Pedersen, Field Tech. (**BEESC**)<br>M. Chambers, Field Tech. (**Pentec**) | Intertidal field team members responsible for collection of data and samples in intertidal habitat as directed by the Intertidal Task Manager. |
| Stephen Jewett, (**UAF**) | Responsible for oversight of taxonomic analyses. |

**Table 2-1**
**Summary of Pebble Project Marine Studies Key Personnel and Roles (Cont'd)**

| Personnel | Responsibilities |
|---|---|
| **CHEMICAL LABORATORIES** | |
| **Columbia Analytical Services, Inc.**<br>Lynda Huckestein, Project Chemist | Responsible for executing and reporting laboratory scope of work for primary marine sediment, fish tissues, and invertebrate tissues collected by field teams. |
| **North Creek Analytical Services, Inc.**<br>Crystal Jones, Project Chemist | Responsible for executing and reporting laboratory scope of work for QA samples for marine sediment, fish tissues, and invertebrate tissues collected by field teams. |
| **TAXONOMIC LABORATORY** | |
| **University of Alaska Fairbanks**<br>Stephen Jewett, Lab Manager | Responsible for executing and reporting laboratory scope of work for taxonomic analysis of sediment infauna samples and prey species found in various fish species collected by field teams. |

**Table 2-2**
**Summary of Primary and Quality Assurance Analytical Laboratories for Marine Studies**

| Media | Primary Laboratory | QA Laboratory |
|---|---|---|
| Marine water and sediment | CAS – Kelso, WA | NCA – Portland, OR |
| Fish tissue and invertebrate tissue | CAS – Kelso, WA | NCA – Portland, OR |

CAS = Columbia Analytical Services, Inc.
NCA = North Creek Analytical, Inc.

**Table 2-3**
**Analytical Laboratory Contact Information**

| | | |
|---|---|---|
| **Crystal Jones**<br>North Creek Analytical, Inc.<br>9405 SW Nimbus Ave.<br>Beaverton, OR 97008<br>503-906-9234 direct phone<br>503-906-9210 fax<br>cjones@ncalabs.com | **Lynda Huckestein**<br>Columbia Analytical Services, Inc.<br>1317 S. 13th Avenue<br>Kelso, WA 98626<br>360-501-3358 direct phone<br>360-636-1068 fax<br>lhuckestein@kelso.caslab.com | **Mike Priebe (local contact)**<br>North Creek Analytical, Inc.<br>2000 W. International Airport Road, Suite A10<br>Anchorage, Alaska 99502<br>907-563-9200 phone, 907-317-3412 cell<br>907-563-9210 fax<br>mpriebe@ncalabs.com |

# 3.0 Marine Studies 2005 Sampling Plan

## 3.1 Field Study Program Activities

Field sampling tasks to be conducted for the Marine Studies Program in 2005 will include:

- Map and characterize intertidal habitat.
- Describe typical assemblages on major habitat types and in the several vertical zones or "biobands" at selected sites, including previously unsampled sites that might be affected by port access road.
- Collect infauna samples for quantitative analysis.
- Assess fish use of littoral habitat in intertidal and shallow subtidal areas by beach seining and otter trawling, respectively.
- Conduct *in situ* water quality measurements at beach seining and trawling sites.
- Collect littoral sediment and animal tissues for laboratory analysis of baseline metals and hydrocarbon concentrations.
- Collect pelagic and demersal fish in offshore subtidal areas with otter trawling for species identification and tissue analyses for baseline metals concentrations.

## 3.2 Field Sampling Schedule

Field sampling for the marine studies will be conducted by Pentec Environmental (Pentec) and BEESC personnel from May through September 2005 as shown in Table 3-1. Matrix codes, used to assist in uniquely identifying/labeling samples, are identified in Table 3-1 where applicable, and are discussed with specific examples in Section 5.5, Labeling and Field Documentation.

**Table 3-1**

**Pebble Project Marine Studies Field Sampling Schedule for 2005**

| 2005 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Consultant** | **Area** | **Media** | **Matrix Code** | **Anal-ysis** | **Apr** | **May** | **June** | **July** | **Aug** | **Sep** |
| Pentec | Intertidal | Sediment | MZ | Chem-ical | | | | X | | |
| Pentec | Intertidal | Fish/Invert. tissues | TF | Chem-ical | | X | X | X | X | X |
| Pentec | Intertidal | Sediment Infauna | - | Taxo-nomic | | | | X | | |
| Pentec | Seining / Trawling | Fish Stomachs | - | Taxo-nomic | | X | X | X | X | X |

Table 3-2 summarizes the analyses to be performed on each media to be collected, including reference to the analytical method to be used. Table 3-3 summarizes the anticipated samples to be collected and analyzed during the 2005 marine studies, including the number of samples by laboratory and matrix.

**Table 3-2**
**Pebble Project 2005 Marine Studies Analytical Methods and Analytes**

| Parameter | Method (Solids) | Media | |
|---|---|---|---|
| | | Sediment | Fish Tissue |
| Ammonia as N | SM4500NH3G | x | |
| Chloride | E300.0 | x | |
| Cyanide, total | SM4500CN or E335.2 | x | |
| Fluoride | E300.00 | x | |
| Sulfate | E300.0 | x | |
| TOC | E415.1 | x | |
| Low-level mercury | E1631 | | x |
| Mercury | SW7471A | x | |
| Metals[1,2] | SW6010B/6020/7000/ E200.8 | x | x |
| GRO | AK101 | x | |
| BTEX | SW8260B | x | |
| DRO/RRO | AK102/103 | x | |
| PAH | SW8270CSIM | x | x |

[1] Metals to be analyzed in sediment include Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn.
[2] Metals to be analyzed in fish tissue include Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag, Tl, Zn

BTEX = benzene, toluene, ethylbenzene, xylenes
DRO = diesel-range organics
GRO = gasoline-range organics
PAH = polycyclic aromatic hydrocarbons
RRO = residual-range organics
TOC = total organic carbon
E = EPA (1983, 1991 and 2001)
M = modified
SW = EPA (1993)
SM = Standard Methods for the Examination of Water and Wastewater, 20th Edition. 1998.

**Table 3-3**

**Pebble Project 2005 Marine Studies Expected Sample Quantities**

| Task | Medium | May | June | July | Aug | Sept | Total # of samples |
|---|---|---|---|---|---|---|---|
| **Analytical Samples for 2005 – Primary Lab (Columbia Analytical Services, Inc.)** | | | | | | | |
| Trace Elements/Inorganics[1] | Sediment | | | 8 | | | 8 |
| TOC/Ammonia as N, TKN | Sediment | | | 8 | | | 8 |
| Trace Elements[2] | Tissue — seine / trawl | 5 | 5 | 5 | 5 | 5 | 25 |
| GRO/BTEX/DRO/RRO/PAH | Sediment | | | 8 | | | 8 |
| **Analytical Samples for 2005 —QA Lab (North Creek Analytical)** | | | | | | | |
| QA Trace Elements/Inorganics | Sediment | | | 1 | | | 1 |
| QA Trace Elements[2] | Tissue — seine/trawl | | | 2 | | | 2 |
| QA TOC/TKN | Sediment | | | 1 | | | 1 |
| QA GRO/BTEX/DRO/RRO/PAH | Sediment | | | **1** | | | **1** |
| **Infauna and Fish Stomach Samples for 2005 — Lab (University of Alaska Fairbanks)** | | | | | | | |
| Infauna Species Identification/Quantification | Sediment - intertidal | | | 40 | | | 40 |
| Stomach – Prey Species Identification | Fish stomachs - seining | 10 | 10 | 10 | 10 | 10 | 50 |
| Stomach – Prey Species Identification | Fish stomachs - trawling | 10 | 10 | 10 | 10 | 10 | 50 |

1 —Al, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl , Cl, F, $SO_4$,and CN
2— Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag, Tl, Zn, and low level Hg
TKN = total Kjeldahl nitrogen
TOC = total organic carbon
GRO = gasoline-range organics
DRO = diesel-range organics
RRO = residual-range organics
PAH = polycyclic aromatic hydrocarbons
BTEX = benzene, toluene, ethylbenzene, and xylenes

## 3.3 Sample Locations

The 2005 field activities will occur at a variety of locations in the IIE. Some of these stations were previously occupied in 2004. Stations proposed for sampling in 2005 and those sampled in 2004 are shown in Figure 3-1.

Table 3-4 provides a summary of the marine studies stations, including types of sampling activities to be performed. Table E-1 in Appendix E provides a complete listing of the global positioning system (GPS) coordinates for all 2005 marine studies sampling stations.

The sampling station names noted in Table 3-4 follow the station naming convention as stipulated in the QAPP. That is, the station name must be no more than 5 letters/numbers, with the replicate number added at the end of the data field, e.g., 1 through 5, so that the total site identification does not exceed 6 characters.

## 3.4 Field Instruments/Equipment

Where applicable, makes and models of field instruments to be used for the 2005 marine studies are:

- YSI Model 85 Handheld Oxygen, Conductivity, Salinity and Temperature System (see Appendix B of this FSP for the Operations Manual containing detailed procedures and calibration procedures)

- Turbidity meter
- Beach seine (standard 37-m, fine mesh)
- 10' Otter Trawl (Research Nets, Inc.): Four-seam semi-balloon style, 1/2"-#9 body, 1"-#15 cod end and 1/4" knotless nylon liner; headrope 10' x 3/8" braided nylon with 2' extensions and 3 2-1/2"x3" floats; footrope 12' x 3/8" braided nylon with 2' extensions and 7 - 4 oz. rolling leads; treated with latex netcoat (green or black). Otter doors are 12"x24" plywood with runners and chain bridles. "V" – Bridle is 3/8" braided nylon with 2 - 20' legs

Field instruments will be calibrated according to the manufacturers' recommendations. See Appendix B of this FSP for field instrument manuals and calibration procedures. Where applicable, time and date of calibrations will be recorded in the field logbook. An entry will be made in the field logbook each time the field instrument is calibrated.

TABLE 3-4
Summary of Marine Studies Station Locations in Iniskin and Iliamna Bays

| Station Name | Station ID | Sampling Activities | | | |
|---|---|---|---|---|---|
| | | Beach Seining | Intertidal Mapping/ Sampling | Off-shore Trawls[1] | Water Qual. *In Situ* Meas. |
| Beach Seine Site 1 | MBS1 | X | | | X |
| Beach Seine Site A | MBSA | X | | | X |
| Beach Seine Site A1 | MBSA1 | X | | | X |
| Beach Seine Site 3 | MBS3 | X | | | X |
| Beach Seine Site 3A | MBS3A | X | | | X |
| Beach Seine Site 4 | MBS4 | X | | | X |
| Port Site 1 | MPS1 | | X | | X |
| Port Site 1 Seine Site A | MPS1A | X | X | | X |
| Port Site 1 Seine Site B | MPS1B | X | | | X |
| Port Site 1 Seine Site C | MPS1C | X | | | X |
| Port Site 1 Trawl Site | MPS1T | | | X | X |
| Port Site 2 | MPS2 | | X | | X |
| Port Site 2 Trawl Site | MPS2T | | | X | X |
| Port Site 2 Trawl Site A | MPS2TA | | | X | X |
| Port Site 2 Trawl Site B | MPS2TB | | | X | X |
| Port Site 3 | MPS3 | | X | | |
| Port Site 4A | MPS4A | X | X | X | X |
| Port Site Existing (Williamsport) | MPSE | X | | | X |
| Port Site Existing Seine Site 1 | MPSE1 | X | | | X |
| Scott Island | MSI | | X | | |
| Blacky Beach | MBB | X | X | | X |
| Trawl Site 1 | MTR1 | | | X | |
| Trawl Site 1A | MTR1A | | | X | |
| Trawl Site 2 | MTR2 | | | X | |
| Trawl Site 3 | MTR3 | | | X | |

[1] Note: Trawling will only occur in soft bottom areas without rocky substrates to prevent damage to gear; if unknown, the status of bottom type will first be determined by inspection during low tides or vessel instrumentation.

# 4.0 Field Methods

For all field sampling, team members will follow the procedures identified in this FSP and abide by the Alaska Department of Fish & Game (ADF&G) collection permit requirements (see Appendix D, ADF&G Fish Collection Permit, Application, and Sampling Plan). All biological samples must be recorded on the Fisheries Resources Permit Collection Log (included in the field forms).

The sampling program will study the nature and usage of the nearshore and intertidal habitats in the project area. The intertidal studies will include habitat mapping, epibiota quantification on hard substrata, infauna and sediment collections on soft substrata, tissue collections, and beach seining.

## 4.1. Intertidal Mapping and Characterization

Intertidal habitat types present around portions of the IIE that may be directly impacted by port development will be mapped, including the Williamsport area and the east side Iliamna Bay, the southwest side of Iniskin Bay, and the headlands between the two bays. Intertidal habitat mapping will build on the base information from the Cook Inlet Regional Citizen's Advisory Council (CIRCAC and EVOS, 2005).

Where field observations differ significantly from existing mapping, dominant substrate types observed in the upper, middle, and lower intertidal zones will be recorded separately. Mapping will include documentation of transitions between habitat types using GPS for later incorporation into the project Geographical Information System (GIS) database.

## 4.2 Intertidal Epibenthic Assemblages

Intertidal epibenthic assemblages on rocky and boulder/cobble substrata will be quantified in fixed quadrats on fixed transects. The sampling program will revisit some sites established in 1978, 1996, and 2004 and will establish new sites along Iliamna Bay to evaluate potential impact from construction of the port access road. Key historic sampling locations will be revisited to ensure that monuments are well established for future reference as well as to evaluate trends observed in algae and epibiota on these beaches. Proposed sampling locations are shown on Figure 3-1 and listed in Table 3-4.

With the help of photographs and previously placed markers, previously sampled intertidal rocky sites and elevations will be resampled as close as possible to the locations (specific quadrats) previously sampled. New sites will be located to be representative of intertidal habitats along previously unsampled shorelines in the IIE that may be impacted by the port or port access road alternatives. At each intertidal sampling site, two or three elevations will be sampled that are representative of the gradient of assemblages present. At some sites, there may be significant substrate changes between the upper and lower elevations. For most of the new Iliamna Bay sites, only upper and possibly middle elevations will be rocky, with many middle and all lower elevations occurring on the mudflats and sampled as soft sites.

At each elevation sampled on rocky or boulder/cobble habitat types, a 30-meter transect line will be laid out along the tidal elevation contour line. Along each transect, five to ten 0.25-$m^2$ quadrats will be randomly located, or, in the case of previously sampled random quadrats,

relocated. In 2005, we will seek to establish permanent marks of marine epoxy, nails, or rebar to allow precise repositioning of each quadrat in subsequent sampling.

Once the quadrat is positioned, a photograph will be taken of the quadrat and immediate surrounding substrate. A pre-printed label showing date, site, elevation and quadrat number will be included in each photograph. In each quadrat, the nature of the substrate and percent cover of all algal species and all sessile animals will be estimated and recorded on the Intertidal Field Form (see Figure A-1 in Appendix A). Area of coverage less than 0.5 percent will be recorded as 0.5 percent. Counts will be made of all mobile species larger than about 4 millimeters (mm) in size. Dominant species will be identified along with less numerically abundant but ecologically important "keystone species." Very abundant organisms may be subsampled by counting the numbers in a randomly selected subsection of the quadrat; data recorded will reflect that subsampling ("=count x 1/fraction of quadrat counted"). Detailed species lists will be compiled for each habitat type and elevation and recorded on the Intertidal Field Form (Figure A-1). These data will provide a quantitative baseline for comparison with the data available from previous work in the IIE, and for assessment of potential project impacts.

## 4.3 Intertidal Infauna and Sediment Characterization

Intertidal infaunal and sediment sampling in soft-bottom habitats (sand or mud) will be conducted to establish the type and distribution of infaunal species in the soft intertidal areas (Figure 3-1). Previously sampled sites will be relocated by using pre-recorded GPS coordinates; previously placed rebar stakes; or other means (e.g., large boulder). New sites along the east side of Iliamna Bay will be similarly marked; most, if not all will comprise the lowest elevation sampled at sites with rocky upper and/or middle elevation stations. At most soft sites, only a single elevation will be sampled.

At each elevation, five replicate samples will be taken at random distances from a transect head stake. Samples will be taken with a 15-centimeter (cm) deep, 80-$cm^2$ hand corer. In addition, at each infaunal core location, two, 2-cm deep sediment samples will be taken from undisturbed sediments adjacent to each core location to form three composite samples: one sample for analysis of total organic carbon (TOC) , ammonia as N and total Kjeldahl nitrogen (TKN), and one for analysis of metals and petroleum hydrocarbon concentrations.

Infauna samples will be processed in the field by washing and sieving through a 1.0-mm mesh screen. Infauna will then be preserved in 10 percent neutral buffered formalin solution with 0.1 percent rose Bengal dye. Each sample will be checked off by the sampler on the Field Inventory Form (Figure A-2). The preserved samples will then be transported to the University of Alaska - Fairbanks (UAF) laboratory in Fairbanks, Alaska. At the taxonomic laboratory, the samples will be transferred from the formalin solution to a 50 percent isopropyl alcohol solution for archival and storage until their analysis (i.e., taxonomic identification).

Each sediment and infaunal sample will be checked off by the sampler on the Field Inventory Form (Figure A-2 in Appendix A). These samples will be entered on the Sampling Transfer Form (Figure A-4) and then packed in coolers and delivered to Shaw as prescribed in the Project QAPP (NDM, 2005b). The Sample Transfer Form will accompany each cooler shipment at all times. Prior to shipment, samples will be segregated into coolers based on laboratory destination. See additional information in Section 5.5, Labeling and Field Documentation.

At selected soft intertidal sites, additional sampling will be conducted to quantify epibiota and larger mega-infauna such as large clams, polychaetes, and echiurids. Each randomly located 0.25-$m^2$ quadrat will first be photographed in the manner described for rocky sites above. All epibiota will be recorded as described for rocky sites. The quadrat will then be excavated to approximately 25 to 30 cm and either sieved or visually examined for animals larger than approximately 5 mm. Organisms may be identified in the field or collected in clean plastic bags for later identification and enumeration on the support vessel; alternatively, they may be preserved and returned to the analytical or taxonomic laboratory for processing.

## 4.4 Intertidal Tissue Collections

Selected species (e.g., bivalves *Mya* spp. or *Macoma* spp.) from soft bottom sampling in the larger (0.25-$m^2$) quadrats or from selective searching in the vicinity of soft bottom sites will be saved for trace metal analyses. Additional species (e.g., mussels *Mytilus trossulus*) which are available at many rocky sites also will be collected for trace metals analysis. Sampling will be done opportunistically in the immediate vicinity of established study sites shown in Figures 3-1. All tissue samples will be listed in the Specimen Log Form (Figure A-3), with information filled out as completely as possible when applicable.

Specimens collected for laboratory analysis of baseline trace metals concentrations will be counted, identified by species, the date and collection locations noted, and if applicable, sex, life stage, age, and lengths and weights will be recorded. For mussels, because their size will be generally small, and because they were consistently found in the IIE in 2004, enough animals will be collected over a wide geographical area at each site to approximate a 25 gram sample of tissue, as noted in the sampling plan submitted to the Alaska Department of Fish and Game (ADF&G) as part of BEESC's 2005 Fish Resource Collection Permit application (see Appendix D). See Figure A-3 and the accompanying documentation in Appendix A for the Specimen Log Form.

All tissue samples will be packaged and shipped to the appropriate analytical laboratory according to the Project QAPP (NDM, 2005b).

## 4.5 Nearshore Fish Assemblages (Seining)

An important function of the littoral zone is its role as a nursery for juvenile salmonids and other forage fish as well as for several important invertebrates. Seining will be performed monthly from May though mid September with more intensive surveys in late May and early June during expected salmonid out-migration through the estuary (see Table 3-1 for the 2005 marine studies field sampling schedule). Proposed beach seining locations are identified in Table 3-4 and shown on Figure 3-1. Beach seining will be conducted using a standard 37-m, fine-mesh seine at up to 11 locations along moderate to low gradient, mud, sand or gravel beaches in Iniskin and Iliamna Bays. Catch will be identified by species and recorded on the Fish Catch Record (see Figure A-5). Total lengths of a representative number of each cohort will be measured to determine the dominant size classes using this shallow water habitat at that time; these data will also be recorded on the Fish Catch Record (Figure A-5).

BEESC will rely on ADF&G herring spawn survey data in the IIE and adjacent bays to further characterize the IIE intertidal habitat. ADF&G currently surveys the study area by air on a

weekly basis, weather permitting, with at least one on-water survey annually. Use of ADF&G personnel will ensure that the surveys methods are consistent with ongoing surveys in the area and defensible. ADF&G has already provided data to our team on surveys conducted between 1978 and 2002. Field crews will seek to minimize the catch of adult herring but will document locations along the shoreline where herring schools and spawning are observed. If time permits, they will also take GPS readings on areas of spawn deposition and notes on algal species receiving spawn deposition.

During seining events, water quality measurements will be made with *in situ* field instruments to record turbidity, conductivity, salinity and temperature.

## 4.6 Offshore Otter Trawling

Trawling with a "try-net" will be conducted concurrent with other marine studies activities to evaluate both resident and migratory species and event-related species interaction such as herring spawning (see the 2005 field sampling schedule in Table 3-1)**.** During the intertidal beach-seining program, the try net will be fished at 4 to 6 locations over flooded tide flats and channels in both Iniskin and Iliamna bays. The locations include at least 3 of the 4 sites sampled in 2004 with additional stations located in Iliamna Bay.

A 3-meter "try net" will be used in soft bottom, subtidal areas and flooded low intertidal soft bottom areas identified during low tides, to sample demersal fish and large invertebrates that may be missed by other sampling protocols. Catch will be identified by species and recorded on the Fish Catch Record (Figure A-5) as well as the Specimen Log Form (Figure A-3) for ADF&G Collection Permit reporting. A representative number of each cohort will be measured to identify dominant size classes using this habitat. Selected specimens will also be retained for tissue metals analyses and/or stomach content analysis (see Table 3-3 and Section 4.4, Offshore Tissue Collections, and Section 4.7, Offshore Fish Stomach Sampling). Fish dissections will follow the procedures noted in Appendix C of this FSP. In addition, procedures will meet the ADF&G Collection Permit requirements (see Appendix D).

During trawling events, water quality measurements will be made with *in situ* field instruments to record turbidity, conductivity, salinity and temperature.

## 4.7 Offshore Fish Stomach Sampling

Stomach samples will be collected during the field season as noted in the field schedule Table 3-1 and in the sample quantities noted in Table 3-3. Fish will be collected in the IIE during beach seining, trawling, and with hook and line.

Stomach dissection and sampling methods are modified from Nielson and Johnson (1983) and are summarized in Section C.1.4 of Appendix C. For large fish (i.e., >155 mm or 6 inches, total fork length [TL]), the fish stomach will be extracted and preserved in the field. For smaller fish (<155 mm or 6 inches TL), the fish stomach will remain in the fish, using the methods detailed in Section C.1.4.2.

# 5.0 Environmental Sampling

## 5.1 Field Tissue Collection

Fish, invertebrates and other organisms collected for tissue sampling will be rinsed in clean seawater upon collection to remove mud, sediment, or other debris from the outer surfaces as needed. Specimens will be placed in a clean plastic bag. Smaller fish and invertebrates that will be combined into a single tissue sample may be placed in the same bag. Larger fish or specimens that will be submitted as separate samples to the laboratory shall be segregated into separate bags. All samples will be kept on ice until properly prepared and packaged for shipment to the laboratory.

## 5.2 Decontamination Procedures – Sediment Sampling

All sample collection equipment which comes into contact with a sample will be decontaminated by means of the following procedure prior to each sample collection. Sample collections which require multiple attempts or passes to acquire adequate sample volume are considered a single sample collection:

1. Rinse in potable fresh water.
2. Wash with Alconox, or the equivalent in potable fresh water or distilled water.
3. Rinse in distilled water. If sampling is being done for low-level mercury, use deionized (DI) water instead for this step.
4. Rinse in DI water (i.e., if sampling is for low level mercury, do second rinse with DI water).

## 5.3 Sample Containers

For all field samples collected for chemical analysis (except biological tissues), containers will be provided by the laboratory selected to conduct the analysis. Samples for chemical analysis will be submitted to Shaw for entry into the electronic chain-of-custody (COC) system. Shaw will be responsible for final shipping and delivery of samples to the analytical lab. Samples for taxonomic analyses will be shipped by the field team to the UAF laboratory. Tables 5-1, summarizes the required containers, sample volumes, preservation, and maximum holding times for all parameters for inorganic sample media. Tables 5-2, summarizes the required containers, sample volumes, preservation, and maximum holding times for all parameters for tissue samples.

**Table 5-1**
**Pebble Project Sample Bottle Schedule and Sampling Parameters for Marine Sediment**

| Analytical Set | Bottle Type (CAS) | Analysis | Lab Method | Preservative | Hold Time | Req. Temp. | Comments |
|---|---|---|---|---|---|---|---|
| | (1) 1L HDPE<br><br>No extra volume for MS/MSD | Total Metals[1] (water) | E200.8/200.7 | $HNO_3$ | 6 Months | None | Equipment rinsate blanks |
| 1 | (1) 8oz | Total Metals[1] | SW6010B/6020/ 7471 (Hg) | None | 6 Months | None | |
| 2 | (1) 4 oz prewt'd amber | Gasoline Range Organics | AK101 | MeOH w/surrogate | 28 days | 4 °C | 2nd 4 oz % solids jar if no other analyses |
| 3 | (1) 4 oz prewt'd amber | Benzene, toluene, ethylbenzene, and xylenes | SW8260B | MeOH w/surrogate | 14 days | 4 °C | 2nd 4 oz % solids jar if no other analyses |
| 4 | (1) 8 oz | Diesel/ residual range organics | AK102/103 | None | 14 days to extraction, 40 days to analysis of extract | 4 °C | |
| 5 | (1) 8 oz | PAHs | 8270C SIM | None | 14 days to extraction, 40 days to analysis of extract | 4 °C | |
| 6 | (1) 4 oz | Cyanide | SM4500CN-E | None | 28 days [2] | 4 °C | |
| 7 | (1) 4 oz | Ammonia as N, TKN | SM4500NH3 | None | 28 days | 4 °C | |
| 8 | (1) 4 oz | Chloride | E300.0 | None | 28 Days [3] | 4 °C | |
| | | Fluoride | E300.0 | None | 28 Days [3] | 4 °C | |
| | | Sulfate | E300.0 | None | 28 Days [3] | 4 °C | |
| 9 | (1) 4 oz | Total Organic Carbon | E415.1 | None | 180 Days | 4 °C | |

1 — Al, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, K, Ag, Na, Sb, V, Zn, As, Pb, Se, Sn, Tl, B, Hg
2 — As per EPA methods fact sheet titled "Total Petroleum Hydrocarbons, Reactive Cyanide, Reactive Sulfide, Ignitability, and Corrosivity"
3 — Holding time is from the date of preparation
oz = ounce
prewt'd = preweighed and tared
CAS - Columbia Analytical Services, Inc.
MeOH = methanol
PAH = polycyclic aromatic hydrocarbons
TKN = total Kjeldahl nitrogen

**Table 5-2**
**Pebble Project**
**Sample Container Schedule and Sampling Parameters for Biological Tissue Collection**

| Tissue Type | Minimum Sample Amount, (grams) | Bottle Type (CAS/NCA) | Analysis | Lab Method | Shipping Preservation and Time | Hold Time | Required Laboratory Storage Temp. |
|---|---|---|---|---|---|---|---|
| Fish & Inverts. | 45 | Ziploc or similar plastic bag | PAHs | 8270C SIM | Cool on blue ice or freeze on dry ice if shipping time will exceed 24 hours. Samples must arrive at the lab within 48 hours of shipment. | 1 year | Freeze at ≤ -20 °C |
| | | | Low-level Hg | E1631 | | 28 days | |
| | | | Total Metals[1] | SW6010B(Cr) E200.8 SW7740 (Se) SW6010B/6020 | | 6 Months | |

1 — Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Se, Ag, Tl and Zn.

## 5.4 Sample Collection and Handling

Field collection and handling procedures will be used to meet QA/QC objectives. Sample handling and custody procedures are required in the field and the laboratory, and during transport. These procedures take into account the nature of the samples, the maximum holding times, and shipping options from the project site to the laboratories. The Field Task Managers are responsible for implementing the sample handling and shipping procedures and will check for QA measures on these activities.

### 5.4.1 Sediment Sampling

Sediment samples will be collected for analysis in the following order, in order of sensitivity of the analysis. That is:

1. Organics/hydrocarbons
2. Total metals
3. Miscellaneous parameters (e.g., ammonia, phosphorus, Cyanide, etc.).

To expedite filling of sample containers, a suitable transfer container (e.g., large bowl for sediment) of the appropriate type of material will be used to speed the filling process and to minimize spillage. These containers and the spoons or other implements used to do the sample transfer will be decontaminated after each sampling event at each station.

Sample containers will be discarded if the container has been damaged or it is apparent that the preservative (if applicable) has leaked out of the container.

### 5.4.2 Tissue Sampling

For fish being collected for contaminant analyses, fish collection procedures will follow many of the methods of Zhang et al. (2001) and Jewett et al. (2003). Also see Appendix C of this FSP, Fish and Invertebrate Tissue Sampling Procedures. General procedures include:

- Total fish fork length and sex will be recorded for each specimen in the field, when feasible; any necessary dissection to determine sex will be done using surgical sheets, powder-free latex gloves, and an acid-washed titanium or high-quality stainless steel knife or scalpel. The disposable gloves will be changed out between each dissection.
- For smaller fish (e.g., < 6 inches or 155 mm TL), the entire animal will be placed in a Ziploc-type plastic bag and frozen immediately.
- For larger fish (e.g., > 6 inches or 155 mm TL), immediate freezing of all tissues in an entire animal would be difficult under field conditions.

Therefore, tissue dissections for muscle and liver samples in larger fish will be done in the field as follows:

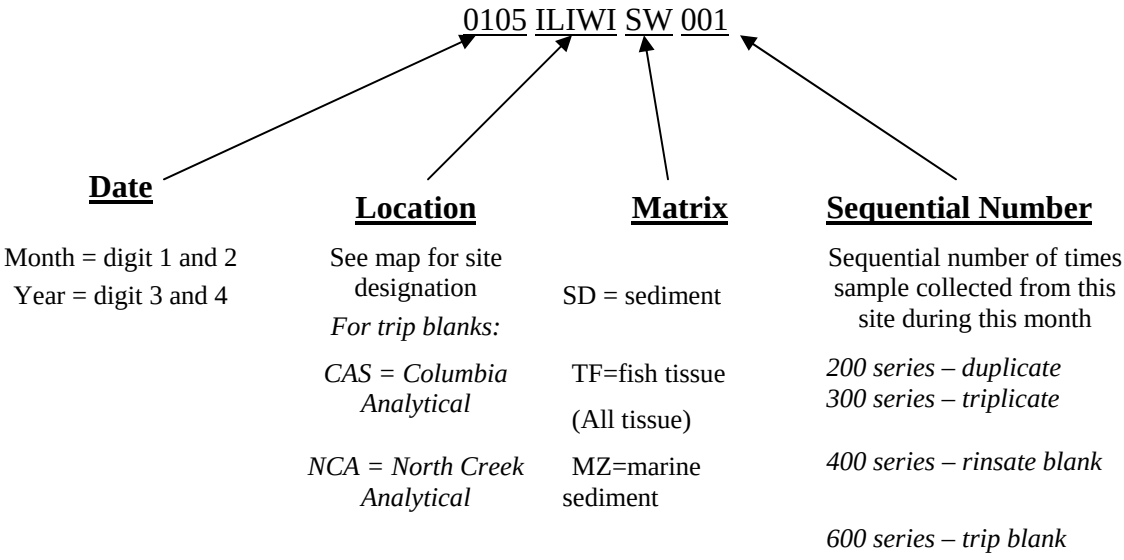
- Immediately upon capture, fish will be placed in clean plastic bags and placed in a cooler with ice.
- Dissection will occur indoors onboard the ship.
- The cutting surface will be washed with soap and water and covered with heavy-duty aluminum foil.
- Either stainless steel disposable scalpels or stainless steel knives will be used for dissection. Scalpels/knives with visible rusting will not be used. Knives will be washed with soap and water and rinsed with DI water between uses. Scalpels will be replaced between fish.
- An approximate 50-gram sample of liver and muscle tissue will be extracted from each fish using powder free gloves and placed in an individually labeled Ziploc bag. Tissue samples will be immediately placed in a freezer.
- An equipment blank will be prepared BEFORE each set of dissections by rinsing the cutting surface and the knives with DI water and collecting the rinse water in an acid-washed jar provided by the analytical laboratory.
- Frozen tissue samples will be packaged in a cooler and sent to the laboratory using packaging recommendations provided by the lab. Chain-of-custody procedures will be followed.
- Each sample from an individual fish will be labeled with the sample ID number and include a suffix of “M” for muscle or “L” for liver tissue (see Section 5.5).
- For the fish tissue samples from large fish, the muscle tissue will be collected immediately below the dorsal fin. When doing the tissue dissections, at least 50 grams of tissue for each type of tissue sample, or about a 3x3x2-inch piece of tissue, will be collected.
- Collect at least 75 grams of tissue for 10 percent of the fish samples. This will allow the preparation of QA/QC samples at the primary tissue laboratory (CAS). CAS will then ship QA samples to NCA for analysis.

## 5.5 Labeling and Field Documentation

Each sample container will have a waterproof label large enough to contain the information needed to easily identify each sample. The information to be included on each label will include the project name, date, time, preservative (if added), sample code, analysis, and sampler's initials. The sample code will be formatted to indicate sample date (month and year), location, matrix, and number.

Each sample will be checked off by the sampler on the Field Inventory Form (Figure A-2) noting day and time of collection and to ensure that all samples are collected and labeled properly prior to moving onto the next sampling station.

In addition to the bottle label, the following information will be entered onto the Sample Transfer Form (see Figure A-4 in Appendix A) for placement in the shipping cooler. An example of sample identification is as follows:




For large fish with analyses conducted on both muscle and liver tissue, the sample ID will include a suffix of "M" for muscle or "L" for liver tissue. For example, fish liver tissue from location MPS4 collected on August 20, 2005, would have the following sample ID:

0805MPS4TF001L.

It is extremely important that the Specimen Log Form (Figure A-3 in Appendix A) is filled out for EVERY tissue sample collected. This log sheet includes all the information that will be needed to properly report the animals collected/sacrificed under the 2005 ADF&G Collection Permit. It is extremely important that this sheet be filled out as completely as possible for all information that is applicable to the animal (even if it is not sent to the lab, e.g., due to damage. see further discussion in Appendix C, Fish Dissection Procedures, as well as the specific Specimen Log Form directions in Appendix A for Figure A-3).

## 5.6 Blank, Duplicate, and Triplicate Samples

A number of QA/QC samples will be collected in the field to assess sample contamination, precision, and accuracy. A summary of field QA/QC samples and the frequency of collection is given in Table 5-3. The types of QA/QC samples are:

- Field Duplicates – For sediments, duplicate samples are taken in the field and analyzed in the laboratory to account for both the sample matrix variability and variability in sampling and analytical practices. Each field duplicate will be collected by filling two sets of containers simultaneously, using the same sampling procedure. Each sample container is treated as a separate sample. For fish tissues, the field duplicate is collected from the homogenate prepared at the laboratory.
- Equipment Rinsate Blanks (also known as decontamination blanks) - These blanks will assess the contamination effects on accuracy due to the combined activities of sampling and analysis. When decontamination occurs, field blanks will be prepared by routing deionized/distilled water through recently decontaminated sampling equipment (e.g., grab sampler, dissection knife) BEFORE beginning the actual sampling or dissection. The final rinsate will be collected in a set of sample containers and analyzed. These samples will verify the efficiency of the decontamination process by detecting any residual chemical constituents remaining on the equipment.
- Trip Blanks - These blanks are used to monitor inadvertent contamination that might occur while the sample containers for VOC in sediments are in transit. This sample is typically a sample of methanol that is placed in each cooler with the sample bottles prior to their shipment into the field. The trip blanks will verify that no inadvertent contamination occurred in the project samples while they were in transit or while stored on-site in the field location.
- Field Triplicates – For sediment samples, field triplicates are collected in the same manner as noted for field duplicates. The triplicate sample is forwarded to a separate designated QA laboratory (see Table 2-2 for the designated laboratories for the primary analyses and the QA laboratories) as an independent check of the primary laboratory. For fish tissues, the field triplicate is collected from the homogenate prepared at the laboratory from the same fish sample as the duplicate..

Each QA sample will be labeled as noted in Section 5.5, Labeling and Field Documentation.

**Table 5-3**
**Pebble Project Marine Studies Summary of Field QA/QC Samples**

| Type of Field QA/QC Sample | Analysis | Frequency | Sampling Events |
|---|---|---|---|
| Field Duplicate (QC sample) | All Parameters | 10 percent | All |
| Field Triplicate (QA sample) | All Parameters | 10 percent | All |
| Equipment blank | Total Metals | 5 percent | Marine sediment, fish tissues (liver/muscle) |
| Trip blank | VOCs | 1 per cooler | Marine sediment |

## 5.7 Field Corrective Action

Field sampling and quality assurance procedures are contained in this FSP. While in the field, corrective actions are the responsibility of the Task Managers, in consultation with the BEESC Project Manager. When a failure in the sampling system occurs, this management team will cooperate to investigate the failure and implement necessary corrective action(s).

# 6.0 References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# FIGURES

1,700,000

1,750,000

2,050,000

Sand & Mud

Right Arm

Foul

Rk

Rks

Bld

M

Cl

Reef
(Cov 1 ft at MLLW)

INISKIN BAY

Summit Lakes

Williams Creek

Williamsport

Back Range

A.C. Point

North Head

Knoll Head

Mushroom Islets

Scott I

The Toadstools

Mt Pomeroy

Diamond Pt

ILIAMNA BAY
(use inset)

COTTONWOOD BAY
(use inset)

Kelp

Vert

Iniskin Rk

Iniskin I

Iniskin Shoal

Pomeroy I

Black Reef

White Gull I
(70)

Turtle Reef
rky (15)

South Head

Big Rk
(9)

LOCAL MAGNETIC DISTURBANCE
(see note)

S Oz

S M

Northern Dynasty Mines Inc.

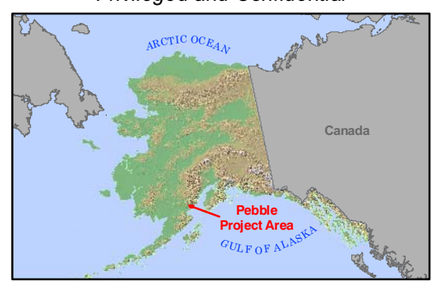
**Pebble Project**

Study Area,
2005 Marine Studies Program
Figure 1-1

**Legend**

- Port Site 1
- Preferred ADOT&PF Road Corridor

*Privileged and Confidential*




N

0 0.7 1.4 2.1 2.8 Miles

0 0.8 1.6 2.4 3.2 Kilometers

Scale 1:70,000

**Alaska State Plane Zone 5 (units US feet)**
**1983 North American Datum**

| | |
|---|---|
| File: Marine_01_V03.mxd | Date: Sept. 26, 2005 |
| Version: 3 | Author: BEESC-ME |

1,700,000

1,750,000

2,050,000

Northern Dynasty Mines Inc.

**Pebble Project**

2005 Marine Sampling Locations

Figure 3-1

**Legend**

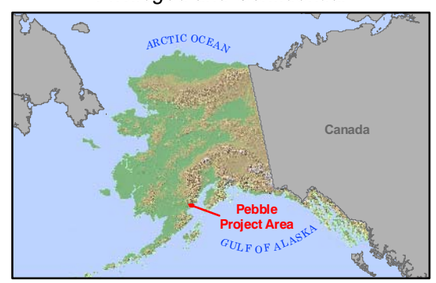
- Port Site 1

**Marine05_V01**

**Sample_Typ**

- Beach seine
- Infauna/sediment sample
- Intertidal
- Trawl
- Preferred ADOT&PF Road Corridor

*Privileged and Confidential*




N

Miles
0 0.7 1.4 2.1 2.8

Kilometers
0 0.8 1.6 2.4 3.2

Scale 1:70,000

**Alaska State Plane Zone 5 (units US feet)**
**1983 North American Datum**

| | |
|---|---|
| **File: Marine05_V01.mxd** | **Date: Sept. 27, 2005** |
| **Version: 1** | **Author: BEESC-ME** |

# APPENDIX A
# FIELD DATA FORMS AND LOG FORMS

**Pebble Marine Studies - Intertidal Inventory Field Form**

Page of

Date: Observer:

Station: Elevation:

| Species | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| **Substrate** | | | | | | | | | | |
| Bedrock | | | | | | | | | | |
| Boulder/cobble | | | | | | | | | | |
| Gravel/sand | | | | | | | | | | |
| Mud | | | | | | | | | | |
| Water | | | | | | | | | | |
| Oil Scale (prim.) | | | | | | | | | | |
| Oil Cover (prim.) | | | | | | | | | | |
| Oil Scale (sec.) | | | | | | | | | | |
| Oil Cover (sec.) | | | | | | | | | | |
| Subsurface oil | | | | | | | | | | |
| | | | | | | | | | | |
| **Plants (% cover)** | | | | | | | | | | |
| *Acrosiphonia areta* | | | | | | | | | | |
| *Alaria marginata* | | | | | | | | | | |
| *Alaria taempata* | | | | | | | | | | |
| *Articulated coralline algae* | | | | | | | | | | |
| *Blue-green algae, crust* | | | | | | | | | | |
| *Blue-green spheroids* | | | | | | | | | | |
| *Ceramium cimbricum* | | | | | | | | | | |
| *Cladophora sericea* | | | | | | | | | | |
| *Clathrohmorphlam reclin* | | | | | | | | | | |
| *Constanfanea sub* | | | | | | | | | | |
| *Corallum frondes* | | | | | | | | | | |
| *Cryptosiphonia woodii* | | | | | | | | | | |
| *Diatoms* | | | | | | | | | | |
| *Diatoms scuz* | | | | | | | | | | |
| *Elaschista fucicola* | | | | | | | | | | |
| *Encrusting brown algae* | | | | | | | | | | |
| *Encrusting coralline algae* | | | | | | | | | | |
| *Encrusting green algae* | | | | | | | | | | |
| *Encrusting red algae* | | | | | | | | | | |
| *Endocladia muricata* | | | | | | | | | | |
| *Enteromorpha intestinalis* | | | | | | | | | | |
| *Enteromorpha Linza* | | | | | | | | | | |
| *Enteromorpha prolifera* | | | | | | | | | | |
| *Filamentous brown algae* | | | | | | | | | | |
| *Filamentous green algae* | | | | | | | | | | |
| *Filamentous red algae* | | | | | | | | | | |
| *Flagelliform brown algae* | | | | | | | | | | |
| *Fucus gardneri* | | | | | | | | | | |
| *Fucus gardneri, germlings* | | | | | | | | | | |
| *Gloiopeltis furcata* | | | | | | | | | | |
| *Halosaccion glandiforme* | | | | | | | | | | |
| *Hildenbrandia rubra* | | | | | | | | | | |
| *Laminaria adoenlandica* | | | | | | | | | | |
| *Laminaria, juv.* | | | | | | | | | | |
| *Lominara sp.* | | | | | | | | | | |
| *Iridaea heterocarpa* | | | | | | | | | | |
| *Leathesia difformis* | | | | | | | | | | |
| *Mastocarpus papillatus* | | | | | | | | | | |
| *Mazzaella sp.* | | | | | | | | | | |
| *Melanosiphon intestinalis* | | | | | | | | | | |
| *Monostroma grevillei* | | | | | | | | | | |
| *Neohypophyllum middendorfii* | | | | | | | | | | |
| *Neorhodomela aculeata* | | | | | | | | | | |
| *Neorhodomela larix* | | | | | | | | | | |
| *Neorhodomela oregona* | | | | | | | | | | |
| *Odonthalia flocccosa* | | | | | | | | | | |
| *Odonthalia kamschatica?* | | | | | | | | | | |
| *Odonthalia sp.* | | | | | | | | | | |
| *Palmaria callophylloides* | | | | | | | | | | |
| *Palmaria hecatensis* | | | | | | | | | | |
| *Palmaria mollis* | | | | | | | | | | |
| *Parphraa aesturlis* | | | | | | | | | | |
| *Petrocelis spp.* | | | | | | | | | | |
| *Pilayella littoralis* | | | | | | | | | | |
| *Polysiphonia spp.* | | | | | | | | | | |
| *Porphyra* | | | | | | | | | | |
| *Pterosiphonia bipinnata* | | | | | | | | | | |
| *Ptilota filicina* | | | | | | | | | | |
| *Ralfsia fungiforms* | | | | | | | | | | |
| *Ralfsia spp.* | | | | | | | | | | |
| *Red Crust* | | | | | | | | | | |
| *Rhodochorton purpureum* | | | | | | | | | | |
| *Soranthera ulvoida* | | | | | | | | | | |
| *Ulothrix spp.* | | | | | | | | | | |
| *Ulva/Ulvaria supp.* | | | | | | | | | | |
| *Verrucaria sp.* | | | | | | | | | | |
| | | | | | | | | | | |
| **Dead Plants (%)** | | | | | | | | | | |
| *Articulated coralline (dead)* | | | | | | | | | | |
| *Encrusting coralline (dead)* | | | | | | | | | | |
| *Fucas gardneri (dead)* | | | | | | | | | | |
| **Animals** | | | | | | | | | | |
| *Abarenicola* (casts) | | | | | | | | | | |
| *Anthophleura artemisia* | | | | | | | | | | |
| *Buccinum baeri* | | | | | | | | | | |

**Figure A-1 Intertidal Field Form**

| Species | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
|---|---|---|---|---|---|---|---|---|---|---|
| *Cancer oregonensis* | | | | | | | | | | |
| *Cryptobranchia concentrica* | | | | | | | | | | |
| *Demasterias imbricata* | | | | | | | | | | |
| *Evasterias troschelii* | | | | | | | | | | |
| *Gammaridea* | | | | | | | | | | |
| *Gnorimosphaeroma oreg.* | | | | | | | | | | |
| *Henricia Lumida* | | | | | | | | | | |
| *Hiatella arctica* | | | | | | | | | | |
| *Lacuna spp.* | | | | | | | | | | |
| *Leptasterias hexactis* | | | | | | | | | | |
| *Ligia* | | | | | | | | | | |
| *Littorina scutulata* | | | | | | | | | | |
| *Littorina sitkana* | | | | | | | | | | |
| *Littorina scut., juv.* | | | | | | | | | | |
| *Littorina sitk., juv.* | | | | | | | | | | |
| *Lottidae* | | | | | | | | | | |
| *Lottidae, juv.* | | | | | | | | | | |
| *Lottia digitalis* | | | | | | | | | | |
| *Lottia pelta* | | | | | | | | | | |
| *Lottia strigatella* | | | | | | | | | | |
| *Margarites marginatus* | | | | | | | | | | |
| *Margarites pupillus (spiral)* | | | | | | | | | | |
| *Modiolus modiolus* | | | | | | | | | | |
| *musculus spp.* | | | | | | | | | | |
| *Nemertea* | | | | | | | | | | |
| *Nucella lamellosa* | | | | | | | | | | |
| *Nucella* eggs | | | | | | | | | | |
| *Nucella lima* | | | | | | | | | | |
| *Onchidella borealis* | | | | | | | | | | |
| *Orange sponge* | | | | | | | | | | |
| *Pagurus granosimanus* | | | | | | | | | | |
| *Pagurus hirsutiusculus* | | | | | | | | | | |
| *Pagurus spp.* | | | | | | | | | | |
| *Paranemertes peregrina* | | | | | | | | | | |
| *Pentidotea wosnesenskii* | | | | | | | | | | |
| *Pholidae* | | | | | | | | | | |
| *Pholis laeta* | | | | | | | | | | |
| *Pholis ornata* | | | | | | | | | | |
| *Pisaster ochraceus* | | | | | | | | | | |
| *Searlesia dira.* | | | | | | | | | | |
| *Serpula vermicularis* | | | | | | | | | | |
| *Siphonaria thersites* | | | | | | | | | | |
| *Tectura persona* | | | | | | | | | | |
| *Tectura scutum* | | | | | | | | | | |
| *Tonicella lineata* | | | | | | | | | | |
| | | | | | | | | | | |
| **Animal Area Cover (%)** | | | | | | | | | | |
| *Balanus crenatus* | | | | | | | | | | |
| *Balanus glandula* | | | | | | | | | | |
| *Balanus rostratus* | | | | | | | | | | |
| *Balanus/Semibalanus* set | | | | | | | | | | |
| *Balanus/Semibalanus* spp. | | | | | | | | | | |
| *Chthamalus dalli* | | | | | | | | | | |
| *Chthamalus dalli, set* | | | | | | | | | | |
| *Encrusting bryozoan* | | | | | | | | | | |
| *Halichondria* | | | | | | | | | | |
| *Littorina spp, eggs* | | | | | | | | | | |
| *Mytilus sp.* | | | | | | | | | | |
| *Mytilus sp., spat* | | | | | | | | | | |
| *Nucella* eggs | | | | | | | | | | |
| *Porifera, color?* | | | | | | | | | | |
| *Rhynchozoon bispinosum* | | | | | | | | | | |
| *Semibalanus balanoides* | | | | | | | | | | |
| *Semibalanus balanoides, set* | | | | | | | | | | |
| *Semibalanus cariosus* | | | | | | | | | | |
| *Semibalanus cariosus, set* | | | | | | | | | | |
| *Spirobidae, unid.* | | | | | | | | | | |
| | | | | | | | | | | |
| **Dead Animals** | | | | | | | | | | |
| *Balanus crenatus, dead* | | | | | | | | | | |
| *Balanus grandula dead* | | | | | | | | | | |
| *Balanus/Semibal., dead* | | | | | | | | | | |
| *Chthamalus dalli, dead* | | | | | | | | | | |
| *Mytilus sp., dead* | | | | | | | | | | |
| *Nucella lamellosa, dead* | | | | | | | | | | |
| *Semibal. balanoides, dead* | | | | | | | | | | |
| *Semibal. cariosus dead* | | | | | | | | | | |
| *Spirobidae, dead* | | | | | | | | | | |

**Figure A-1 Intertidal Field Form**

# PEBBLE PROJECT MARINE SAMPLE INVENTORY

**Date:** _____

| Media | Location | Station | Sample ID | Date/Time Collected | # of Containers | Analysis | Preservative | Lab | Comments | Sample Transfer Form # |
|---|---|---|---|---|---|---|---|---|---|---|
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Page _____ of _____

**Figure A-2 Field Inventory Form**

# A.3 Specimen Log Form

It is extremely important that the Specimen Log Form (Appendix A-2) is filled out for EVERY tissue sample collected. This log sheet includes all the information that will be needed to properly report the animals collected/sacrificed under the 2005 ADF&G Collection Permit. It is therefore important that this sheet be filled out as completely as possible for all information that is applicable to the animal (even if it is not sent to an analytical laboratory but is sacrifced, e.g., due to damage—see further discussion in Appendix C, Fish Dissection Procedures). All Specimen Log Form codes are listed on the bottom of the form; some further explanation is provided below for a fish and an invertebrate.

For a fish, the Specimen Log Form (Figure A-2) fields should be filled out as follows:

- Enter Control I.D. No. - begin with 001 for all animals collected that day at that station, then 002 for the second animal etc. When move to another station, OR continue sampling the next day at the same station, start over again with 001
- Enter Station I.D. - include site number or intertidal zone (low, L; middle, M, if applicable)
- Date (MMDDYY) and Time Collected (military format e.g., 1730 for 5:30 p.m.)
- Species - if uncertain, e.g., sculpin, identify to Family or Genus if possible
- Sex - note sex if large fish and can be dissected for positive i.d.; if smaller fish, e.g., 6 inches or 155 mm, do not gut to sex but note if there are distinctive external characteristics to determine sex
- Fish fork length - in cm
- Fish weight - in gm
- Life stage - adult, juvenile, fry, larvae
- Egg Condition – if present, note if eyed/non-eyed
- Gear type – crab pot (CP), shrimp pot (SP), hook and line (HL), seine, trawl, diver, hand
- Type – QA sample (QA), voucher specimen (V), or other (specify)
- Other Comments - note number of animals in sample if more than one animal is needed to obtain 50 g of soft tissue; if animal was damaged and therefore not sent to the lab for analysis; other information of interest.

For an invertebrate, the Specimen Log Form would be filled out as above with the following differences:

- Enter Control I.D. No. - begin with 001 for first animal collected that day at that station (or for first sample of 50 g soft tissue, such as in mussels), then 002 for the second animal/sample, etc. When move to another station, OR continue sampling the next day at the same station, start over again with 001
- Sex – identify sex of crab by using characteristics on ventral side (see crab field guidebooks for differentiating characteristics)

- For crab, note carapace width/length (in mm); for group of mussels note range of shell lengths (in cm)
- For crab, note shell condition (new, old, very old i.e., w/epiphytes such as barnacles) etc.)

For a QA sample such as a Voucher Specimen for verifying species identification, the Specimen Log Form would note under “Type” that it is a Voucher (V) and under “Other Comments” that it was shipped to UAF for identification.

Sheet _____ of _____

**PEBBLE PROJECT**
**2005 MARINE STUDIES**
**SPECIMEN LOG SHEET**

Shipment No. _____

Date Shipped _____

| Control I.D. No. | Station I.D. | Date Collected | Time Collected | Species | Sex F/M | Crab Carapace[1] Width/Length | | Fish Fork Length (cm) | Fish[2] Wt. (g ) | Life Stage[3] A/J/F/L | Egg/ Shell Condition[4] | Gear[5] | Type[6] QA/V /? | Other Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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1 Carapace Width and Length in mm
2 Specify measurement units
3 Life Stage: Adult:, juvenile, fry, larvae
4 Egg: Eyed/Non-Eyed Shell: New/Old/Very Old (i.e., w/epiphytes)
5 Gear: Crab Pot (CP), Shrimp Pot (SP), Hook & Line (HL), Seine, Trawl, Diver, Hand
6 Sample Type: Quality Assurance, Voucher, Unknown

**Figure A-3 Specimen Log Form**

**PEBBLE PROJECT**
**SAMPLE TRANSFER LOG**

**PEBBLE PROJECT**
**SAMPLE TRANSFER LOG**

| SAMPLE INFORMATION | | | | | | TRANSFER INFORMATION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Sample Identification | matrix | type | no. bottles | relinquished by | company | date/time | received by | company | date/time |
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For use when samples are transferred to sample receiving and processing

Date: _____

**Figure A-4 Sample Transfer Form**

# Fish Catch Record

Job Number: _____ Page_____ of_____

Project Name: _____ Date: _____ Recorded by:_____

| | | | Time | | | | | | Tide | |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | Station | Sample Type | Set | Retrieve | Rep. # | Species | Length (mm) | Count (if no length taken) | Species | Temp. ● | Salinity ● | D.O. ● | Weather | Set | Retrieve |
| | | | | | | | | | | | | | | | |
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wp/forms/field/fish catch.xls

**Figure A-5 - Fish Catch Record**

# Fish Catch Codes

**Sample Type**

0 = Beach Seine
1 = Fyke Net
2 = Trawl
3 = Hook and Line
4 = Tow Net

**Tide**

E = Ebb
F = Flood
L = Low Slack
H = High Slack

**Weather**

S = Sunny
P = Partly Cloudy
C = Overcast
R = Rain
F = Fog

**Species**

0 = No fish
1 = Pink Salmon
2 = Chum
3 = Coho
4 = Sockeye
5 = Chinook
6 = Dolly Varden
7 = Steelhead (rainbow trout)
8 = Cutthroat trout
9 = Starry Flounder
10 = Sand Sole
11 = Rock Sole
12 = Snake Blenny
13 = Pacific Sand Lance
14 = Smelt (long fin)
15 = Herring
16 = Stickleback (threespine)
17 = Sculpin
18 = Bering Cisco
19 = Perch
20 = Eulachon
21 = Pumpkinseed
22 = hermit crab (Pagurus)
23 = Rock Crab
24 = Dungeness Crab
25 = Crab - other
26 = Ninespine stickleback
27 = Saffron cod
28 = Bering Cisco
29 = Liparid (clingfish)
30 = Yellowfin sole
31 = Alaska Plaice
32 = Unidentified flatfish
33 = Crangon shrimp

# Pebble Project
# Northern Dynasty Mines Inc.

## Field Sampling Plan Acknowledgment Form

**Disciplines:** Hydrology, Surface Water Quality and Sediment Trace Elements
**Consultant:** Bristol Environmental and Engineering Services Corp

I understand and agree to abide by the procedures as detailed in this Field Sampling Plan (FSP). Should conditions prevent compliance with the FSP I will clearly document actual procedures conducted and explain the rationale for deviation from the plan.

| Printed Name | Company | Signature | Date |
|---|---|---|---|
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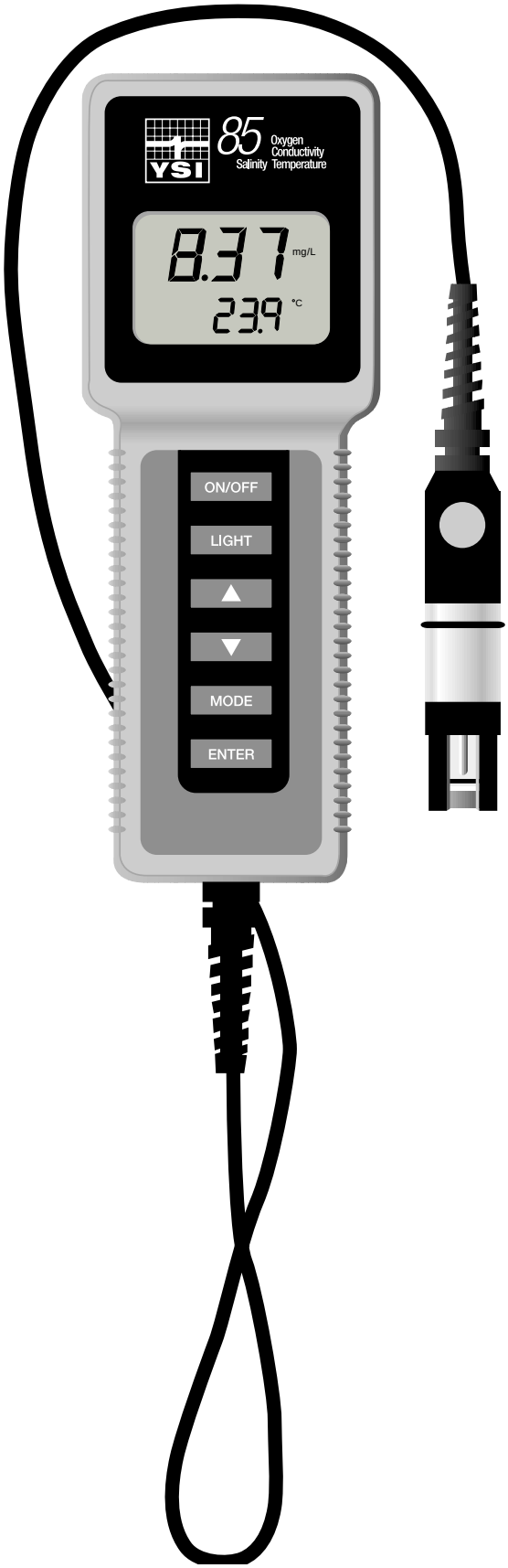
**Figure A-6 FSP Acknowledgement Form**

# APPENDIX B
# FIELD INSTRUMENT MANUALS AND CALIBRATION PROCEDURES

YSI *incorporated*




# YSI Model 85

## Handheld Oxygen, Conductivity, Salinity, and Temperature System

## **Operations Manual**

# CONTENTS

# SECTION 1 INTRODUCTION

The YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System is a rugged, micro-processor based, digital meter with an attached YSI combination conductivity and dissolved oxygen probe.

The YSI Model 85 is designed for use in field, lab, and process control applications as well as for environmental, aquaculture, and industrial uses. The Model 85 is available with cable lengths of either 10, 25, 50 or 100 feet. The body of the probe has been manufactured with stainless steel to add rugged durability and sinking weight. The probe also utilizes our easy to install cap membranes for measuring dissolved oxygen.

The YSI Model 85 probe is a non-detachable, combination sensor designed specifically for the YSI Model 85 Handheld System. The conductivity portion is a four-electrode cell with a cell constant of 5.0/cm ±4%. The dissolved oxygen portion is a polargraphic Clark type sensor.

The Model 85's microprocessor allows the system to be easily calibrated for dissolved oxygen or conductivity with the press of a few buttons. Additionally, the microprocessor performs a self-diagnostic routine each time the instrument is turned on. The self-diagnostic routine provides you with useful information about the conductivity cell constant and function of the instrument circuitry.
The system simultaneously displays temperature (in °C), along with one of the following parameters: dissolved oxygen in either mg/L (milligrams per liter) or % air saturation; conductivity; temperature compensated conductivity; (in µS/cm or mS/cm), and salinity (in parts per thousand {ppt}).

The system requires only a single calibration regardless of which dissolved oxygen display you use. The calibration of conductivity is not required but is available. A single calibration will adjust the instrument, regardless if you are reading conductivity or temperature compensated conductivity. You can switch between all of these parameters with the push of a single key.

A calibration\storage chamber is built into the instrument case. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration of the dissolved oxygen probe. This chamber also provides a convenient place to store the probe when the system is not in use, and provides protection for the electrodes within the conductivity probe. The Model 85 case is also waterproof (rated to IP65). You can operate your Model 85 in the rain without damage to the instrument.

Six AA-size alkaline batteries power the instrument. A new set of alkaline batteries will provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a **"LO BAT"** message.

# SECTION 2 PREPARING THE METER

## 2.1 UNPACKING

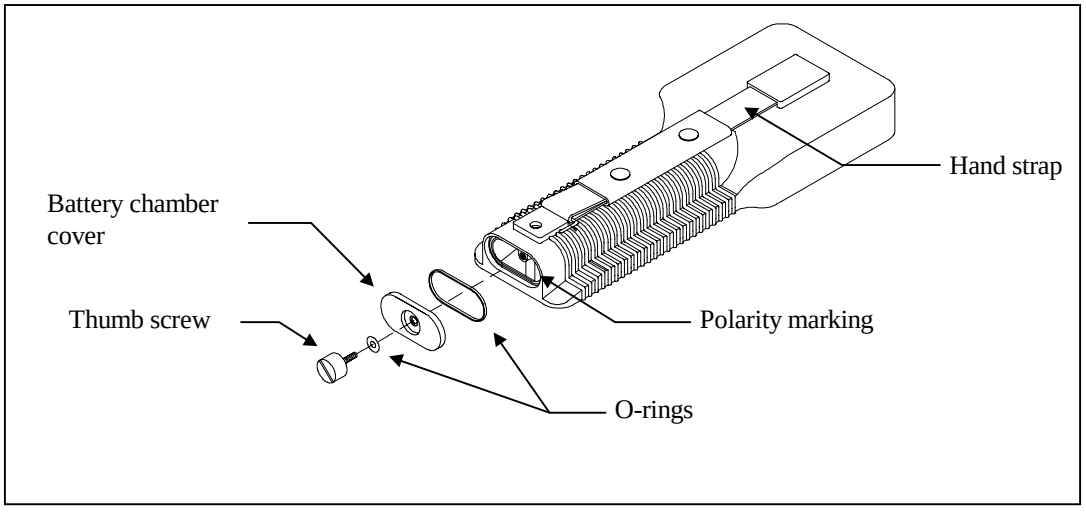
When you unpack your new YSI Model 85 Handheld Dissolved Oxygen, Conductivity, Salinity and Temperature System for the first time, check the packing list to make sure you have received everything you should have. If there is anything missing or damaged, call the dealer from whom you purchased the Model 85. If you do not know which of our authorized dealers sold the system to you, call YSI Customer Service at 800-765-4974 or 937-767-7241, and we'll be happy to help you.

## 2.2 WARRANTY CARD

Before you do anything else, please complete the Warranty Card and return it to YSI. This will record your purchase of this quality instrument in our computer system. Once your purchase is recorded, you will receive prompt, efficient service in the event any part of your YSI Model 85 should ever need repair and we will be able to quickly verify the warranty period.

## 2.3 BATTERIES

There are a few things you must do to prepare your YSI Model 85 for use. First, locate the six AA-size alkaline batteries that were included in your purchase. Use a screwdriver or a small coin to remove the thumbscrew on the bottom of the instrument. This thumbscrew holds the battery-chamber cover in place. The battery-chamber cover is marked with the words "OPEN" and "CLOSE."



NOTE: On some models, the battery cover thumbscrew may be unscrewed by hand (a screwdriver may not be required).

There is a small label inside each of the two battery-chamber sleeves. These labels illustrate the correct way to install the batteries into each sleeve of the battery-chamber.

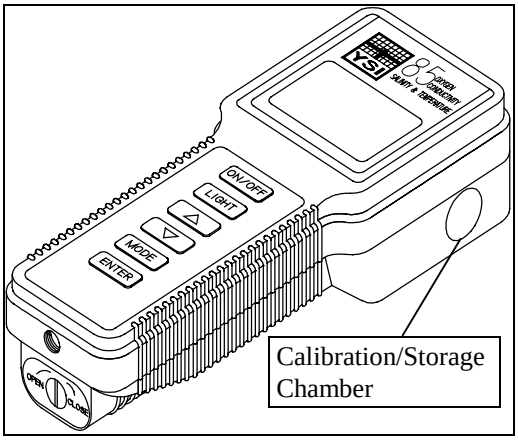
**NOTE:** It is very important that the batteries be installed ONLY as illustrated. The instrument will not function and may be damaged if the batteries are installed incorrectly.

Turn the instrument on by pressing and releasing the **ON/OFF** button on the front of the instrument. The liquid crystal display (LCD) should come on. Allow a few seconds for the instrument to complete its diagnostic routine. Notice that the instrument will display the specific cell constant of the conductivity probe during this diagnostic routine. If the instrument does not operate, consult the section entitled Troubleshooting.

You may also want to take the instrument into a dark room and with the instrument ON, hold down the **LIGHT** button. The instrument backlight should illuminate the LCD so that the display can be easily read.

## 2.4 CALIBRATION/STORAGE CHAMBER

The Model 85 has a convenient calibration storage chamber built into the instruments' side. This chamber provides an ideal storage area for the probe during transport and extended non-use. If you look into the chamber you should notice a small round sponge in the bottom of the chamber. 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, which is ideal for dissolved oxygen calibration.




## 2.5 HAND STRAP

The hand strap is designed to allow comfortable operation of the Model 85 with minimum effort. If the hand strap is adjusted correctly, it is unlikely that the instrument will be easily dropped or bumped from your hand. See figure on previous page.

To adjust the hand strap on the back of the meter, unsnap the vinyl cover and pull the two Velcro strips apart. Place your hand between the meter and the strap and adjust the strap length so that your hand is snugly held in place. Press the two Velcro strips back together and snap the vinyl cover back into place.

## 2.6 THE METER CASE

The meter case is sealed at the factory and is not intended to be opened, except by authorized service technicians. Do not attempt to separate the two halves of the meter case as this may damage the instrument, break the waterproof seal, and will void the manufacturer's warranty.

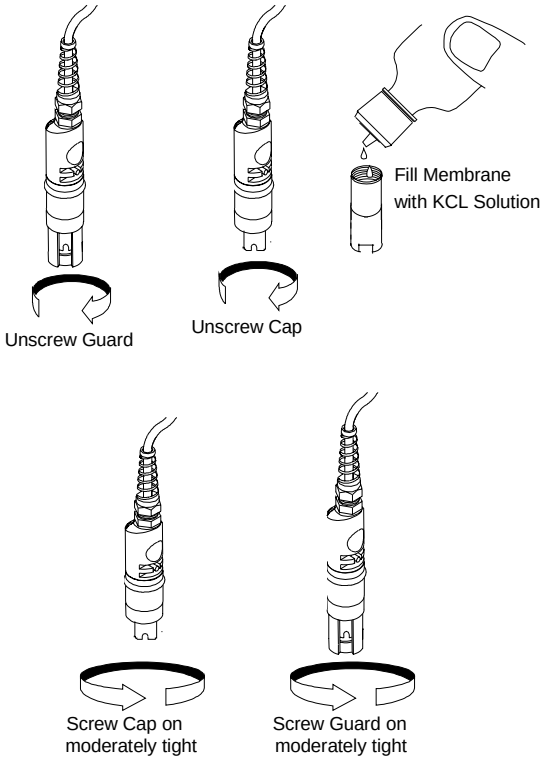
# SECTION 3 PREPARING THE PROBE

**The YSI Model 85 dissolved oxygen probe is shipped dry. The protective membrane cap on the probe tip must be removed and replaced with KCl solution and a new membrane cap before using the probe. Follow the instructions below to install KCl solution and the new membrane cap.**

## 3.1 MEMBRANE CAP INSTALLATION

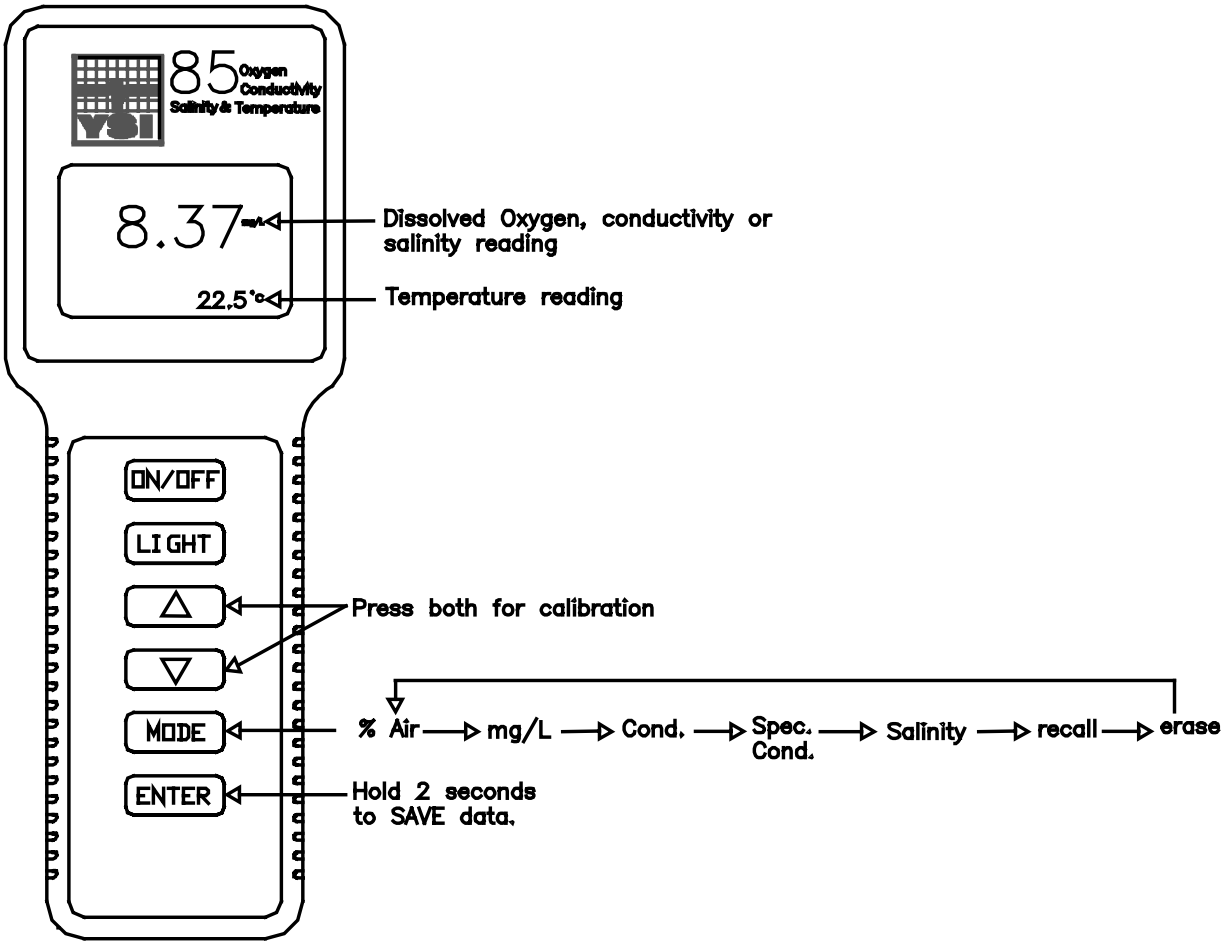
To install a new membrane on your YSI Model 85 dissolved oxygen probe:

1. Unscrew and remove the probe sensor guard.
2. Unscrew and remove the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the KCl solution bottle.
5. Hold the membrane cap and fill it at least 1/2 full with the electrolyte solution.
6. Screw the membrane cap onto the probe moderately tight. A small amount of electrolyte should overflow.
7. Screw the probe sensor guard on moderately tight.



# SECTION 4 OVERVIEW OF OPERATION

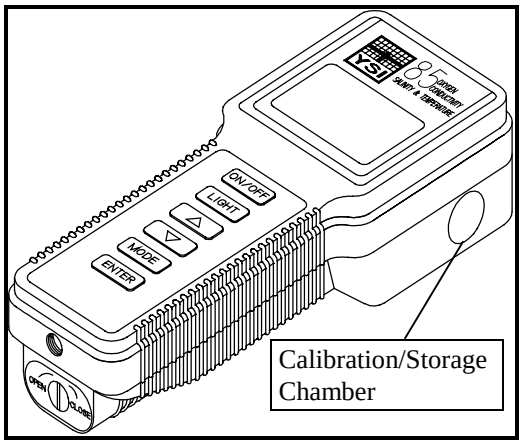
The following diagram is an overview of the operation of the Model 85. See the following sections for details of operation.



# SECTION 5 CALIBRATION

## 5.1 CALIBRATION OF DISSOLVED OXYGEN

**To accurately calibrate the YSI Model 85 you will need to know the approximate altitude of the region in which you are located.**




1. Ensure that the sponge inside the instrument's calibration chamber is wet. Insert the probe into the calibration chamber.

2. Turn the instrument on by pressing the **ON/OFF** button on the front of the instrument. Press the **MODE** button until dissolved oxygen is displayed in mg/L or %. Wait for the dissolved oxygen and temperature readings to stabilize (usually 15 minutes is required).

3. Use two fingers to press and release both the **UP ARROW** and **DOWN ARROW** buttons at the same time.

4. 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** button once.

**EXAMPLE:** Entering the number 12 here indicates 1200 feet.

5. The Model 85 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 % reading (before calibration) should be on the main display. Make sure that the current % reading (large display) is stable, then press the **ENTER** button. The display should read **SAVE** then should return to the Normal Operation Mode.

**Each time the Model 85 is turned off, it may be necessary to re-calibrate before taking measurements. All calibrations should be completed at a temperature which is as close as possible to the sample temperature. Dissolved oxygen readings are only as good as the calibration.**

## 5.2 CALIBRATION OF CONDUCTIVITY

**IMPORTANT: System calibration is rarely required because of the factory calibration of the YSI Model 85. However, from time to time it is wise to check the system calibration and make adjustments when necessary.**

### Prior to calibration of the YSI Model 85, it is important to remember the following:

1. Always use clean, properly stored, NIST traceable calibration solutions (see Accessories and Replacement Parts). When filling a calibration container prior to performing the calibration procedures, make certain that the level of calibrant buffers is high enough in the container to cover the entire probe. Gently agitate the probe to remove any bubbles in the conductivity cell.
2. Rinse the probe with distilled water (and wipe dry) between changes of calibration solutions.
3. During calibration, allow the probe time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration process. The readings after calibration are only as good as the calibration itself.
4. Perform sensor calibration at a temperature as close to 25°C as possible. This will minimize any temperature compensation error.

### Follow these steps to perform an accurate calibration of the YSI Model 85:

1. Turn the instrument on and allow it to complete its self-test procedure.
2. Select a calibration solution that is most similar to the sample you will be measuring.
    - For sea water choose a 50 mS/cm conductivity standard (YSI Catalog# 3169)
    - For fresh water choose a 1 mS/cm conductivity standard (YSI Catalog# 3167)
    - For brackish water choose a 10 mS/cm conductivity standard (YSI Catalog # 3168)
3. Place at least 3 inches of solution in a clean glass beaker.
4. Use the **MODE** button to advance the instrument to display conductivity.
5. Insert the probe into the beaker deep enough so that the oval-shaped hole on the side of the probe is completely covered. Do not rest the probe on the bottom of the container -- suspend it above the bottom at least 1/4 inch.
6. Allow at least 60 seconds for the temperature reading to become stable.
7. Move the probe vigorously from side to side to dislodge any air bubbles from the electrodes.
8. Press and release the **UP ARROW** and **DOWN ARROW** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display to indicate that the instrument is now in Calibration mode.


9. Use the **UP ARROW** or **DOWN ARROW** button to adjust the reading on the display until it matches the value of the calibration solution you are using.
10. Once the display reads the exact value of the calibration solution being used (the instrument will make the appropriate compensation for temperature variation from 25°C), press the **ENTER** button once. The word "**SAVE"** will flash across the display for a second indicating that the calibration has been accepted.

The YSI Model 85 is designed to retain its last conductivity calibration permanently. Therefore, there is no need to calibrate the instrument after battery changes or power down.

# SECTION 6 ADVANCED CONDUCTIVITY SETUP

The default settings of the YSI Model 85 are appropriate for the vast majority of measurement applications. However, some measurement applications require very specific measurement criteria. For that reason, we have made the YSI Model 85 flexible to accommodate these "advanced users."

If, for example, you are using the YSI Model 85 for a process control application that requires that the conductivity readings be compensated to 20 $^{o}$C instead of 25 $^{o}$C -- this is the section to read. Or, if your application for the YSI Model 85 involves the measurement of a very specific saline solution, the default temperature coefficient may need to be changed to get the very best measurement of that specific salt.

**IMPORTANT:** There is never a need to enter Advanced Setup Mode unless your special measurement application calls for a change in reference temperature and or temperature coefficient. Therefore, unless you are certain that your application requires a change to one or both of these criteria, do not modify the default reference temperature (25$^{o}$C) or the default temperature coefficient (1.91%).

## 6.1 CHANGING THE TEMPERATURE COEFFICIENT

Follow these steps to modify the temperature coefficient of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new temperature coefficient.
5. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
6. Press the **MODE** button to return to normal operation; the CAL symbol will disappear from the display.

## 6.2 CHANGING THE REFERENCE TEMPERATURE

Follow these steps to modify the reference temperature of the Model 85.

1. Turn the instrument on and wait for it to complete its self-test procedure.
2. Use the **MODE** button to advance the instrument to display conductivity.
3. Press and release both the **DOWN ARROW** and the **MODE** buttons at the same time.

The **CAL** symbol will appear at the bottom left of the display. The large portion of the display will show **1.91 %** (or a value set previously using Advanced Setup).

4. Press and release the **MODE** button; the large portion of the display will show **25.0C** (or a value set previously using Advanced Setup).
5. Use the **UP ARROW** or **DOWN ARROW** button to change the value to the desired new reference temperature (any value between 15 $^{o}$C and 25 $^{o}$C is acceptable).
6. Press the **ENTER** button. The word "**SAVE**" will flash across the display for a second to indicate that your change has been accepted.
7. The instrument will automatically return to normal operation mode.

## 6.3 CHANGING FROM AUTORANGING TO MANUAL RANGING

If your application is easier to perform using a manual range that you select, the YSI Model 85 allows you to turn off the default autoranging feature. While you are making conductivity or temperature compensated conductivity measurements, simply press and release the **UP ARROW** button. Each additional press of the **UP ARROW** button will cycle the Model 85 to a different manual range until you return again to autoranging. Five pushes of the **UP ARROW** button will cycle the Model 85 through the four manual ranges and return the instrument to autoranging.

**NOTE:** You may see an error message in some manual ranges if the manual range selected is not adequate for the sample you are measuring. If this happens, simply press and release the **UP ARROW** button again until a range is selected which is suitable for your sample. If you get lost and don't know if you're in a manual range or autoranging, simply turn the instrument off and back on. Also note that the conductivity units will flash while you are in manual range. The instrument will always default to autoranging when first turned on.

The four ranges of the YSI Model 85 are:

| Range 1 | Range 2 | Range 3 | Range 4 |
|---|---|---|---|
| 0 to 499.9 µS/cm | 0 to 4999 µS/cm | 0 to 49.99 mS/cm | 0 to 200.0 mS/cm |

# SECTION 7 MAKING MEASUREMENTS

## 7.1 TURNING THE INSTRUMENT ON

Once the batteries are installed correctly, press the **ON/OFF** button. The instrument will activate all segments of the display for a few seconds, which will be followed by a self-test procedure that will last for several more seconds. During this power on self-test sequence, the instrument's microprocessor is verifying that the instrument is working properly. The Model 85 will display the cell constant of the conductivity probe when the self-test is complete. If the instrument were to detect an internal problem, the display would show a **continuous** error message. See the section entitled Troubleshooting for a list of these error messages.

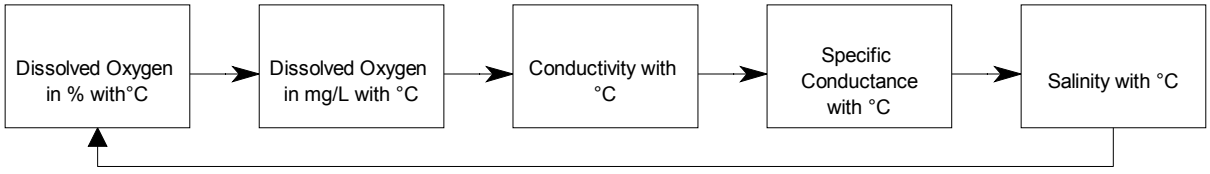
## 7.2 THE MEASUREMENT MODES OF THE MODEL 85

The Model 85 is designed to provide six distinct measurements:

- **Dissolved Oxygen %** -- A measurement of oxygen in percent of saturation.
- **Dissolved Oxygen mg/L** -- A measurement of oxygen in mg/L
- **Conductivity** -- A measurement of the conductive material in the liquid sample without regard to temperature
- **Specific Conductance** -- Also known as temperature compensated conductivity which automatically adjusts the reading to a calculated value which would have been read if the sample had been at $25^{o}$ C (or some other reference temperature which you choose). See Advanced Setup.
- **Temperature** -- which is always displayed.
- **Salinity** -- A calculation done by the instrument electronics, based upon the conductivity and temperature readings.

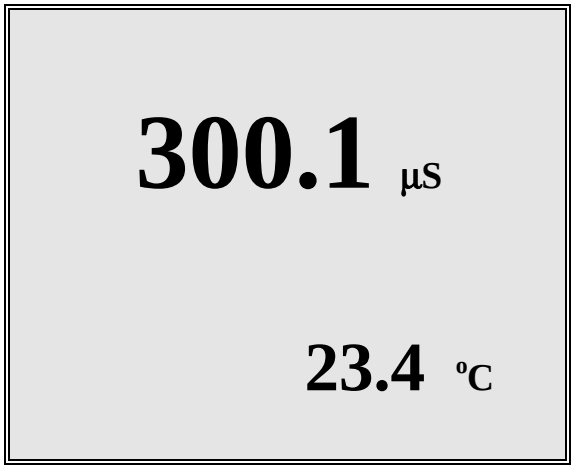
**NOTE:** When you turn the Model 85 off, it will "remember" which mode you used last and will return to that mode the next time the instrument is turned on.

To choose one of the measurement modes above (temperature is always displayed) simply press and release the **MODE** button. Carefully observe the small legends at the far right side of the LCD.



If the instrument is reading **Specific Conductance** the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally the small portion of the display will show the **° C** flashing on and off.

If the instrument is reading **Conductivity** (not temperature compensated) the large numbers on the display will be followed by either a **µS** or an **mS.** Additionally the small portion of the display will show the **° C** **NOT** flashing.




If the instrument is reading **Dissolved Oxygen** the large numbers on the display will be followed by either a mg/L or %. It is important to remember that the dissolved oxygen probe is stirring dependent. This is due to the consumption of oxygen at the sensor tip during measurement. When taking dissolved oxygen measurements the probe must be moved through the sample at a rate of 1 foot per second to provide adequate stirring.

If the instrument is reading **Salinity** the large numbers on the display will be followed by a **ppt.**

## 7.3 AUTORANGING & RANGE SEARCHING

The YSI Model 85 is an autoranging instrument. This means that regardless of the conductivity or salinity of the solution (within the specifications of the instrument) all you need to do to get the most accurate reading is to put the probe in the sample. This feature makes the Model 85 as simple as possible to operate.

When you first place the Model 85 probe into a sample or calibration solution, and again when you first remove the probe the instrument will go into a range search mode that may take as long as 5 seconds. During some range searches the instrument display will flash **rANG** to indicate its movement from one range to another. The length of the range search depends on the number of ranges that must be searched in order to find the correct range for the sample. During the range search, the instrument will appear to freeze on a given reading for a few seconds then, once the range is located, will pinpoint the exact reading on the display. The display may also switch to **00.0** for a second or two during a range search before it selects the proper range.

## 7.4 THE BACKLIGHT

At times it may be necessary to take measurements with the Model 85 in dark or poorly lit areas. To help in this situation, the Model 85 comes equipped with a backlight that will illuminate the display so that it can be easily read. To activate the backlight, press and hold the **LIGHT** button. The

# SECTION 8 SAVING DATA

The Model 85 is equipped with non-volatile memory that is capable of storing up to 50 different sets of readings. Non-volatile means that you do not need to worry that your data will be lost due to a power failure or power interrupt. The Model 85 will also assign a site identity number to each set of readings to allow easy review of the data. This feature is useful in situations where transcribing data is difficult or not available.

## 8.1 SAVING DATA TO MEMORY

1. While any parameter is displayed on the screen depress the **ENTER** button and hold for approximately 2 seconds. The meter will flash **SAVE** on the display along with the current site identity being used.

2. When all 50 sites are full the display will flash **FULL** on the screen. This message will remain on the screen (even after power down) until a button is pushed.

Once you have acknowledged the memory is full, any subsequent saved data will begin overwriting existing data starting with site #1.

## 8.2 RECALLING STORED DATA

1. To put the Model 85 into the **RECALL** mode depress the **MODE** button repeatedly until **rcl** is displayed on the screen along with the site ID number in the lower right corner. (see figure #1)

2. Depress the **ENTER** button to review the last set of data that was saved. The Model 85 will display the dissolved oxygen in % saturation and temperature. Another press of the **ENTER** button will display the dissolved oxygen in mg/L and the temperature.

Depress the **ENTER** button again and again to review the conductivity, specific conductivity and salinity readings. All of which are displayed with the temperature.

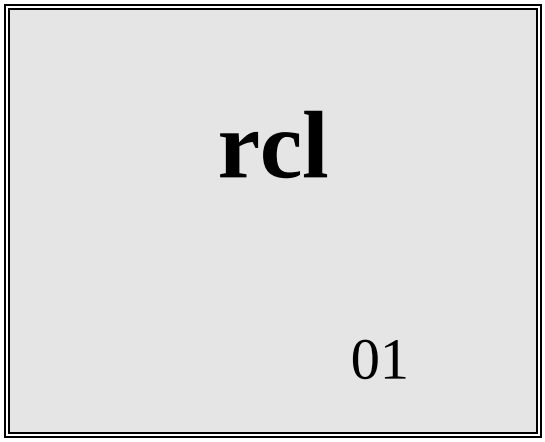



figure #1

3. Depress the **UP ARROW** button to increment through the saved sets of data.

4. Depress the **DOWN ARROW** button to decrement through the saved sets of data.

5. When the correct site ID# is displayed, press the **ENTER** button to display the data.

6. When you have finished recalling data, press the **MODE** button to return to normal operation.

**NOTE:** The Model 85 will recall data as a list. When the **UP ARROW** is depressed the Model 85 will display the Site ID# for the previously recorded date. For example: If you are reviewing Site ID# 5 and the **UP ARROW** is depressed the Model 85 will display Site ID# 4. If you are reviewing Site ID# 5 and Site ID# 5 was the last set of data stored the **DOWN ARROW** button will display Site ID# 1.

Here is an example of the Model 85 memory.
Site ID #1
Site ID #2
Site ID #3 ←— If the **UP ARROW** button was pressed the Model 85 would display Site ID #2
Site ID #4
Site ID #5

## 8.3 ERASING STORED DATA

1. To erase the data that is stored into the Model 85's memory, depress the **MODE** button repeatedly until the Model 85 displays **ErAS** on the screen. (see figure #2)

2. Depress and hold the **DOWN ARROW** and **ENTER** buttons simultaneously for approximately 5 seconds.

3. The Model 85 flashing DONE on the display for 1 to 2 seconds indicates successful erasure. The instrument will automatically change to normal operation after completion.

**IMPORTANT:** Data in all 50 site ID's will be erased completely and will be lost forever. Do not use the erase function until all recorded data has been transcribed to an archive outside the Model 85.

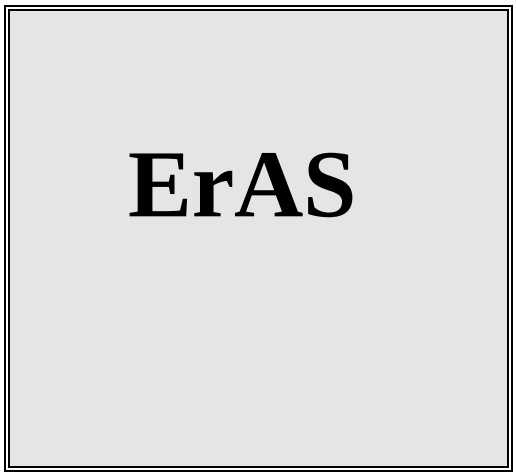



figure #2

# SECTION 9 MAINTENANCE

## 9.1 CLEANING AND STORAGE

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it.

**NOTE:** ALWAYS RINSE THE CONDUCTIVITY CELL WITH CLEAN WATER AFTER EACH USE.

To clean the conductivity cell:

1. Dip the cell in cleaning solution and agitate for two to three minutes. Any one of the foaming acid tile cleaners, such as Dow Chemical Bathroom Cleaner, will clean the cell adequately. When a stronger cleaning preparation is required, use a solution of 1:1 isopropyl alcohol and 10N HCl. Remove the cell from the cleaning solution.

2. Use the nylon brush (supplied) to dislodge any contaminants from inside the electrode chamber.

3. Repeat steps one and two until the cell is completely clean. Rinse the cell thoroughly in deionized, or clean tap water.

4. Store the conductivity cell in the meter storage chamber.

NOTE: See Section 11, Dissolved Oxygen Probe Precautions for instructions on cleaning the dissolved oxygen electrodes.

# SECTION 10 PRINCIPLES OF OPERATION

The dissolved oxygen sensor utilizes an oxygen permeable membrane that covers an electrolytic cell consisting of a gold cathode and a porous silver anode. This membrane acts as a diffusion barrier and an isolation barrier preventing fouling of the cathode surface by impurities in the environment. Upon entering the cell through the membrane, oxygen is reduced at an applied potential of -0.8 V referenced to the silver electrode. The reduction current at the cathode is directly proportional to the partial pressure of oxygen in liquid (expressed as %-air saturation) which is proportional to the concentration of dissolved oxygen (in mg/L) at a particular temperature. Thus the same partial pressure of oxygen (% air-saturation) in liquid gives different concentrations of dissolved oxygen (mg/L) at different temperatures because of the different solubility's of oxygen at different temperatures.

The conductivity cell utilizes four pure nickel electrodes for the measurement of solution conductance. Two of the electrodes are current driven, and two are used to measure the voltage drop. The measured voltage drop is then converted into a conductance value in milli-Siemens (millimhos). To convert this value to a conductivity (specific conductance) value in milli-Siemens per cm (mS/cm), the conductance is multiplied by the cell constant that has units of reciprocal cm ($cm^{-1}$). The cell constant for the Model 85 conductivity cell is 5.0/cm $\pm$ 4%. For most applications, the cell constant is automatically determined (or confirmed) with each deployment of the system when the calibration procedure is followed. Solutions with conductivity's of 1.00, 10.0, 50.0, and 100.0 mS/cm, which have been prepared in accordance with recommendation 56-1981 of the Organisation Internationale de Métrologie Légale (OIML) are available from YSI. The instrument output is in µS/cm or mS/cm for both conductivity and specific conductance. The multiplication of cell constant times conductance is carried out automatically by the software.

## 10.1 TEMPERATURE EFFECT ON CONDUCTIVITY

The conductivity of solutions of ionic species is highly dependent on temperature, varying as much as 3% for each change of one degree Celsius (temperature coefficient = 3%/C). In addition, the temperature coefficient itself varies with the nature of the ionic species present.

Because the exact composition of a natural media is usually not known, it is best to report a conductivity at a particular temperature, e.g. 20.2 mS/cm at 14 C. However, in many cases, it is also useful to compensate for the temperature dependence in order to determine at a glance if gross changes are occurring in the ionic content of the medium over time. For this reason, the Model 85 software also allows the user to output conductivity data in either raw or temperature compensated form. If "Conductivity" is selected, values of conductivity that are NOT compensated for temperature are output to the display. If "Specific Conductance" is selected, the Model 85 uses the temperature and raw conductivity values associated with each determination to generate a specific conductance value compensated to a user selected reference temperature (see Advanced Setup) between 15 C and 25 C. Additionally the user can select any temperature coefficient from 0% to 4%

(see Advanced Setup). Using the Model 85 default reference temperature and temperature coefficient (25 C and 1.91%), the calculation is carried out as in equation (1) below:

$$\text{Specific Conductance (25°C)} = \frac{\text{Conductivity}}{1 + TC * (T - 25)}$$

As noted above, unless the solution being measured consists of pure KCl in water, this temperature compensated value will be somewhat inaccurate, but the equation with a value of TC = 0.0191 will provide a close approximation for solutions of many common salts such as NaCl and $NH_4Cl$ and for seawater.

Salinity is determined automatically from the Model 85 conductivity readings according to algorithms found in Standard Methods for the Examination of Water and Wastewater (ed. 1989). The use of the Practical Salinity Scale 1978 results in values which are unitless, since the measurements are carried out in reference to the conductivity of standard seawater at 15 C. However, the unitless salinity values are very close to those determined by the previously-used method where the mass of dissolved salts in a given mass of water (parts per thousand) was reported. Hence, the designation "ppt" is reported by the instrument to provide a more conventional output.
For further information on conductivity and the above standard information, refer to the ASTM document, Standard Methods of Test for Electrical Conductivity of Water and Industrial Wastewater, ASTM Designation D1125-82, and OIML Recommendation Number 56. ASTM symbols for conductivity, cell constant, and path length differ from those preferred in the general literature and also from those used in this manual.

# SECTION 11 DISCUSSION OF MEASUREMENT ERRORS

## 11.1 DISSOLVED OXYGEN MEASUREMENT ERRORS

There are three basic types of error. Type 1 errors are related to limitations of instrument design and tolerances of instrument components. These are chiefly the meter linearity and the resistor tolerances. Type 2 errors are due to basic probe accuracy tolerances, chiefly background signal, probe linearity, and variations in membrane temperature coefficient. Type 3 errors are related to the operator's ability to determine the conditions at the time of calibration. If calibration is performed against more accurately known conditions, type 3 errors are appropriately reduced.

**The sample calculations that follow are for a near extreme set of conditions.**

**TYPE 1 ERRORS**

A. Meter linearity error: ±1% of full scale reading, or ±0.15 mg/l

B. Component and circuitry error: ±0.05 mg/l

**TYPE 2 ERRORS**

A. Temperature compensation for membrane temperature coefficient: ±0.03 mg/l

B. Temperature measurement errors: A maximum ±0.2$^{o}$C probe error is equal to ±0.14 mg/l

## TYPE 3 ERRORS

A. Altitude:

A 1000-foot change in altitude is equal to an error of approximately 3% at the 10 mg/l level.

B. Humidity:

Errors occur if calibration is performed at less than 100% humidity. The error varies with the temperature as follows:

| TEMPERATURE | ERROR |
|---|---|
| 0°C | 0.02 mg/l |
| 10°C | 0.05 mg/l |
| 20°C | 0.12 mg/l |
| 30°C | 0.27 mg/l |
| 40°C | 0.68 mg/l |

## APPROXIMATING THE ERROR

It is unlikely that the actual error in any measurement will be the maximum possible error. A better error approximation is obtained using a root mean squared (r.m.s.) calculation:

$$\text{r.m.s. error} = \pm[1a^2 + 1b^2 + 2a^2 + 2b^2 + 3a^2 + 3b^2]^{½} \text{ mg/l}$$

## 11.2 CONDUCTIVITY MEASUREMENT ERRORS

System accuracy for conductivity measurements is equal to the sum of the errors contributed by the environment and the various components of the measurement setup. These include:

- Instrument accuracy
- Cell-constant error
- Solution temperature offset
- Cell contamination (including air bubbles)
- Electrical noise
- Galvanic effects

Only the first three are of major concern for typical measurements, although the user should also be careful to see that cells are clean and maintained in good condition at all times.

**Instrument Accuracy** = ± .5% maximum
The accuracy specified for the range being used is the worst case instrument error.

**Cell-Constant Error** = ± .5% maximum
Although YSI cells are warranted to be accurate to within one percent, you should still determine the exact cell constant of your particular cell. Contamination or physical damage to the cell can alter the cell constant. Performing a calibration will eliminate any error that might arise because of cell constant change.

YSI cells are calibrated to within one percent of the stated cell constant at a single point. We consider these products to be usefully linear over most instrument ranges. The cell constant can be calibrated to ±0.35% accuracy with YSI conductivity calibrator solutions.

**Temperature Error** = ± 1% maximum
The solution temperature error is the product of the temperature coefficient and the temperature offset from 25 C, expressed as a percentage of the reading that would have been obtained at 25 C. The error is not necessarily a linear function of temperature. The statement of error is derived from a 25 C temperature offset and a 3%/ C temperature coefficient.

**Total Error**
Considering only the above three factors, system accuracy under worst case conditions will be ±2%, although the actual error will be considerably less if recommended and properly calibrated cells and instrument ranges are used. Additional errors, which can essentially be eliminated with proper handling, are described below.

**Cell Contamination**
This error is usually due to contamination of the solution being measured, which occurs when solution is carried-over from the last solution measured. Thus, the instrument might be correctly

reporting the conductivity seen, but the reading does not accurately represent the value of the bulk solution. Errors will be most serious when low conductivity solutions are contaminated by carry-over from high conductivity solutions, and can then be of an order of magnitude or more.

Follow the cleaning instructions carefully before attempting low conductivity measurements with a cell of unknown history or one that has been previously used in higher value solutions.

An entirely different form of contamination sometimes occurs due to a buildup of foreign material directly on cell electrodes. While rare, such deposits have, on occasion, markedly reduced the effectiveness of the electrodes. The result is an erroneously low conductance reading.

**Electrical-Noise Errors**

Electrical noise can be a problem in any measurement range, but will contribute the most error and be the most difficult to eliminate when operating in the lowest ranges. The noise may be either line-conducted or radiated or both, and may require, grounding, shielding, or both.

**Galvanic and Miscellaneous Effects**

In addition to the error sources described above, there is another class of contributors that can be ignored for all but the most meticulous of laboratory measurements. These errors are always small and are generally completely masked by the error budget for cell-constant calibration, instrument accuracy, etc. Examples range from parasitic reactance associated with the solution container and its proximity to external objects to the minor galvanic effects resulting from oxide formation or deposition on electrodes. Only trial and error in the actual measurement environment can be suggested as an approach to reduce such errors. If the reading does not change as the setup is adjusted, errors due to such factors can be considered too small to see.

## 11.3 DISSOLVED OXYGEN PROBE PRECAUTIONS

1. Membrane life depends on usage. Membranes will last a long time if installed properly and treated with care. Erratic readings are a result of loose, wrinkled, damaged, or fouled membranes, or from large (more than 1/8" diameter) bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occurs, you should replace the membrane and the KCl solution. The average replacement interval is two to four weeks.

2. If the membrane is coated with oxygen consuming (e.g. bacteria) or oxygen evolving organisms (e.g. algae), erroneous readings may occur.

3. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the probe. If you suspect erroneous readings, it may be necessary to determine if these gases are the cause.

4. Avoid any environment that contains substances that may attack the probe materials. Some of these substances are concentrated acids, caustics, and strong solvents. The probe materials that come in contact with the sample include FEP Teflon, stainless steel, epoxy, polyetherimide and the polyurethane cable covering.

5. For correct probe operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases) or plated with silver, the gold surface must be restored. To restore the cathode, you may either return the instrument to the factory or clean it using the YSI 5238 probe reconditioning kit. Never use chemicals or abrasives not supplied with this kit.

**NOTE: Model 85 probes built before July, 1996 (serial numbers starting with 96F or lower), should be cleaned with the sanding disc mounted on a FLAT surface. Do NOT use the curved tool provided in the 5238 probe reconditioning kit on these probes.**

6. It is also possible for the silver anode to become contaminated, which will prevent successful calibration. To clean the anode, remove the membrane and soak the probe overnight in 3% ammonium hydroxide. Next, rinse the sensor tip with deionized water, add new KCl solution, and install a new membrane. Turn the instrument on and allow the system to stabilize for at least 30 minutes. If, after several hours, you are still unable to calibrate, return the YSI Model 85 system to an authorized service center for service.

7. To keep the electrolyte from drying out, store the probe in the calibration chamber with the small piece of sponge.

# SECTION 12 TROUBLESHOOTING

| SYMPTOM | POSSIBLE CAUSE | ACTION |
|---|---|---|
| 1. Instrument will not turn on | A. Low battery voltage<br>B. Batteries installed wrong<br>C. Meter requires service | A. Replace batteries<br>B. Check battery polarity.<br>C. Return system for service |
| 2. Instrument will not calibrate (Dissolved Oxygen) | A. Membrane is fouled or damaged<br>B. Probe anode is fouled or dark<br>C. Probe cathode is tarnished<br>D. System requires service | A. Replace membrane & KCl<br>B. Clean anode<br>C. Clean cathode<br>D. Return system for service |
| 3. Instrument will not calibrate (Conductivity) | A. Cell is contaminated | A. See "Maintenance" Section |
| 4. Instrument "locks up" | A. Instrument has rec'd a shock<br>B. Batteries are low or damaged<br>C. System requires service | A & B. Remove battery lid, wait 15 seconds for reset, replace lid.<br>C. Return system for service |
| 5. Instrument readings are inaccurate (Dissolved Oxygen) | A. Cal altitude is incorrect<br>B. Probe not in 100% $O_2$ saturated air during Cal procedure<br>C. Membrane fouled or damaged<br>D. Probe anode is fouled or dark<br>E. Probe cathode is tarnished<br>F. System requires service | A. Recalibrate w/correct value<br>B. Moisten sponge & place in Cal chamber w/ probe & Recal<br>C. Replace membrane<br>D. Clean anode<br>E. Clean cathode<br>F. Return system for service |
| 6. Instrument readings are inaccurate (Conductivity) | A. Calibration is required<br>B. Cell is contaminated<br>C. Tempco is set incorrectly<br>D. Reference temperature incorrect<br>E. Readings are or are not temperature compensated. | A. See "Calibration" Section<br>B. See "Maintenance" Section<br>C. See "Advanced Setup" Section<br>D. See "Advanced Setup" Section<br>E. See "Making Measurements" Section |
| 7..LCD displays "LO BAT"<br>Main display flashes "off" | A. Batteries are low or damaged | A. Replace batteries |
| 8. Main Display reads "OVEr"<br>(Secondary display reads "ovr")<br>(Secondary display reads "udr") | A. Conductivity reading is >200 mS<br>B. Temperature reading is >65°C<br>C. Temperature reading is <-5°C<br>D. Salinity reading is >80 ppt<br>E. User cell constant cal K is >5.25<br>F. DO temperature is >46°C<br>G. DO % saturation is >200%<br>H. DO concentration is >20 mg/L | In all cases, check calibration values and procedures; check advanced setup settings.<br><br>If each of these are set correctly, return instrument for service. |
| 9. Main display reads "Undr" | A. User cell constant cal K is <4.9<br>B. DO current too low to calibrate | A. Recalibrate instrument using known good conductivity standard. Follow cell cleaning procedure in the Maintenance section.<br>B. Replace membrane, clean probe |
| 10. Main display reads "rErr" | A. Reading exceeds user selected manual range. | A. Use the mode key to select a higher or lower manual range, or set system to autoranging. |
| 11. Main display reads "PErr" | A. User cell constant cal K is 0.0<br>B. Incorrect sequence of keystrokes. | A. See "Advanced Setup" section.<br>B. Refer to manual section for step by step instruction for the function you are attempting. |

| SYMPTOM | POSSIBLE CAUSE | ACTION |
|---|---|---|
| 12. Main display reads “LErr” | A. In temperature compensated conductivity mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature.<br>B. In cell constant cal mode, temperature exceeds the values computed using user defined temperature coefficient and/or reference temperature. | A. & B. Adjust user defined tempco or reference temperature. (pg. 10) |
| 13. Main display reads “Err” (Secondary display reads “ra”) | A. System has failed its RAM test check procedure. | A. Turn instrument OFF and back ON again.<br>B. Return the system for service (pg. 26) |
| 14. Main display reads “Err” (Secondary display reads “ro”) | A. System has failed its ROM test check procedure. | A. Turn instrument OFF and back ON again.<br>B. Return the system for service (pg. 26) |
| 15. Secondary display reads “rEr” | A. Temperature jumper is set to °F and reading is >199.9°F but <203°F. | A. Return the system for service. (pg. 26) |
| 16. Main display reads “FAIL” (Secondary display reads “eep”) | A. EEPROM has failed to respond in time. | A. Return the system for service. (pg. 26) |
| 17. Readings on main display don’t change | A. Meter is in recall mode. | A. Press **MODE** button to return to Normal Operation (pg. 12) |

# SECTION 13 WARRANTY AND REPAIR

YSI Model 85 Handheld Meters are warranted for two years from date of purchase by the end user against defects in materials and workmanship. YSI Model 85 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.

# AUTHORIZED U.S. SERVICE CENTERS

**North and East Region**

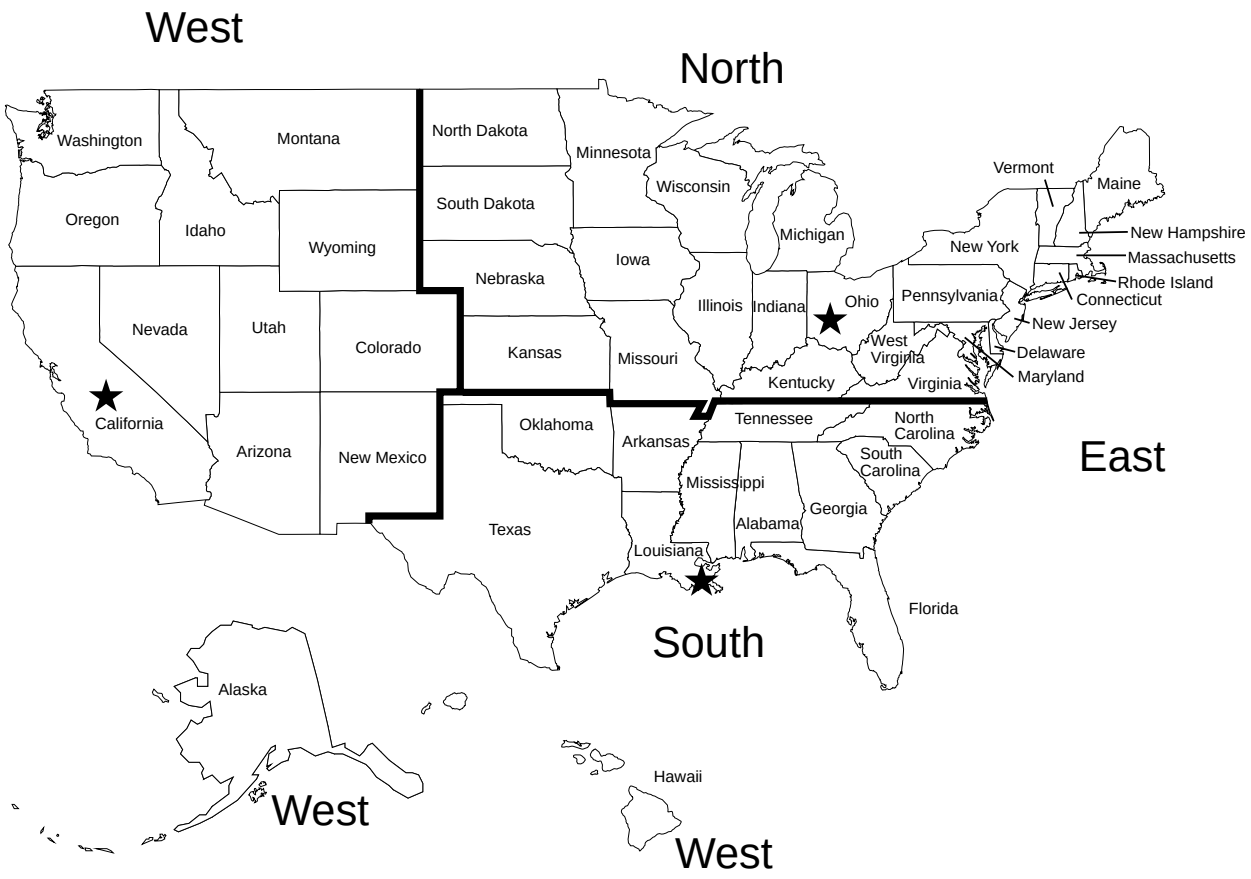
YSI Incorporated • Repair Center • 1725 Brannum Lane • Yellow Springs, Ohio • 45387 • Phone: (800) 765-4974 • (937) 767-7241• E-Mail: ysi@info.com

**South Region**

C.C. Lynch & Associates • 212 E. 2nd Street • Suite 203 • Pass Christian, Mississippi • 39571 • Phone: (800) 333-2252 • (228) 452-4612 • Fax: (228) 452-2563

**West Region**

EnviroServices & Repair • 1110 Burnett Avenue, Suite D • Concord, CA • 94520 • Phone: (800) 550-5875 • Fax: (510)674-8655



## INTERNATIONAL SERVICE CENTERS

YSI Incorporated • Repair Center • 1725 Brannum Lane • Yellow Springs, Ohio • 45387 • Phone: (937) 767-7241• E-Mail: info@ysi.com

Lynchford House • Lynchford Lane • Farnborough • Hampshire • GU146LT • Phone: (44-1252) 514711 • Fax: (44-1252) 511855 • Tlx: 858210

Sakura – Building 6-5-6-13 • Shinjuku, Shinjuku-ku, Tokyo • 160 • Phone: (81-3) 5360-3561 • Fax: (81-3) 5360-3565

## SPECIALTY SERVICE CENTERS

**Aquaculture**

Aquatic Eco Systems, Inc. • 1767 Benbow Court • Apopka, Florida • Phone: (407) 886-3939 • Fax: ( 407) 886-6787

Aquacenter • 166 Seven Oaks Road • Leland, Mississippi • 38756 • Phone: (601) 378-2861 • Fax: (601) 378-2862

**Wastewater**

Q.C. Services • P.O. Box 68 • Harrison, Maine • 04040 • Phone: (207) 583-2980

Q.C. Services • P.O. Box 14831 • Portland, Oregon • 97293 • Phone: (503) 236-2712

## CLEANING INSTRUCTIONS

**NOTE: Before they can be serviced, equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected.** Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at YSI, the following steps must be taken to insure the safety of our service personnel.

1. In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4 cup bleach to 1-gallon tap water are suitable for most disinfecting. Instruments used with wastewater may be disinfected with .5% Lysol if this is more convenient to the user.
2. The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
3. If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
4. Any product being returned to the YSI Repair Center, should be packed securely to prevent damage.
5. Cleaning must be completed and certified on any product before returning it to YSI.

## PACKING INSTRUCTIONS

1. Clean and decontaminate items to insure the safety of the handler.
2. Complete and include the Cleaning Certificate.
3. Place the product in a plastic bag to keep out dirt and packing material.
4. Use a large carton, preferably the original, and surround the product completely with packing material.
5. Insure for the replacement value of the product.

**Cleaning Certificate**

Organization _____

Department _____

Address _____

City _____ State _ Zip _____

Country _____ Phone _____

Model No. of Device _ Lot Number _____

Contaminant (if known) _____

Cleaning Agent(s) used _____

Radioactive Decontamination Certified?

(Answer only if there has been radioactive exposure)

_____ Yes _____ No

Cleaning Certified By _____

Name Date

# SECTION 14 ACCESSORIES AND REPLACEMENT PARTS

The following parts and accessories are available from YSI or any Franchise Dealer authorized by YSI.

| YSI ORDER NUMBER | DESCRIPTION |
|---|---|
| YSI 5906 | Replacement Membrane Cap Kit ( 6 each ) |
| YSI 5238 | Probe Reconditioning Kit |
| YSI 3161 | Conductivity Calibration Solution 1,000 µ/cm (1 Quart) |
| YSI 3163 | Conductivity Calibration Solution 10,000 µ/cm (1 Quart) |
| YSI 3165 | Conductivity Calibration Solution 100,000 µ/cm (1 Quart) |
| YSI 3167 | Conductivity Calibration Solution 1,000 µ/cm (8 pints) |
| YSI 3168 | Conductivity Calibration Solution 10,000 µ/cm (8 pints) |
| YSI 3169 | Conductivity Calibration Solution 50,000 µ/cm (8 pints) |
| YSI 5520 | Carrying Case |
| YSI 118510 | Replacement Probe & Cable Assembly (10 feet) |
| YSI 118522 | Replacement Probe & Cable Assembly (25 feet) |
| YSI 118527 | Replacement Probe & Cable Assembly (50 feet) |
| YSI 118519 | Replacement Probe and Cable Assembly (100 feet) |
| YSI 038501 | Replacement Front Case Cover |
| YSI 055242 | Replacement Rear Case Cover |
| YSI 055244 | Replacement Battery Cover Kit |
| YSI 055204 | Replacement Case Gasket and Screw |
| YSI 055219 | Storage Chamber Sponge |
| YSI 030156 | Main Board Assembly |
| YSI 038213 | Replacement Electrode Cleaning Brush |

# APPENDIX A SPECIFICATIONS

**Operating Environment**

Medium: fresh, sea, or polluted water and most other liquid solutions.
Temperature: -5 to +65 °C
Depth: 0 to 10, 0 to 25, 0 to 50, or 0 to 100 feet (depending on cable length)

**Storage Temperature:** -10 to +50 °C

**Material:** ABS, Stainless Steel, and other materials

**Dimensions:**

| | | |
|---|---|---|
| Height: | 9.5 inches | (24.13 cm) |
| Thickness: | 2.2 inches | (5.6 cm) |
| Width: | 3.5 inches max. | (8.89 cm) |
| Weight: | 1.7 pounds (w/ 10' cable) | (.77 kg) |
| Display: | 2.3"W x 1.5"L | (5.8cm W x 3.8cm L) |

**Power:** 9 VDC -6 AA-size Alkaline Batteries (included)
Approximately 100 hours operation from each new set of batteries

**Water Tightness:** Meets or exceeds IP65 standards

***Extensive testing of the YSI Model 85 indicates the following typical performance:***

| Measurement | Range | Resolution | Accuracy |
|---|---|---|---|
| Conductivity | 0 to 499.9 µS/cm | 0.1 µS/cm | ± .5% FS |
| | 0 to 4999 µS/cm | 1.0 µS/cm | ± .5% FS |
| | 0 to 49.99 mS/cm | .01 mS/cm | ± .5% FS |
| | 0 to 200.0 mS/cm | 0.1 mS/cm | ± .5% FS |
| Salinity | 0 to 80 ppt | .1 ppt | ± 2%, or ± 0.1 ppt |
| Temperature | -5 to +65 °C | 0.1 °C | ± 0.1 °C (±1 lsd) |
| Dissolved Oxygen | 0 to 200 % Air Sat. | 0.1% Air Saturation | ± 2% Air Saturation |
| | 0 to 20 mg/L | 0.01 mg/L | ± 0.3 mg/L |

**Adjustable Conductivity Reference Temperature**: 15°C to 25°C

**Adjustable Temperature Compensation Factor for Conductivity:** 0% to 4%

**Temperature Compensation:** Automatic

**Range:** Autoranging for Dissolved Oxygen

User selected or Autoranging for Conductivity

# APPENDIX B - TEMPERATURE CORRECTION DATA

## Temperature Correction Data for Typical Solutions

### A. Potassium Chloride** (KCl)

| Concentration: 1 mole/liter | | | Concentration: 1 x $10^{-1}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 65.10 | 1.67 | 0 | 7.13 | 1.78 |
| 5 | 73.89 | 1.70 | 5 | 8.22 | 1.80 |
| 10 | 82.97 | 1.72 | 10 | 9.34 | 1.83 |
| 15 | 92.33 | 1.75 | 15 | 10.48 | 1.85 |
| 20 | 101.97 | 1.77 | 20 | 11.65 | 1.88 |
| 25 | 111.90 | 1.80 | 25 | 12.86 | 1.90 |
| | | | 30 | 14.10 | 1.93 |
| | | | 35 | 15.38 | 1.96 |
| | | | 37.5 | 16.04 | 1.98 |
| | | | 40 | 16.70 | 1.99 |
| | | | 45 | 18.05 | 2.02 |
| | | | 50 | 19.43 | 2.04 |

| Concentration: 1 x $10^{-2}$ mole/liter | | | Concentration: 1 x $10^{-3}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 0.773 | 1.81 | 0 | 0.080 | 1.84 |
| 5 | 0.892 | 1.84 | 5 | 0.092 | 1.88 |
| 10 | 1.015 | 1.87 | 10 | 0.105 | 1.92 |
| 15 | 1.143 | 1.90 | 15 | 0.119 | 1.96 |
| 20 | 1.275 | 1.93 | 20 | 0.133 | 1.99 |
| 25 | 1.412 | 1.96 | 25 | 0.147 | 2.02 |
| 30 | 1.553 | 1.99 | 30 | 0.162 | 2.05 |
| 35 | 1.697 | 2.02 | 35 | 0.178 | 2.07 |
| 37.5 | 1.771 | 2.03 | 37.5 | 0.186 | 2.08 |
| 40 | 1.845 | 2.05 | 40 | 0.194 | 2.09 |
| 45 | 1.997 | 2.07 | 45 | 0.210 | 2.11 |
| 50 | 2.151 | 2.09 | 50 | 0.226 | 2.13 |

** Charts developed by interpolating data from International Critical Tables, Vol. 6, pp. 229-253, McGraw-Hill Book Co., NY.

## B. Sodium Chloride* (NaCl)

| Saturated solutions at all temperatures | | |
|---|---|---|
| C | mS/cm | %/ C (to 25 C) |
| 0 | 134.50 | 1.86 |
| 5 | 155.55 | 1.91 |
| 10 | 177.90 | 1.95 |
| 15 | 201.40 | 1.99 |
| 20 | 225.92 | 2.02 |
| 25 | 251.30 | 2.05 |
| 30 | 277.40 | 2.08 |

| Concentration: 0.5 mole/liter | | |
|---|---|---|
| C | mS/cm | %/ C (to 25 C) |
| 0 | 25.90 | 1.78 |
| 5 | 29.64 | 1.82 |
| 10 | 33.61 | 1.86 |
| 15 | 37.79 | 1.90 |
| 20 | 42.14 | 1.93 |
| 25 | 46.65 | 1.96 |
| 30 | 51.28 | 1.99 |
| 35 | 56.01 | 2.01 |
| 37.5 | 58.40 | 2.02 |
| 40 | 60.81 | 2.02 |
| 45 | 65.65 | 2.04 |
| 50 | 70.50 | 2.05 |

| Concentration: 1 x $10^{-1}$ mole/liter | | |
|---|---|---|
| C | mS/cm | %/ C (to 25 C) |
| 0 | 5.77 | 1.83 |
| 5 | 6.65 | 1.88 |
| 10 | 7.58 | 1.92 |
| 15 | 8.57 | 1.96 |
| 20 | 9.60 | 1.99 |
| 25 | 10.66 | 2.02 |
| 30 | 11.75 | 2.04 |
| 35 | 12.86 | 2.06 |
| 37.5 | 13.42 | 2.07 |
| 40 | 13.99 | 2.08 |
| 45 | 15.14 | 2.10 |
| 50 | 16.30 | 2.12 |

| Concentration: 1 x $10^{-2}$ mole/liter | | |
|---|---|---|
| C | mS/cm | %/ C (to 25 C) |
| 0 | 0.632 | 1.87 |
| 5 | 0.731 | 1.92 |
| 10 | 0.836 | 1.97 |
| 15 | 0.948 | 2.01 |
| 20 | 1.064 | 2.05 |
| 25 | 1.186 | 2.09 |
| 30 | 1.312 | 2.12 |
| 35 | 1.442 | 2.16 |
| 37.5 | 1.508 | 2.17 |
| 40 | 1.575 | 2.19 |
| 45 | 1.711 | 2.21 |
| 50 | 1.850 | 2.24 |

| Concentration: 1 x $10^{-3}$ mole/liter | | |
|---|---|---|
| C | mS/cm | %/ C (to 25 C) |
| 0 | 0.066 | 1.88 |
| 5 | 0.076 | 1.93 |
| 10 | 0.087 | 1.98 |
| 15 | 0.099 | 2.02 |
| 20 | 0.111 | 2.07 |
| 25 | 0.124 | 2.11 |
| 30 | 0.137 | 2.15 |
| 35 | 0.151 | 2.19 |
| 37.5 | 0.158 | 2.20 |
| 40 | 0.165 | 2.22 |
| 45 | 0.180 | 2.25 |
| 50 | 0.195 | 2.29 |

* Charts developed by interpolating data from the CRC Handbook of Chemistry and Physics, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

## C. Lithium Chloride* (LiCl)

| Concentration: 1 mole/liter | | | Concentration: 1 x $10^{-1}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 39.85 | 1.82 | 0 | 5.07 | 1.87 |
| 5 | 46.01 | 1.85 | 5 | 5.98 | 1.85 |
| 10 | 52.42 | 1.89 | 10 | 6.87 | 1.85 |
| 15 | 59.07 | 1.92 | 15 | 7.75 | 1.85 |
| 20 | 65.97 | 1.95 | 20 | 8.62 | 1.85 |
| 25 | 73.10 | 1.98 | 25 | 9.50 | 1.86 |
| 30 | 80.47 | 2.02 | 30 | 10.40 | 1.88 |
| 35 | 88.08 | 2.05 | 35 | 11.31 | 1.91 |
| 37.5 | 91.97 | 2.07 | 37.5 | 11.78 | 1.92 |
| 40 | 95.92 | 2.08 | 40 | 12.26 | 1.94 |
| 45 | 103.99 | 2.11 | 45 | 13.26 | 1.98 |
| 50 | 112.30 | 2.15 | 50 | 14.30 | 2.02 |

| Concentration: 1 x $10^{-2}$ mole/liter | | | Concentration: 1 x $10^{-3}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 0.567 | 1.88 | 0 | 0.059 | 1.93 |
| 5 | 0.659 | 1.92 | 5 | 0.068 | 2.03 |
| 10 | 0.755 | 1.96 | 10 | 0.078 | 2.12 |
| 15 | 0.856 | 2.00 | 15 | 0.089 | 2.19 |
| 20 | 0.961 | 2.04 | 20 | 0.101 | 2.25 |
| 25 | 1.070 | 2.08 | 25 | 0.114 | 2.28 |
| 30 | 1.183 | 2.12 | 30 | 0.127 | 2.31 |
| 35 | 1.301 | 2.16 | 35 | 0.140 | 2.32 |
| 37.5 | 1.362 | 2.18 | 37.5 | 0.147 | 2.32 |
| 40 | 1.423 | 2.20 | 40 | 0.154 | 2.31 |
| 45 | 1.549 | 2.24 | 45 | 0.166 | 2.29 |
| 50 | 1.680 | 2.28 | 50 | 0.178 | 2.25 |

## D. Potassium Nitrate** ($KNO_3$)

| Concentration: 1 x $10^{-1}$ mole/liter | | | Concentration: 1 x $10^{-2}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 6.68 | 1.78 | 0 | 0.756 | 1.77 |
| 5 | 7.71 | 1.79 | 5 | 0.868 | 1.80 |
| 10 | 8.75 | 1.81 | 10 | 0.984 | 1.83 |
| 15 | 9.81 | 1.83 | 15 | 1.105 | 1.86 |
| 20 | 10.90 | 1.85 | 20 | 1.229 | 1.88 |
| 25 | 12.01 | 1.87 | 25 | 1.357 | 1.90 |
| 30 | 13.15 | 1.90 | 30 | 1.488 | 1.93 |
| 35 | 14.32 | 1.92 | 35 | 1.622 | 1.95 |
| 37.5 | 14.92 | 1.94 | 37.5 | 1.690 | 1.96 |
| 40 | 15.52 | 1.95 | 40 | 1.759 | 1.97 |
| 45 | 16.75 | 1.97 | 45 | 1.898 | 1.99 |
| 50 | 18.00 | 2.00 | 50 | 2.040 | 2.01 |

* Charts developed by interpolating data from the CRC Handbook of Chemistry and Physics, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.
** Charts developed by interpolating data from International Critical Tables, Vol. 6, pp. 229-253, McGraw-Hill Book Co., NY.

## E. Ammonium Chloride* ($NH_4Cl$)

| Concentration: 1 mole/liter | | | Concentration: $1 \times 10^{-1}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 64.10 | 1.60 | 0 | 6.96 | 1.82 |
| 5 | 74.36 | 1.53 | 5 | 7.98 | 1.88 |
| 10 | 83.77 | 1.45 | 10 | 9.09 | 1.93 |
| 15 | 92.35 | 1.37 | 15 | 10.27 | 1.97 |
| 20 | 100.10 | 1.29 | 20 | 11.50 | 2.00 |
| 25 | 107.00 | 1.21 | 25 | 12.78 | 2.03 |
| | | | 30 | 14.09 | 2.06 |
| | | | 35 | 15.43 | 2.07 |
| | | | 37.5 | 16.10 | 2.08 |
| | | | 40 | 16.78 | 2.08 |
| | | | 45 | 18.12 | 2.09 |
| | | | 50 | 19.45 | 2.09 |

| Concentration: $1 \times 10^{-2}$ mole/liter | | | Concentration: $1 \times 10^{-3}$ mole/liter | | |
|---|---|---|---|---|---|
| C | mS/cm | %/ C (to 25 C) | C | mS/cm | %/ C (to 25 C) |
| 0 | 0.764 | 1.84 | 0 | 0.078 | 1.88 |
| 5 | 0.889 | 1.86 | 5 | 0.092 | 1.90 |
| 10 | 1.015 | 1.88 | 10 | 0.105 | 1.91 |
| 15 | 1.144 | 1.91 | 15 | 0.119 | 1.93 |
| 20 | 1.277 | 1.94 | 20 | 0.133 | 1.95 |
| 25 | 1.414 | 1.97 | 25 | 0.148 | 1.98 |
| 30 | 1.557 | 2.02 | 30 | 0.162 | 2.01 |
| 35 | 1.706 | 2.06 | 35 | 0.178 | 2.04 |
| 37.5 | 1.782 | 2.08 | 37.5 | 0.186 | 2.06 |
| 40 | 1.860 | 2.10 | 40 | 0.194 | 2.07 |
| 45 | 2.020 | 2.14 | 45 | 0.210 | 2.11 |
| 50 | 2.186 | 2.18 | 50 | 0.227 | 2.15 |

* Charts developed by interpolating data from the CRC Handbook of Chemistry and Physics, 42nd ed., p. 2606, The Chemical Rubber Company, Cleveland.

# APPENDIX C 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 computer with respect to the receiver
- move the computer away from the receiver
- plug the computer 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, D.C. 20402, Stock No. 0004-000-00345-4.

# APPENDIX D CONVERSION CHART

| TO CONVERT FROM | TO | EQUATION |
|---|---|---|
| Feet | Meters | Multiply by 0.3048 |
| Meters | Feet | Multiply by 3.2808399 |
| Degrees Celsius | Degrees Fahrenheit | (9/5 $^{o}$C)+32 |
| Degrees Fahrenheit | Degrees Celsius | 5/9 ($^{o}$F-32) |
| Milligrams per liter (mg/l) | Parts per million (ppm) | Multiply by 1 |

# APPENDIX E OXYGEN SOLUBILITY TABLE

Table A: Solubility of Oxygen in mg/l in Water Exposed to Water-Saturated Air at 760 mm Hg Pressure.
Salinity = Measure of quantity of dissolved salts in water.
Chlorinity = Measure of chloride content, by mass, of water.
$S(^0/_{00}) = 1.80655 \times \text{Chlorinity } (^0/_{00})$

| **Temp °C** | **Chlorinity:0 Salinity:0** | **5.0 ppt 9.0 ppt** | **10.0 ppt 18.1 ppt** | **15.0 ppt 27.1 ppt** | **20.0 ppt 36.1 ppt** | **25.0 ppt 45.2 ppt** |
|---|---|---|---|---|---|---|
| 0.0 | 14.62 | 13.73 | 12.89 | 12.10 | 11.36 | 10.66 |
| 1.0 | 14.22 | 13.36 | 12.55 | 11.78 | 11.07 | 10.39 |
| 2.0 | 13.83 | 13.00 | 12.22 | 11.48 | 10.79 | 10.14 |
| 3.0 | 13.46 | 12.66 | 11.91 | 11.20 | 10.53 | 9.90 |
| 4.0 | 13.11 | 12.34 | 11.61 | 10.92 | 10.27 | 9.66 |
| 5.0 | 12.77 | 12.02 | 11.32 | 10.66 | 10.03 | 9.44 |
| 6.0 | 12.45 | 11.73 | 11.05 | 10.40 | 9.80 | 9.23 |
| 7.0 | 12.14 | 11.44 | 10.78 | 10.16 | 9.58 | 9.02 |
| 8.0 | 11.84 | 11.17 | 10.53 | 9.93 | 9.36 | 8.83 |
| 9.0 | 11.56 | 10.91 | 10.29 | 9.71 | 9.16 | 8.64 |
| 10.0 | 11.29 | 10.66 | 10.06 | 9.49 | 8.96 | 8.45 |
| 11.0 | 11.03 | 10.42 | 9.84 | 9.29 | 8.77 | 8.28 |
| 12.0 | 10.78 | 10.18 | 9.62 | 9.09 | 8.59 | 8.11 |
| 13.0 | 10.54 | 9.96 | 9.42 | 8.90 | 8.41 | 7.95 |
| 14.0 | 10.31 | 9.75 | 9.22 | 8.72 | 8.24 | 7.79 |
| 15.0 | 10.08 | 9.54 | 9.03 | 8.54 | 8.08 | 7.64 |
| 16.0 | 9.87 | 9.34 | 8.84 | 8.37 | 7.92 | 7.50 |
| 17.0 | 9.67 | 9.15 | 8.67 | 8.21 | 7.77 | 7.36 |
| 18.0 | 9.47 | 8.97 | 8.50 | 8.05 | 7.62 | 7.22 |
| 19.0 | 9.28 | 8.79 | 8.33 | 7.90 | 7.48 | 7.09 |
| 20.0 | 9.09 | 8.62 | 8.17 | 7.75 | 7.35 | 6.96 |
| 21.0 | 8.92 | 8.46 | 8.02 | 7.61 | 7.21 | 6.84 |
| 22.0 | 8.74 | 8.30 | 7.87 | 7.47 | 7.09 | 6.72 |
| 23.0 | 8.58 | 8.14 | 7.73 | 7.34 | 6.96 | 6.61 |

| Temp °C | Chlorinity:0 Salinity:0 | 5.0 ppt 9.0 ppt | 10.0 ppt 18.1 ppt | 15.0 ppt 27.1 ppt | 20.0 ppt 36.1 ppt | 25.0 ppt 45.2 ppt |
|---|---|---|---|---|---|---|
| 24.0 | 8.42 | 7.99 | 7.59 | 7.21 | 6.84 | 6.50 |
| 25.0 | 8.26 | 7.85 | 7.46 | 7.08 | 6.72 | 6.39 |
| 26.0 | 8.11 | 7.71 | 7.33 | 6.96 | 6.62 | 6.28 |
| 27.0 | 7.97 | 7.58 | 7.20 | 6.85 | 6.51 | 6.18 |
| 28.0 | 7.83 | 7.44 | 7.08 | 6.73 | 6.40 | 6.09 |
| 29.0 | 7.69 | 7.32 | 6.96 | 6.62 | 6.30 | 5.99 |
| 30.0 | 7.56 | 7.19 | 6.85 | 6.51 | 6.20 | 5.90 |
| 31.0 | 7.43 | 7.07 | 6.73 | 6.41 | 6.10 | 5.81 |
| 32.0 | 7.31 | 6.96 | 6.62 | 6.31 | 6.01 | 5.72 |
| 33.0 | 7.18 | 6.84 | 6.52 | 6.21 | 5.91 | 5.63 |
| 34.0 | 7.07 | 6.73 | 6.42 | 6.11 | 5.82 | 5.55 |
| 35.0 | 6.95 | 6.62 | 6.31 | 6.02 | 5.73 | 5.46 |
| 36.0 | 6.84 | 3.52 | 6.22 | 5.93 | 5.65 | 5.38 |
| 37.0 | 6.73 | 6.42 | 6.12 | 5.84 | 5.56 | 5.31 |
| 38.0 | 6.62 | 6.32 | 6.03 | 5.75 | 5.48 | 5.23 |
| 39.0 | 6.52 | 6.22 | 5.98 | 5.66 | 5.40 | 5.15 |
| 40.0 | 6.41 | 6.12 | 5.84 | 5.58 | 5.32 | 5.08 |
| 41.0 | 6.31 | 6.03 | 5.75 | 5.49 | 5.24 | 5.01 |
| 42.0 | 6.21 | 5.93 | 5.67 | 5.41 | 5.17 | 4.93 |
| 43.0 | 6.12 | 5.84 | 5.58 | 5.33 | 5.09 | 4.86 |
| 44.0 | 6.02 | 5.75 | 5.50 | 5.25 | 5.02 | 4.79 |
| 45.0 | 5.93 | 5.67 | 5.41 | 5.17 | 4.94 | 4.72 |

* This table is provided for your information only. It is **NOT** required when calibrating the Model 85 in accordance with the instructions outlined in the section entitled Calibration.

# APPENDIX F CALIBRATION VALUES TABLE

Table A: Calibration values for various atmospheric pressures and altitudes.
Note: This table is for your information only. It is not required for calibration.

| Pressure Inches of Hg | Pressure mm Hg | Pressure kPA | Altitude in feet | Altitude in meters | Calibration Value in % |
|---|---|---|---|---|---|
| 30.23 | 768 | 102.3 | -276 | -84 | 101 |
| 29.92 | 760 | 101.3 | 0 | 0 | 100 |
| 29.61 | 752 | 100.3 | 278 | 85 | 99 |
| 29.33 | 745 | 99.3 | 558 | 170 | 98 |
| 29.02 | 737 | 98.3 | 841 | 256 | 97 |
| 28.74 | 730 | 97.3 | 1126 | 343 | 96 |
| 28.43 | 722 | 96.3 | 1413 | 431 | 95 |
| 28.11 | 714 | 95.2 | 1703 | 519 | 94 |
| 27.83 | 707 | 94.2 | 1995 | 608 | 93 |
| 27.52 | 699 | 93.2 | 2290 | 698 | 92 |
| 27.24 | 692 | 92.2 | 2587 | 789 | 91 |
| 26.93 | 684 | 91.2 | 2887 | 880 | 90 |
| 26.61 | 676 | 90.2 | 3190 | 972 | 89 |
| 26.34 | 669 | 89.2 | 3496 | 1066 | 88 |
| 26.02 | 661 | 88.2 | 3804 | 1160 | 87 |
| 25.75 | 654 | 87.1 | 4115 | 1254 | 86 |
| 25.43 | 646 | 86.1 | 4430 | 1350 | 85 |
| 25.12 | 638 | 85.1 | 4747 | 1447 | 84 |
| 24.84 | 631 | 84.1 | 5067 | 1544 | 83 |
| 24.53 | 623 | 83.1 | 5391 | 1643 | 82 |
| 24.25 | 616 | 82.1 | 5717 | 1743 | 81 |
| 23.94 | 608 | 81.1 | 6047 | 1843 | 80 |
| 23.62 | 600 | 80.0 | 6381 | 1945 | 79 |
| 23.35 | 593 | 79.0 | 6717 | 2047 | 78 |
| 23.03 | 585 | 78.0 | 7058 | 2151 | 77 |
| 22.76 | 578 | 77.0 | 7401 | 2256 | 76 |
| 22.44 | 570 | 76.0 | 7749 | 2362 | 75 |
| 22.13 | 562 | 75.0 | 8100 | 2469 | 74 |
| 21.85 | 555 | 74.0 | 8455 | 2577 | 73 |
| 21.54 | 547 | 73.0 | 8815 | 2687 | 72 |
| 21.26 | 540 | 71.9 | 9178 | 2797 | 71 |
| 20.94 | 532 | 70.9 | 9545 | 2909 | 70 |
| 20.63 | 524 | 69.9 | 9917 | 3023 | 69 |
| 20.35 | 517 | 68.9 | 10293 | 3137 | 68 |

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ITEM # 038503
DRW # A38503
Revision D
November 1998

CAT. NO. 46500-88

# PORTABLE TURBIDIMETER

## Model 2100P

## Instrument and Procedure Manual



te/dk 3/04 8ed

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## TABLE OF CONTENTS, continued

# CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The Model 2100P Portable Turbidimeter has been tested and is certified as indicated to the following instrumentation standards:

## Product Safety

**Battery/Eliminator Power Supply Only:**
120 Vac, 60 Hz, UL Listed & CSA Certified, Class 2
230 Vac, 50 Hz, VDE Approved, GS & CE marked

## Immunity

**2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:**
**EN 50082-1** (European Generic Immunity Standard) **per 89/336/EEC EMC:** Supporting test records with Dash Straus and Goodhue, Inc. (now Intertek Testing Services), certified compliance by Hach Company.

**Standards include:**
IEC 801-2 Electro-Static Discharge
IEC 801-3 Radiated RF Electro-Magnetic Fields
IEC 801-4 Electrical Fast Transients/Burst

## Emissions

**2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:**
**EN 50081-1** (Emissions) **per 89/336/EEC EMC:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

**Standards include:**
EN 55022 (CISPR 22) Emissions, Class B Limits

**Canadian Radio Interference-Causing Regulation, Chapter 1374, Class A:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

## CERTIFICATION, continued

**FCC Part 15, Class "A" Limits:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two 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.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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 may cause harmful interference in which case the user will be required to correct the interference at his own expense.

The following techniques of reducing interference problems are applied easily:

1. Disconnect the battery eliminator from it's power source and from the 2100P Portable Turbidimeter to verify if it is the source of the interference
2. If the battery eliminator for the 2100P Portable Turbidimeter is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the 2100P Portable Turbidimeter away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

# SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

## Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

***DANGER***
***Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.***

***CAUTION***
***Indicates a potentially hazardous situation that may result in minor or moderate injury.***

***NOTE***
***Information that requires special emphasis.***

## Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

 This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

# SPECIFICATIONS

Specifications subject to change without notice.
Operating specifications applicable at 25 °C unless noted.


**Measurement Method:** Ratio Nephelometric signal (90°) scatter light ratio to transmitted light

**Range:** 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU

**Accuracy:** ± 2% of reading plus stray light from 0-1000 NTU

**Resolution:** 0.01 NTU on lowest range

**Repeatability:** ±1% of reading or 0.01 NTU, whichever is greater (with Gelex standards)

**Response Time:** 6 seconds for full step change without signal averaging in constant reading mode

**Stray Light:** <0.02 NTU

**Standardization:** StablCal® Stabilized Formazin primary standards or Formazin primary standards

**Secondary Standards:** Gelex® Secondary Standards

**Display:** Four-digit liquid crystal; 10.16 mm (0.4 in) high digits with custom icons

**Light Source:** Tungsten filament lamp; lamp life typically greater than 100,000 readings

**Detectors:** Silicon photovoltaic

**Signal Averaging:** Operator selectable on or off

**Sample Cells:** (Height X width) 60.0 X 25 mm (2.36 X 1 in) Borosilicate glass with screw caps, marking band and fill line

**Sample Required:** 15 mL (0.5 oz.)

**Storage Temperature:** -40 to 60 °C (-40 to 140 °F) (instrument only)

## SPECIFICATIONS, continued

**Operating Temperature:** 0 to 50 °C (32 to 122 °F) (instrument only)

**Operating Humidity Range:** 0 to 90% RH noncondensing at 30 °C;
0 to 80% RH noncondensing at 40 °C;
0 to 70% RH noncondensing at 50 °C

**Power Requirements:** Four AA Alkaline cells or optional battery eliminator

**Battery Life:** Typically 300 tests with signal average mode off; 180 tests with signal average mode on

**Battery Eliminator (optional):**

For 120 V eliminator: CSA and UL approved for 120 VAC ±10%, 60 Hz, 6 V at 800 mA DC output

For 230 V eliminator: CE (VDE) approval pending for 230 VAC ±10%, 50 Hz, 6 V at 900 mA DC output

**Enclosure:** High impact ABS plastic

**Dimensions:** 22.2 X 9.5 X 7.9 cm (8.75 X 3.75 X 3.12 in)

**Instrument Weight:** 520 kg (1 lb 2.5 oz)

**Shipping Weight:** 3.1 kg (6 lbs 8.5 oz)

# OPERATION

### *DANGER*

***Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.***

### *DANGER*

***La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.***

### *PELIGRO*

***La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.***

### *GEFAHR*

***Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.***

### *PERIGO*

***A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.***

### *PERICOLO*

***La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.***

# SECTION 1 DESCRIPTION

## 1.1 General Description

The Hach Model 2100P Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01 to 9.99, 10 to 99.9 and 100 to 1000 NTU. Designed primarily for field use, the microprocessor-based Model 2100P has the range, accuracy, and resolution of many laboratory instruments. The instrument operates on four AA batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The instrument automatically shuts off after 5.5 minutes if no keystrokes occur (does not influence operation). If this occurs, simply turn the instrument on – the 2100P will resume operation as if the power had not been interrupted. The instrument, all standard accessories, and the optional battery eliminator may be conveniently stored in the carrying case.

**Figure 1 2100P Turbidimeter and Accessories**

***Note:*** *Avoid prolonged exposure to ultraviolet light and sunlight.*

***Note:*** *Do not hold the instrument during measurements; place the instrument on a flat, steady surface.*

## 1.2 Accessories

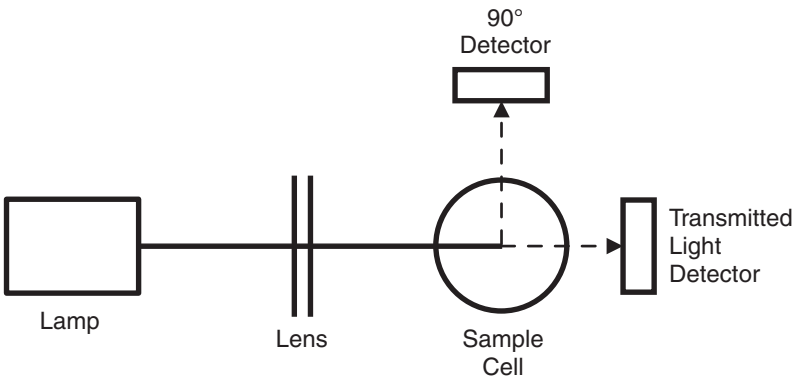
Accessories supplied with the turbidimeter include nine sample cells; three Gelex® Secondary Standards; one sealed vial each of: <0.1-NTU, 20-NTU, 100-NTU, and 800-NTU StablCal® Stabilized Formazin Standards; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

## 1.3 Principle of Operation

The Model 2100P Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1.

The optical system* (*Figure 2*) includes a tungsten-filament lamp, a 90° detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90° and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

**Figure 2 Ratio Optical System**




* Patent number 4,198,161; other patents pending.

## 1.4 Preparation for Use

### 1.4.1 Unpacking

Remove the instrument and accessories from the shipping box and inspect them for damage that may have occurred due to rough handling or extreme weather conditions. Verify the following are present:

- Model 2100P Portable Turbidimeter
- Instrument Manual (with quick reference card)
- Set of StablCal Primary Standards in sealed vials, one each of:
  <0.1 NTU*
  20 NTU
  100 NTU
  800 NTU
- Standardization Kit containing Gelex Secondary Standards (0-10, 0-100 and 0-1000 ranges) plus nine sample cells with caps.
- Silicone Oil, 15-mL (0.5 oz) dropping bottle
- Oiling Cloth
- Carrying Case
- Four AA alkaline batteries

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. The toll-free number in the United States is 800-227-4224. International customers should contact the Hach office or authorized distributor serving your area. Refer to *REPAIR SERVICE* on page *77*. **Please do not return the instrument without prior authorization from Hach.**

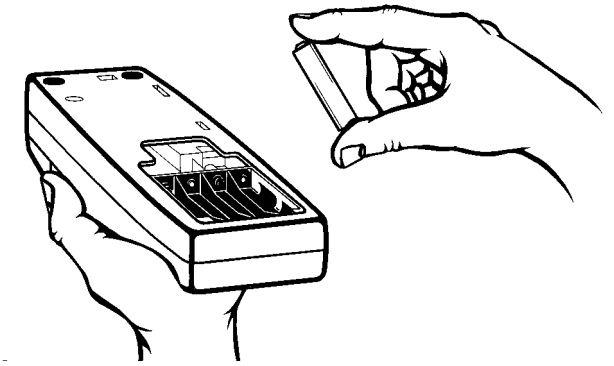
### 1.4.2 Battery Installation

The instrument is shipped completely assembled without the batteries installed. Before use, install the four AA alkaline batteries or connect

* Used in place of the dilution water standard when performing a calibration.

the battery eliminator (*Figure 3*). For battery operation, remove the battery compartment cover on the instrument bottom and install the batteries. Correct battery polarity is shown on the battery holder. The instrument will not function if the batteries are not installed correctly. Reinstall the battery compartment cover.

**Figure 3 Battery Installation**



### 1.4.3 Using the Battery Eliminator and Rechargeable Batteries

For operation with the optional battery eliminator, plug the eliminator jack into the connector on the turbidimeter side. The battery eliminator may be used with or without the batteries installed. **The eliminator will not charge batteries.** Rechargeable batteries may be used in the instrument, but must be removed for recharging. See *HOW TO ORDER* on page *76* for ordering information. To prolong battery life, the instrument lamp turns on temporarily when the **READ** key is depressed. Batteries are not necessary for battery eliminator operation.

### 1.4.4 Calibration

The 2100P Portable Turbidimeter is calibrated with Formazin Primary Standard at the factory and **does not require recalibration before use.** Hach recommends recalibration with formazin once every three months, or more often as experience dictates. The Gelex Secondary Standards supplied with the instrument are labelled with general ranges

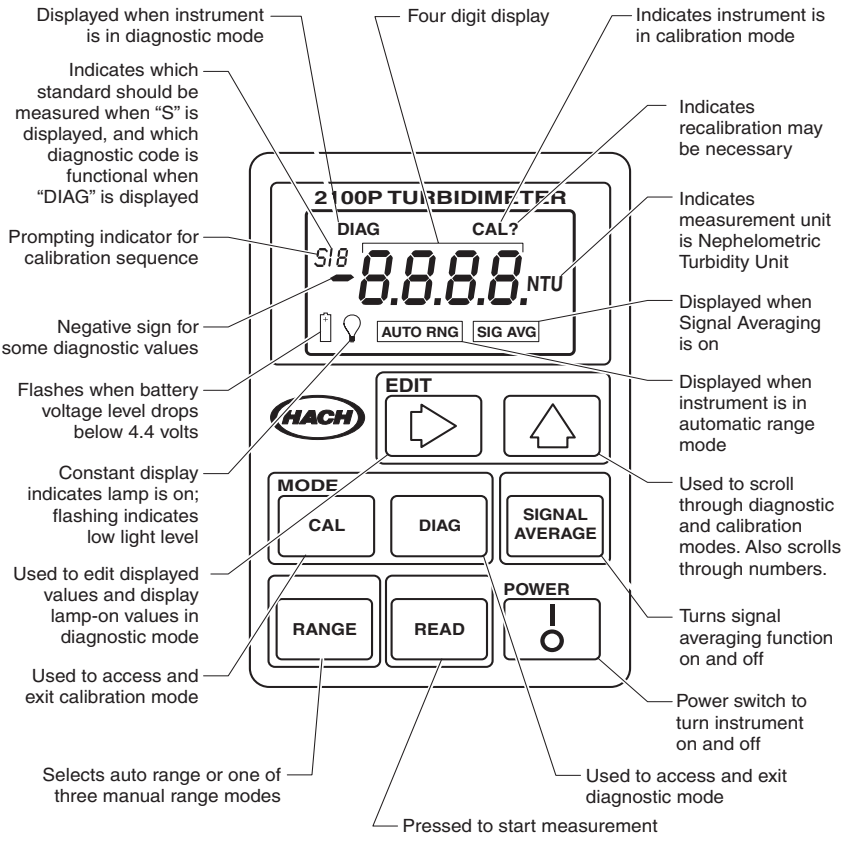
for application, but must be assigned values before use from formazin calibration. See *Section 3.6* on page *37* for calibration instructions.

# SECTION 2 TURBIDITY MEASUREMENT

## 2.1 Operating Controls and Indicators

*Figure 4* shows the 2100P controls and indicators. Refer to *SECTION 3* for a detailed description of each control and indicator.

**Figure 4 Keyboard and Display with Descriptions**




## 2.2 Turbidity Measurement

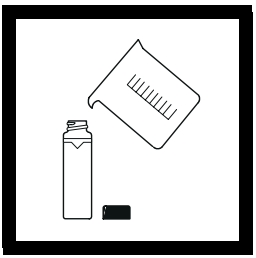
Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode. Using automatic range selection is recommended. Signal averaging uses more power and should be used only when the sample causes an unstable reading. Signal averaging measures and averages ten measurements while displaying

intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 20 seconds). After this, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When not in signal average mode, the final value is displayed after about 13 seconds.

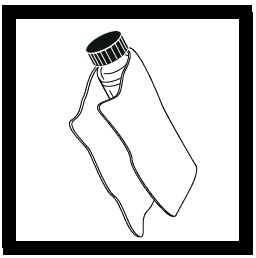
Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Refer to *Section 2.3* on page *22* for a detailed discussion of measurement techniques.

### 2.2.1 Turbidity Measurement Procedure

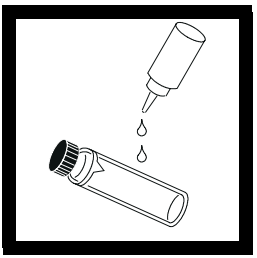


**1.** Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *22* for more information about collecting a representative sample).

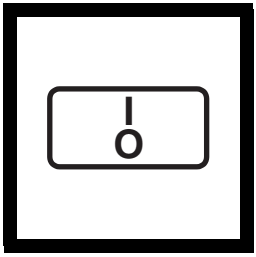
***Note:*** *The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press* **I/O**.



**2.** Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

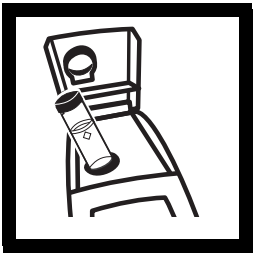


**3.** Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.



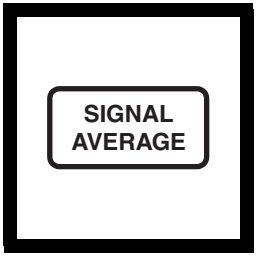

**4.** Press: **I/O**.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

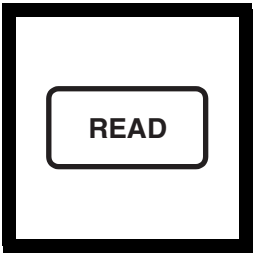


**5.** Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.
**Close the lid.**


**6.** Select manual or automatic range selection by pressing the **RANGE** key. The display will show **AUTO RNG** when the instrument is in automatic range selection.




**7.** Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).




**8.** Press: **READ**

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

***Note:*** *The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.*

### 2.2.2 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings.
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Avoid operating in direct sunlight.
- Make certain cold samples do not “fog” the sample cell.
- Avoid settling of sample prior to measurement.
- Keep sample compartment lid closed to prevent dust and dirt from entering.

## 2.3 Measurement Techniques

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Regardless of the instrument used, measurements are more accurate, precise and repeatable if the analyst pays close attention to proper measurement techniques.

Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.

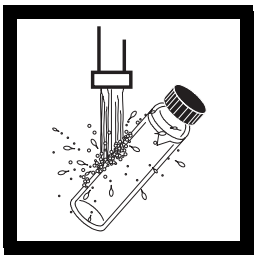
### 2.3.1 Cleaning Sample Cells

Cells must be extremely clean and free from significant scratches. The glass used to make cells is easily scratched – manufacturing cells free of minor scratches and other imperfections is difficult. However, minor imperfections are effectively masked by applying silicone oil as outlined in *Section 2.3.2*.

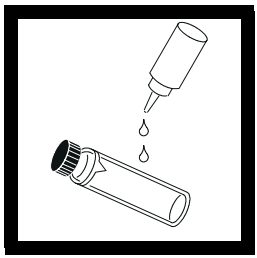
Clean the inside and outside of the cells by washing with laboratory detergent. Follow with multiple rinses of distilled or deionized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.

### 2.3.2 Oiling the Sample Cell

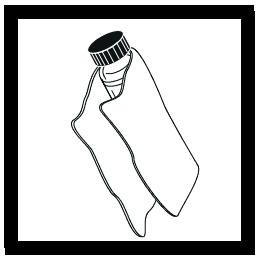
Applying a thin coat of silicone oil will mask minor imperfections and scratches which may contribute to turbidity or stray light. Use silicone oil equivalent to Hach Cat. No. 1269-36. This silicone oil has the same refractive index as glass. When applied in a thin, uniform coat, the oil fills in and masks minor scratches and other imperfections in the glass. Apply the oil uniformly by wiping with a soft, lint-free cloth.
**Avoid application of excess oil.** Applying excess oil may retain dirt and contaminate the instrument's cell compartment.



**1.** Thoroughly clean the sample cell.



**2.** Apply a small bead of silicone oil from the top to the bottom of the cell-- just enough to coat the cell with a thin layer of oil.



**3.** Using a soft, lint-free cloth, spread the oil uniformly, then wipe off the excess so that only a thin coat of oil is left. The cell should appear nearly dry with little or no visible oil.

***Note:*** *Soft, lint-free cloth (velvet) works well for oiling. Store the oiling cloth with the sample cells and keep it free of dirt. After a few applications of oil, the cloth will contain enough residual oil that simply wiping the cell with the oiled cloth will provide a sufficient oil coat on the sample cell. Periodically, add a small amount of oil to the sample cell surface to replenish the oil in the cloth.*

***Note:*** *Only a thin coat of oil on the sample cells is necessary.* ***Avoid using excessive amounts of oil.***

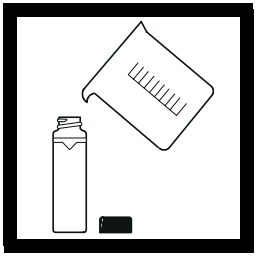
### 2.3.3 Orienting Sample Cells

***Note:*** *When orienting and matching cells, it may be more efficient to use the continuous reading mode. The instrument performs continuous readings if the* **READ** *key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds. The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.*

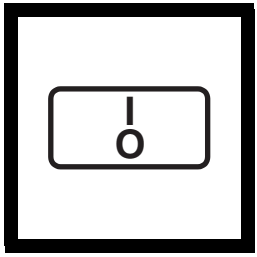
Precise measurements for very low turbidity samples require using a single cell for all measurements or optically matching the cells. Using one cell provides the best precision and repeatability. When one cell is used, an orientation mark (other than the factory-placed diamond) can be placed on the cell so it's inserted into the instrument with the same orientation each time.

#### 2.3.3.1 Orienting a single cell

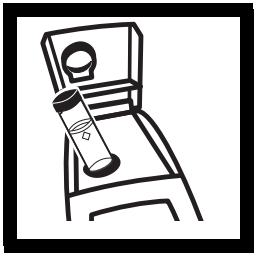
When using a single cell, make an index or orientation mark on the cell as follows:



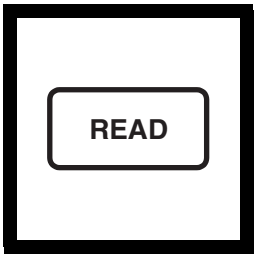
**1.** Fill the clean sample cell to the line with high quality water (< 0.5 NTU). Cap and wipe with lint-free cloth. Apply silicone oil. See *Section 3.6.2.2* on page *40* for more information about high quality water.




**2.** Press: **I/O** to turn the instrument on.



**3.** Insert the sample cell into the sample compartment. Close the cover.




**4.** Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

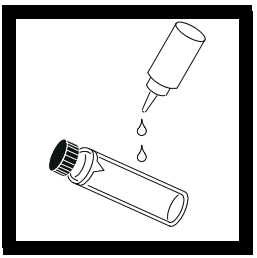
***Note:*** *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

**5.** Remove the cell, rotate it slightly and reinsert it into the cell compartment. Close the cover, then press **READ**. Record the cell's position and the displayed reading.

**6.** Repeat *step 5* until the lowest reading is displayed. Place an orientation mark on the cell's marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading. When using the cell, always place it in the instrument so the orientation mark aligns with the raised mark on the instrument.

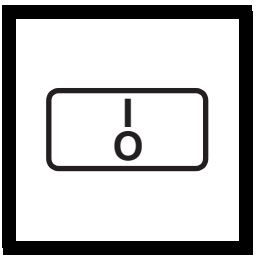
### 2.3.4 Matching multiple sample cells

Precise measurements of very low turbidity samples require the cells be optically matched or a single cell be used for all measurements. If more than one cell is used, follow this procedure to match (index) the cells:



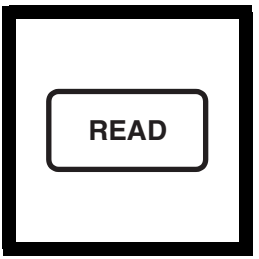
**1.** Clean and oil the sample cells as instructed in *Section 2.3.1* on page *23* and *Section 2.3.2* on page *23*.

**2.** Fill the clean sample cells to the line with the same sample.




**3.** Press: **I/O** to turn the instrument on.

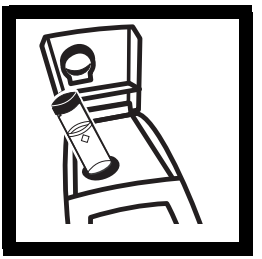
**4.** Insert the **first** sample cell into the sample compartment and close the cover.



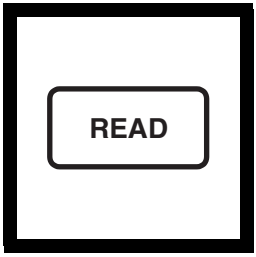

**5.** Press: **READ**

Record the cell's position in the cell compartment and the displayed reading. Place an orientation mark on the cell's marking band.

***Note:*** *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*



**6.** Insert the **second** sample cell into the cell compartment and close the cover.




**7.** Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

**8.** Remove the cell, rotate it slightly and reinsert into the cell compartment. Close the cover, then press **READ** again. Record the cell's position and the displayed reading.

**9.** Repeat *step 8* until the value displayed for the second cell is within 0.01 NTU (or 1%) of the value obtained for the first cell. Place an orientation mark on the second cell's marking band so it is consistently inserted in this position.

***Note:*** *Due to variability in glass, it may not be possible to match all cells.*

**10.** Repeat *step 6* through *step 9* if matching other sample cells.

### 2.3.5 Removing Bubbles (Degassing)

Before measurement, removing air and other trapped gasses from the sample is strongly recommended, even if bubbles are not visible. Four degassing methods are commonly used:

**1.** applying a partial vacuum

**2.** adding a surfactant

**3.** using an ultrasonic bath

**4.** heating the sample

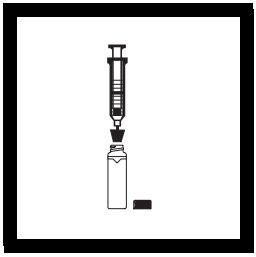
In some cases, more than one method may be necessary for effective bubble removal. For example, use of both a surfactant and ultrasonic bath may be necessary for some severe conditions. Use care with these techniques. If misused, sample turbidity can be altered.

Removing air bubbles by letting the sample stand for a period of time is not recommended. Particulates that cause turbidity may settle and the sample temperature may change. Both conditions may alter sample turbidity, resulting in measurements not representative of the original turbidity.

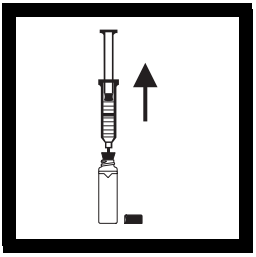
#### 2.3.5.1 Application of vacuum

Apply a vacuum with any convenient, clean, oil-free vacuum source. The vacuum lowers the atmospheric pressure, allowing trapped bubbles to escape into the air above the sample. Vacuum works well with non-viscous samples (such as water) that don't contain volatile components. Applying vacuum to viscous, volatile-containing samples (paint resins) may cause the volatile components to come out of solution and aggravate the bubble problem.

To apply a vacuum, use a sample degassing kit equivalent to Cat No. 43975-00 (Degassing Kit) or 43975-10 (Degassing and Filtration Kit). These kits contain a syringe and rubber stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat No. 14283-00 or 14697-00, respectively, may also be used.



**1.** Fill a sample cell to the mark with sample. Insert a #2 single-hole rubber stopper and syringe into the cell. If using a pump, insert a piece of glass tubing into the stopper.



**2.** **Slowly** apply the vacuum by carefully pulling the plunger upward, then holding it. If using a hand or electric pump, connect the tubing to the vacuum pump with vacuum hose. Apply vacuum until visible gas bubbles disappear. **Slowly** release the vacuum. Remove the vacuum apparatus and cap the cell.

### 2.3.5.2 Adding a surfactant

Surfactants should be limited to severe problems when other degassing methods are ineffective. Surfactants change the surface tension of the water, which releases trapped gases. Hach recommends a surfactant such as Triton X-100 or the equivalent, Hach Cat No. 14096-37. Put one drop of Triton X-100 in the sample cell before adding sample.

***Note:*** *Any turbidity contributed by surfactant addition is negligible.*

This technique is very effective when the water is super-saturated with air. However, changing the surface tension may accelerate settling of turbidity-causing particles. Mix the sample gently, but thoroughly, and analyze as soon as possible after adding the surfactant. Avoid vigorous mixing as the surfactant may foam. Rinse the sample cells thoroughly between samples to prevent surfactant accumulation.

### 2.3.5.3 Using an ultrasonic bath

***Note:*** *The time necessary to expel bubbles may vary from a few seconds to a minute or more. To avoid excessive application of ultrasound, a simple procedure can be followed. First, apply ultrasound until all visible bubbles are absent. Then measure the sample turbidity. Apply ultrasound for a short time period and again measure turbidity. Continue for several repetitions, noting the treatment time and turbidity readings. If turbidity begins to increase instead of decrease, the ultrasound waves have probably started to alter the suspended particles. Note the time it takes for this to occur and record it as the maximum time limit for ultrasonic treatment.*

Ultrasonic baths effectively remove gas bubbles from most samples, especially viscous liquids. However, the ultrasonic waves which cause degassing may also alter the characteristics of the particles causing the turbidity. Turbidity depends on the size, shape, composition and refractive index of the suspended particles. Excessive ultrasound application may alter particle size and shape, thus changing sample turbidity. In some cases, ultrasound may aggravate air bubble removal by fracturing the bubbles, making degassing more difficult.

**1.** Fill a clean sample cell to the line with sample. Leave uncapped.

**2.** Immerse the cell (1/2 to 2/3 immersed) in an ultrasonic bath and allow it to stand until visible bubbles are expelled.

**3.** Remove the cell, cap, then thoroughly dry the cell. Apply silicone oil as directed.

### 2.3.5.4 Application of heat

Whenever possible, avoid using heat to degas samples because heat may change the characteristics of the suspended particles and cause volatile components to come out of solution. Gentle heating may be helpful for degassing some very viscous samples when combined with application of vacuum or ultrasound. If heat is necessary, heat the sample only until degassing occurs. The simplest technique is to prepare a warm water bath and partially immerse the filled sample cell. Use the shortest time necessary for expelling visible bubbles. Cool sample to original sample temperature before taking measurements.

### 2.3.6 Measuring Overrange Samples

Nephelometric turbidity measurement depends on detection of light scattered from particles suspended in the liquid. If the turbidity is very high, a significant amount of light is blocked or absorbed by the particles and only a small amount of light reaches the detector. This results in a negative interference – the measured turbidity is lower than the actual turbidity. This condition is called “going blind”. A multidetector ratioing instrument, such as the Hach 2100P Turbidimeter, minimizes this effect and extends the instrument range. Highly turbid samples may also be diluted, but this should be avoided when possible since it may alter the characteristics of the suspended particles and produce erroneous results.

Light absorbing particles such as activated carbon and highly colored samples may also cause an instrument to “go blind”. Dilution may not correct for these interferences. A ratioing instrument will correct for the presence of light absorbing particles and color.

### 2.3.7 Condensation (fogging)

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at room temperature or immersing it in a warm bath for a short period. After warming, mix the sample thoroughly before measurement. Allowing samples to warm can alter sample turbidity, so it is best to avoid warming samples before measurement when possible.

### 2.3.8 Calibration

Turbidimeters must be properly calibrated with a primary standard. Hach recommends formazin or StablCal Stabilized Formazin for calibration. For U.S. Environmental Protection Agency (USEPA) reporting, calibrate at least as often as required by the appropriate regulatory agencies. The frequency of calibration depends on environmental conditions (humidity, temperature) and use. If necessary, calibrate more frequently.

Use secondary standards for periodic calibration checks. Please note that Gelex® standards must be assigned values after StablCal Stabilized Formazin calibration or formazin calibration and before use as secondary standards. Gelex standards must be recalibrated (values assigned) each time the instrument is calibrated with StablCal Stabilized Formazin or formazin. See *Section 3.6* on page *37* for detailed information on the use of StablCal Stabilized Formazin, formazin, and Gelex standards.

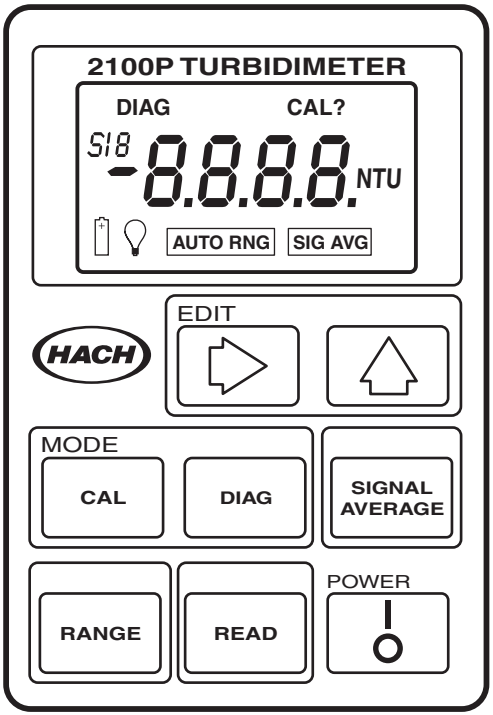
### 2.3.9 Representative Sampling

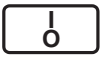
A representative sample accurately reflects the true condition of the water source from which the sample was taken. To ensure a representative sample, gently, but thoroughly, mix every sample before aliquots are taken. Do not allow the sample to settle.

When sampling from a tap in a distribution system or treatment plant, allow the water to run for at least five minutes before sampling. When sampling from a stream, reservoir, clarifier, or storage tank, collect at least one liter (l quart) and thoroughly mix before measurement. If the water source is not uniform, it may be necessary to sample several locations at varying depths and combine the samples into a single, well-mixed composite sample before measurement.

# SECTION 3 OPERATION

## 3.1 Operational Controls and Indicators




| Key | Description |
|---|---|
|  | Power key to turn instrument on and off. If no keys are pressed for 5.5 minutes, the instrument turns off automatically. |
|  | Depressed to perform a measurement. To conserve battery power, the lamp turns on only when **READ** is depressed. A reading is displayed about 12 seconds after the key is depressed. During the delay, a flashing **NTU** is displayed. After the reading is displayed, the lamp turns off and the reading continues to be displayed. Continuous readings may be done by holding this key if **not** in the Signal Averaging mode. After the initial delay, the reading is updated every 1.2 seconds. |
|  | Used to perform a calibration or review calibration data. Also terminates a calibration or calibration review and returns to the 2100P measurement mode. |

| Key | Description |
|---|---|
|  | Edits a flashing digit in the calibration mode or sequences through the calibration standards (S0,S1, S2, S3) or diagnostic menu. |
|  | Used to move the editing cursor to the digits being edited in the calibration mode or initiate editing of a standard value. |
| SIGNAL AVERAGE | Turns the signal averaging function on or off. |
| DIAG | Selects the diagnostic mode. |
| RANGE | Selects Auto Range or Manual Range (one of three manual modes). |

| Display Icon | Description |
|---|---|
| **DIAG** | Turns on after the **DIAG** is pressed to access the diagnostic mode. A number displayed under the **DIAG** icon (1-9) indicates which diagnostic function is active. See *Section 5.1* on page *67* for more information on diagnostic codes. |
| **CAL** | Turns on after the **CAL** key is pressed to access the calibration mode and remains on during the calibration. |
| **CAL?** | Appears after calibration if a value entered during calibration is outside an acceptable range. May indicate an operator error or possible instrument malfunction. Flashing **CAL?** indicates the default calibration coefficients are being used (even after a user-calibration has been done) or that no calibration data is currently stored. |
| **S__** | Displayed during calibration. The S is followed by a number to indicate which standard value is currently being edited or displayed. Flashing number is prompting user for measurement of **S0**, **S1**, **S2** or **S3** to establish a calibration. Steady number identifies which standard's value is being displayed. |
|  | Flashes when the battery voltage drops to 4.4 volts as an indication to change batteries. At <4.0 volts, the instrument automatically shuts off. |
|  | The lamp symbol is constantly on when the lamp is on and flashes after a reading if a marginal light level reaches the transmitted light detector. A flashing icon indicates the sample may be too turbid (not within measurement range) and needs dilution or the lamp needs replacing. |

| Display Icon | Description |
|---|---|
| **SIGNAL AVERAGE** | Indicates the signal averaging mode is on. The icon turns off if signal averaging is not selected. |
| **AUTO RNG** | Indicates instrument is in automatic range mode. The icon turns off when manual range mode is selected. |
| **8888** | The 4-digit display is active when the instrument is on (measurements are displayed to three digits). After the **READ** key is pressed **- - - -** is displayed during wait periods. |
| **NTU** | Identifies the measurement units- Nephelometric Turbidity Units. This icon is active during measurements and in the calibration mode. |

## 3.2 Using the Read Key

To preserve battery power and prolong lamp life, the lamp turns on only after the **READ** key is pressed. Pressing the key turns the instrument lamp on; after about 12 seconds, the lamp turns off, but the measurement value continues to be displayed. After the first measurement, a four-second recovery time occurs before another measurement can be started. If **READ** is pressed during the recovery time, the display will begin flashing, but the lamp will not turn on until the full four seconds have passed. If no other key strokes occur within 5.5 minutes, the instrument turns off.

### 3.2.1 Continuous Reading

The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.

The instrument will perform continuous readings if the **READ** key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds.

## 3.3 Using the Signal Averaging Key

The signal averaging mode compensates for reading fluctuations caused by drifting of sample particles through the light path. Signal averaging is turned on or off by pressing the **SIGNAL AVERAGE** key. The **SIG AVG** icon is displayed when signal averaging is on.

Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about

11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 22 seconds). After 22 seconds, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When signal averaging is off, the instrument takes three measurements, the microprocessor averages them, then displays the average. If the **READ** key is held during measurement, the initial value is displayed in 12 seconds and is updated every 1.2 seconds as long as the **READ** key is held.

When the instrument is turned on, the instrument defaults to the signal averaging mode which was used during the last measurement.

## 3.4 Using the Range Selection Key

As shipped, the instrument defaults to automatic range mode. The first time the **RANGE** key is pressed, the instrument goes into manual range mode. The second, third, and fourth key strokes put the instrument in the 0.00-9.99, 10 to 99.9 or 100-1000 NTU range, respectively. Another key stroke brings the selection back to automatic range mode. When the automatic range mode is selected, the **AUTO RNG** icon is displayed. Range selection can be done any time except when a measurement or calibration is in progress.

When the instrument is turned on, the instrument defaults to the range mode and measurement range which was used during the last measurement.

## 3.5 Restoring the Default Calibration

To restore and use the default calibration, turn the instrument off. Press and hold **DIAG**, then press and release **I/O**. Release **DIAG** when the software version number disappears from the display. (For models with serial number less than 920300000800, **2100** disappears). This clears any user-entered calibration from memory; the 2100P will use the default calibration for measurement. **CAL?** will appear and continue to flash until a user-entered calibration is successfully completed.

For best results, a user-entered calibration should be done every three months.

## 3.6 Calibration

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provide long-term stability and minimize the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. When calibration is necessary, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

**Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions.**

***Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.***

### 3.6.1 StablCal Stabilized Formazin Standards*

Most consistent results will be achieved with the use of StablCal Stabilized Formazin Standards for calibration. Refer to *Section 3.6.1.2* and *Section 3.6.1.3* for information on preparing the standards for use.

***Note:*** *Hach StablCal Stabilized Formazin in 20-, 100-, and 800-NTU values is packaged in convenient sets for calibration of the 2100P Turbidimeter. The set may be ordered in 500-mL size bottles by specifying Cat. No. 26594-00, in 100-mL size bottles by specifying Cat. No. 26594-10 or in sealed vials by ordering Cat. No. 26594-05. (See OPTIONAL ACCESSORIES AND REAGENTS on page 74.)*

#### 3.6.1.1 Storing and Handling StablCal Stabilized Standards

For optimum results when using StablCal Stabilized Standards, adhere to the following recommendations:

* StablCal Stabilized Formazin is cited as a primary standard in Hach Method 8195, an acceptable version of USEPA Method 180.1.

- Do not transfer the standard to another container for storage.
- Do not return standard from the sample cell back into the its original container. Standard contamination will result.
- Store standards between 0 and 25 °C.
- For long-term storage, refrigeration at 5 °c is recommended. Do not store above 25 °C.
- Allow the standard to acclimate to ambient instrument conditions before use (not to exceed 40 °C).
- Store away from direct sunlight. Store vials in their respective kit or shipping box with the cover in place.

#### 3.6.1.2 Preparing Bulk StablCal Stabilized Standards

Bulk standards that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

***Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.***

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the bottle of StablCal 5 to 7 times.
4. Prepare the sample cell for measurement using traditional preparation techniques. This usually consists of oiling the sample cell (see*Section 2.3.2* on page *23*) and marking the cell to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample cell.

* Used in place of the dilution water standard when performing a calibration.

5. Rinse the sample cell at least one time with the standard and discard the rinse.

6. Immediately fill the sample cell with the standard. Cap the sample cell and let it stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

#### 3.6.1.3 Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*

***Important Note: These instructions do not apply to <0.1-NTU* StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.***

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.

2. Allow the standard to stand undisturbed for 5 minutes.

3. Gently invert the vial of StablCal 5 to 7 times.

4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2* on page *23*) and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3* on page *24*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure, *Section 3.6.3*.

### 3.6.2 Formazin Primary Standards

Perform the procedure in *Section 3.6.2.1* to prepare a 4000-NTU standard. Alternately, order a 4000-NTU stock solution from Hach by specifying Cat. 2461-49. Prepare the dilutions from the 4000-NTU stock solution by following the instructions in *Section 3.6.2.4*.

#### 3.6.2.1 Preparing Formazin Stock Solution

Dilute formazin standard solutions from a 4000 NTU stock solution equivalent to Hach Cat. No. 2461-49. The prepared stock solution is stable for up to one year when properly prepared. An alternative to purchasing the 4000 NTU stock solution is preparing a stock solution as follows:

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \cdot H_2SO_4$) in 400 mL of distilled water.

2. Dissolve 50.000 grams of pure hexamethylenetetramine in 400 mL of distilled water.

3. Pour the two solutions into a 1000-mL volumetric flask and dilute to the mark with distilled water.

4. Let the solution stand for 48 hours at 25 °C (77 °F) to develop the 4000-NTU stock suspension. The standing temperature is critical for correct formation of formazin polymers.

5. Mix the 4000 NTU suspension for at least ten minutes before use. Then it can be diluted with distilled or demineralized water to achieve a solution of the desired NTU value.

Instead of diluting a formazin stock solution, StablCal Stabilized Formazin Standards may be used. Order the StablCal Calibration Set for the 2100P Turbidimeter, Cat.No. 26594-00 (500-mL bottles), Cat. No. 26594-10 (100 mL bottles), or Cat. No. 26594-05 (sealed vials). (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *74*.)

#### 3.6.2.2 Correcting for Turbidity of Dilution Water

The 2100P Turbidimeter automatically compensates for turbidity contributed by dilution water when calculating the true value of the lowest formazin standard. Use high quality distilled or deionized water less than 0.5 NTU. The instrument will display E 1 after calibration if

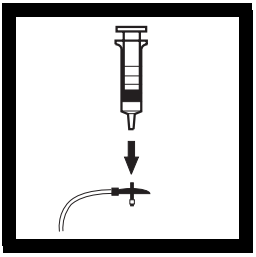
the dilution water turbidity is greater than 0.5 NTU. In this case, prepare the water as directed below.

The value of the dilution water can be arbitrarily forced to zero (see calibration procedure). This is not recommended for most applications and, if done, should be done only if the dilution water turbidity is less than 0.2 NTU.

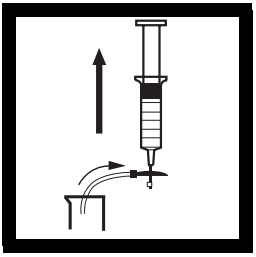
#### 3.6.2.3 Preparing Dilution Water

***Note:*** *Use the same dilution water for all dilutions and the sample blank.*

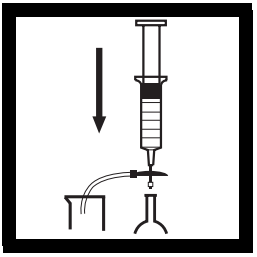
Collect at least 1000 mL of high quality dilution water (distilled or deionized water). The 2100P Turbidimeter, as received from the factory, is precalibrated and may be used to check the dilution water turbidity. If the turbidity is greater than 0.5 NTU, filter the water with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or equivalent. When measuring low range turbidity, clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water. If the glassware is not used immediately, use stoppers to prevent contamination from small particles.



**1.** Attach the syringe to the 3-way valve by gently twisting the square end into the syringe tip. Attach the connector, tubing and a 0.2 micron filter (clear part faces syringe) as shown. Be sure the connections are tight.



**2.** Fill a beaker or container with the water to be filtered. Insert the tubing into the container. Slowly draw the water into the syringe by pulling up on the syringe plunger.



**3.** Draw about 50 mL of sample into the syringe. Slowly push on the plunger to force the water through the filter and into a graduated cylinder or volumetric flask. Repeat Steps 2 and 3 until the desired amount of water is obtained.

***Note:*** *As the filter clogs, it gets more difficult to push water through it. At this point, discard the filter and attach a new filter. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

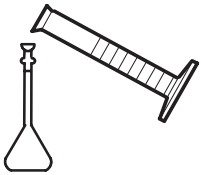
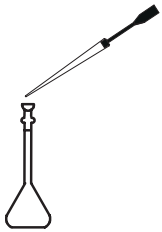
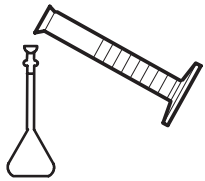
### 3.6.2.4 Preparing Formazin Dilutions (Factory recommended)

Hach Company recommends using 20, 100, and 800 NTU formazin standards for calibrating the 2100P Turbidimeter. Dilutions with other NTU values can be prepared and used (see *Section 3.6.3.1* on page *48*). If problems occur when using alternate solutions, use the dilutions specified here.

Prepare all formazin dilutions immediately before use and discard after calibration. The 4000 NTU solution is stable for up to a year, but dilutions deteriorate more rapidly. Use the same high quality water (turbidity <0.5 NTU) for the dilutions and the blank.

## Preparing the 20, 100 and 800 NTU standards

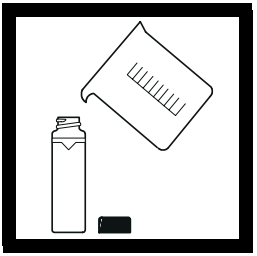
**Table 1 Formazin Standard Preparation**

| | Step 1 | Step 2 | Step 3 |
|---|---|---|---|
| **Standards** |  |  |  |
| 20 NTU | Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask. | With a TenSette* pipet, add 1.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask. | Dilute to the mark with dilution water. Stopper and mix. |
| 100 NTU | Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask. | With a TenSette pipet, add 5.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask. | Dilute to the mark with dilution water. Stopper and mix. |
| 800 NTU | Add 50 mL of dilution water to a clean **100-mL** class A volumetric flask. | With a TenSette pipet, add 20.00 mL of well-mixed 4000 NTU Formazin stock solution to the 100-mL flask. | Dilute to the mark with dilution water. Stopper and mix. |

* A class A volumetric pipet may be used in place of a TenSette Pipet.

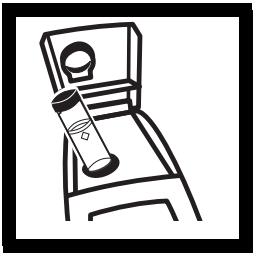
### 3.6.3 Calibrating the Turbidimeter

***Note:*** *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the cell so the orientation mark placed on the cell during the matching procedure is correctly aligned. (See Section 2.3.4 on page 26 for matching sample cells).*



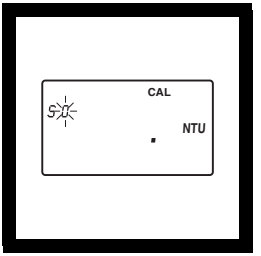
**1.** Rinse a clean sample cell with dilution water several times. Then fill the cell to the line (about 15 mL) with dilution water or use StablCal <0.1 NTU standard.

***Note:*** *The same dilution water used for preparing the standards must be used in this step.*



**2.** Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

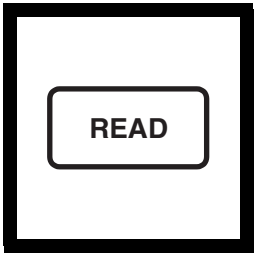
***Note:*** *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*




**3.** Press: **CAL**

The **CAL** and **S0** icons will be displayed (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank (as shown). Press → to get a numerical display.

**Hach Company only recommends the use of StablCal® Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions. DO NOT calibrate with Gelex® Secondary Standards.**

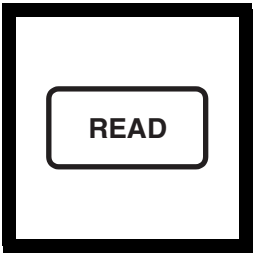



**4.** Press: **READ**

The instrument will count from 60 to 0, (67 to 0 if signal average is on), read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (See *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

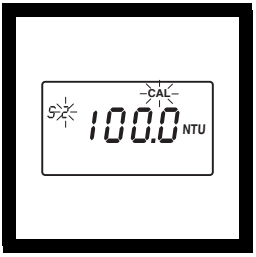
***Note:*** *The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show* **S0 NTU** *and the ↑ key must be pressed to continue with the next standard.*


**5.** The display will show the **S1** (with the 1 flashing) and **20 NTU** or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 20 NTU StablCal Standard or 20 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

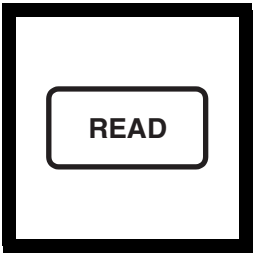



**6.** Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

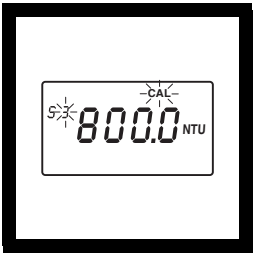



**7.** The display will show the **S2** (with the 2 flashing) and **100 NTU** or the value of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 100 NTU StablCal Standard or 100 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

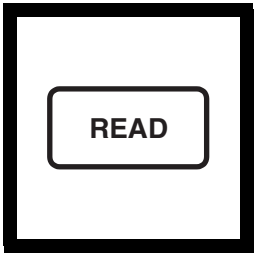



**8.** Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then, the display will automatically increment to the next standard. Remove the sample cell from the cell compartment.




**9.** The display will show the **S3** (with the 3 flashing) and **800 NTU** or the value of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 800 NTU StablCal Standard or 800 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.




**10.** Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.


**11.** Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

***Note:*** *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

**NOTES**

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

#### 3.6.3.1 Preparing User-selected Formazin Dilutions

The formazin solutions should span the entire range of the instrument. Hach recommends preparing three standards:

**1.** 10 to 30 NTU

**2.** 90 to 110 NTU

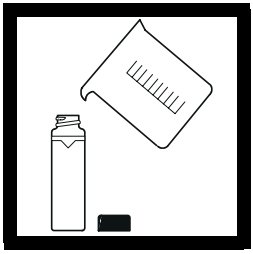
**3.** 700 to 900 NTU

**The standards must have a difference of at least 60 NTU.**
In addition, a blank made from the dilution water should be prepared.

Prepare the formazin standard solutions from the well mixed 4000 NTU stock solution as specified in *Section 3.6.2.4* on page *42* and dilution water as specified in *Section 3.6.2.2* and *Section 3.6.2.3* on page *41*. Make the standards **immediately** before use and discard them after calibration is done.

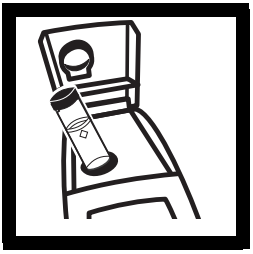
### 3.6.3.2 Calibrating with User-selected Standards

***Note:*** *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the sample cell with the same orientation.*



**1.** Fill a clean sample cell to the line (about 15 mL) with dilution water.

***Note:*** *The same dilution water used for preparing the standards must be used in this step.*

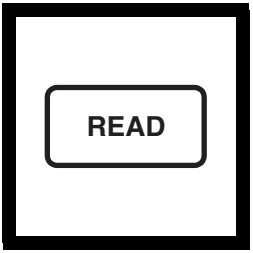


**2.** Insert the sample cell into the cell compartment and close the lid. Press **I/O**.

***Note:*** *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*

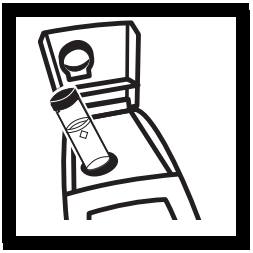

**3.** Press: **CAL**.

The **CAL** and **S0** icons will appear (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.

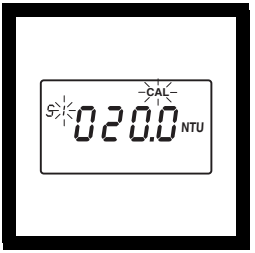



**4.** Press: **READ**.

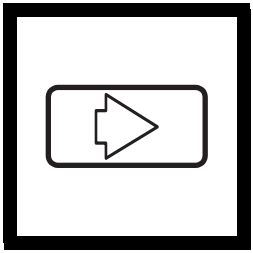
The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the blank and use it to calculate a correction factor for the lowest standard. If the dilution water is ≥0.5 NTU, **E 1** will appear (see *Section 3.6.2.3* on page *41* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



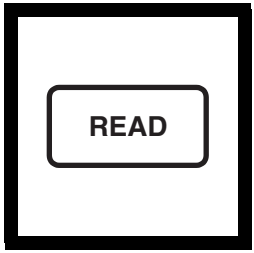
**5.** Thoroughly mix the 10 to 30 NTU range standard, then fill a clean sample cell to the line with the standard. Insert the sample cell into the cell compartment



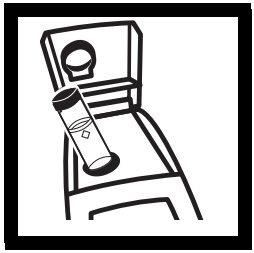

**6.** The display will show the **S1** icon (with the **1** flashing) and **20 NTU** or the value of the S1 standard for the previous calibration.



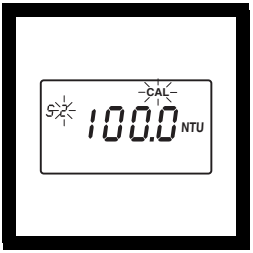
**7.** Edit the standard concentration by pressing →. The **1** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



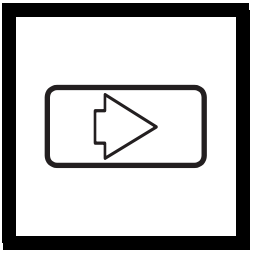

**8.** When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



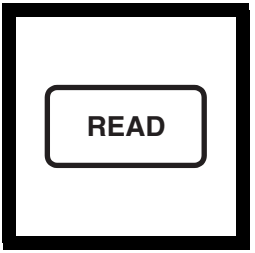
**9.** Thoroughly mix the 90 to 110 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



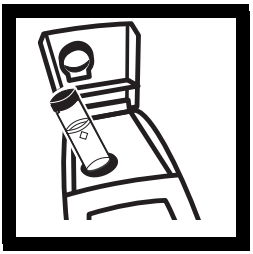

**10.** The display will show the **S2** icon (with the **2** flashing) and **100 NTU** or the value of the S2 standard for the previous calibration.



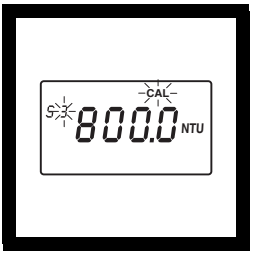
**11.** Edit the standard concentration by pressing →. The **2** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



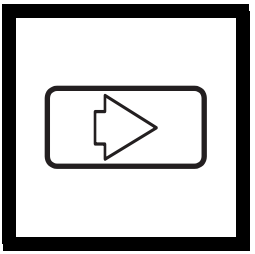

**12.** When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Remove the sample cell from the cell compartment.



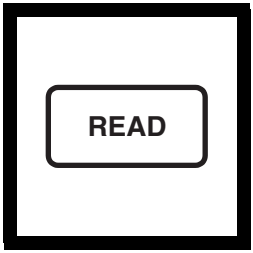
**13.** Thoroughly mix the 700 to 900 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.




**14.** The display will show the **S3** icon (with the **3** flashing) and **800 NTU** or the value of the S3 standard for the previous



**15.** Edit the standard concentration by pressing →. The **3** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.




**16.** When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The instrument will increment back to **S0**. Remove the sample cell from the cell compartment.


**17.** Press: **CAL**.

The instrument will store the new calibration data and return the instrument to the measurement mode. It will use the new calibration to calculate turbidity for subsequent measurements.

***Note:*** *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

**NOTES**

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. If the error messages recur, calibrate using the factory specified standards, *Section 3.6.2.4* on page *42* and *Section 3.6.3* on page *44*. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then only ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** isn't flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

### 3.6.4 Using Gelex® Secondary Turbidity Standards

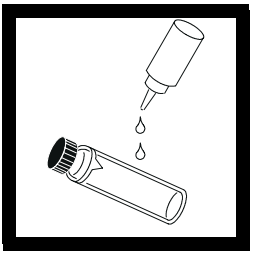
***Note:*** *Store Gelex standards at room temperature. Do not allow to freeze or exceed 50 °C.*

The instrument comes with Gelex Secondary Standards which are particulate suspensions similar to formazin primary standards in light scattering characteristics. NTU values on the Gelex standards indicate the range for which they should be used. Due to minor variations in glass and individual instrument optical systems, the true value of the Gelex standards must be determined against formazin in the same instrument they will be used with for later calibration checks.

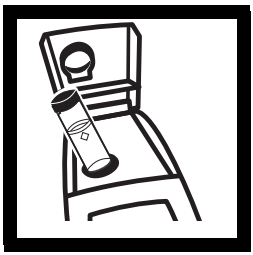
### 3.6.4.1 Assigning Values to Gelex Standards


**1.** Calibrate the instrument with formazin.


**2.** Select automatic range mode using the **RANGE** key.

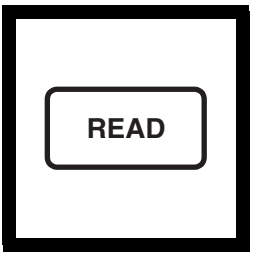


**3.** Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicone oil.



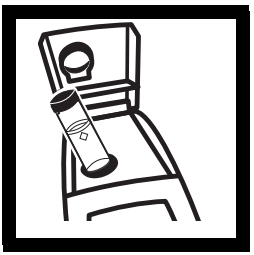
**4.** Place the 0-10 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument. Close the sample lid.

***Note:*** *Correct cell orientation is essential to obtain accurate Gelex values. Always orient the cell so the diamond mark aligns with the orientation mark on the instrument.*

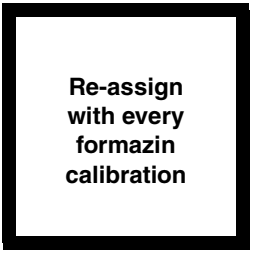



**5.** Press: **READ**.

Record the displayed value, remove the vial from the instrument and mark the value on the band near the top of the vial.



**6.** Repeat *step 3* through *step 5* for the other Gelex standards, being careful to orient the cells properly.




**7.** Re-assign values to the Gelex standards each time the instrument is calibrated with formazin.

### 3.6.4.2 Routine Calibration Check With Gelex Standards

The 2100P Turbidimeter does not require standardization before every measurement as some turbidimeters do. Periodically, as experience dictates, check the instrument calibration using the appropriate Gelex Secondary Standard. Be sure the Gelex standards are aligned correctly when inserting them (diamond aligns with orientation mark). If the reading is not within 5% of the previously established value, recalibrate the instrument with StablCal Stabilized Formazin Primary Standard or formazin primary standard (*Section 3.6.3* on page *44*).

***Important Note: DO NOT calibrate with Gelex® Secondary Standards. Gelex standards are designed for instrument verification, not calibration.***

# MAINTENANCE

**Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the maintenance tasks described in this portion of the manual.**

**Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détoriation de l'appareil. Les tâches d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.**

**Algunos de los capítulos del manual que presentamos contienen muy importante información en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.**

**Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vyyyermeiden. In diesem Abschnitt beschriebene Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.**

**Algumas das seguintes secções do manual contêm informações em forma de advertências, precauções e notas que requerem especial atenção. Leia e siga atentamente as presentes instruções para evitar ferimentos pessoais e não danificar o instrumento. As tarefas de manutenção descritas nesta parte do manual só poderão ser executadas por pessoal qualificado.**

# SECTION 4 MAINTENANCE

## 4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1* on page *23* for more information about sample cell care.

## 4.2 Battery Replacement

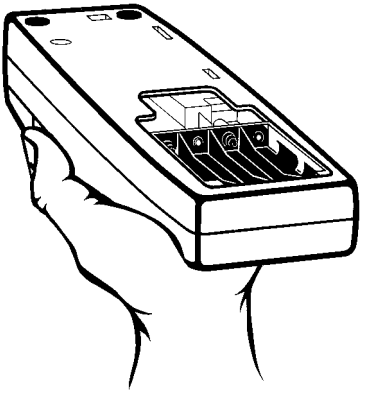
AA alkaline cells typically last for about 300 tests with the signal averaging mode off, about 180 tests if signal averaging is used. The “battery” icon flashes when battery replacement is needed. Refer to *Section 1.4.2* on page *15* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings.

If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

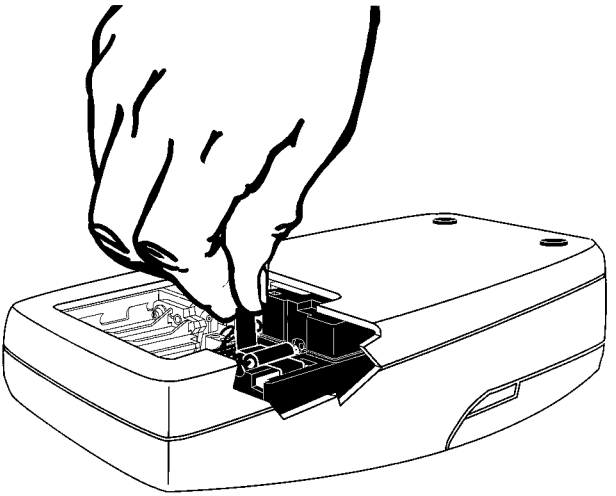
## 4.3 Lamp Replacement

The procedure below explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

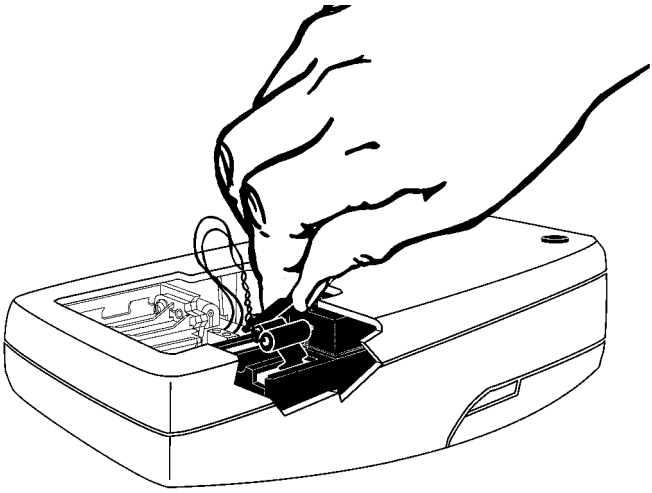
**1.** Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.



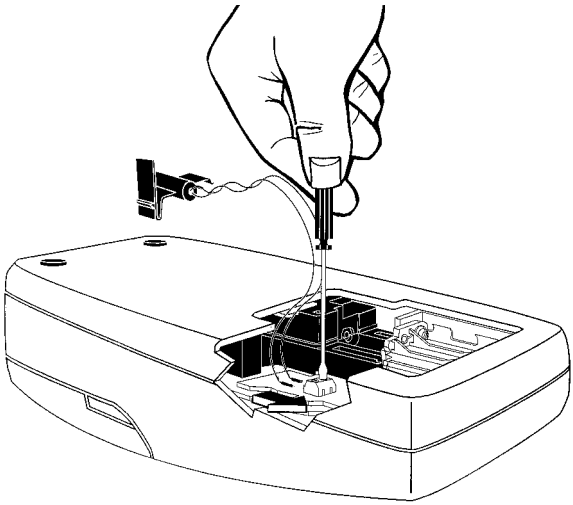
**2.** Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.



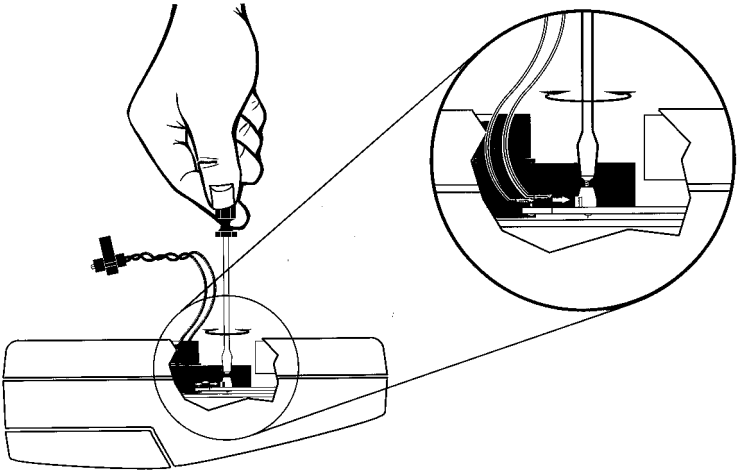
**3.** Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.



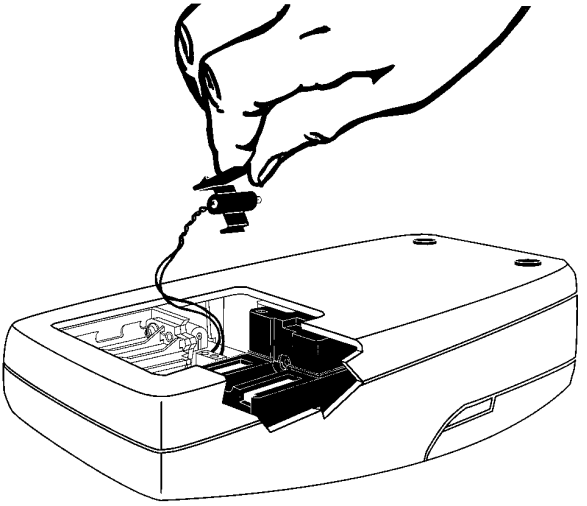
**4.** Back the terminal block screws **partially** out (1 to 2 turns) and remove the old lamp leads.



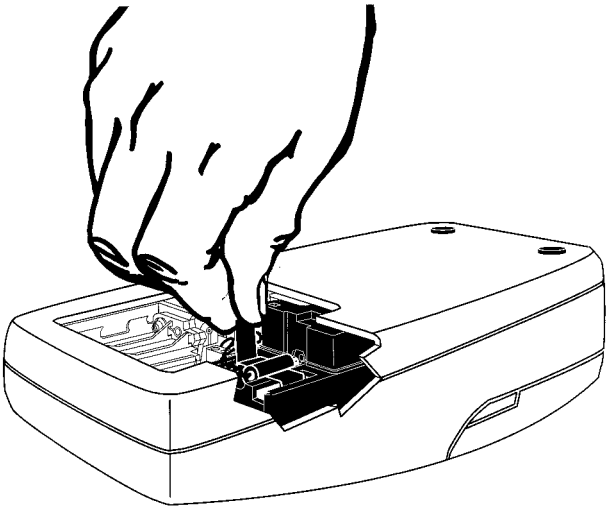
**5.** Gently bend the wires of the new lamp assembly into an “L” shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug on the wires to make sure they are connected to the terminal block.



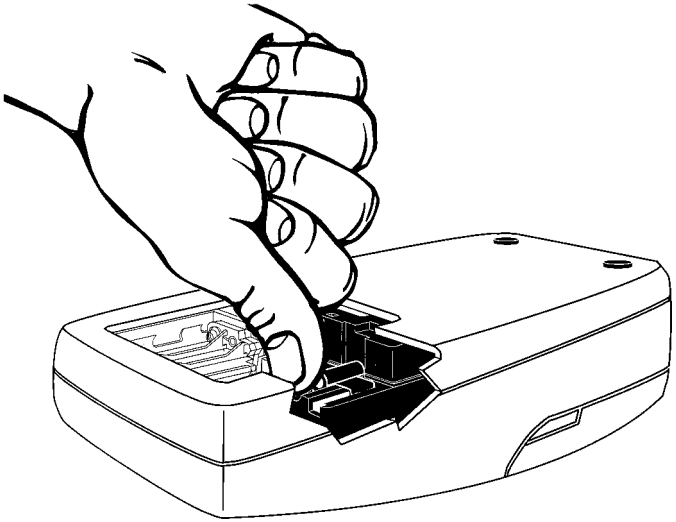
**6.** Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).



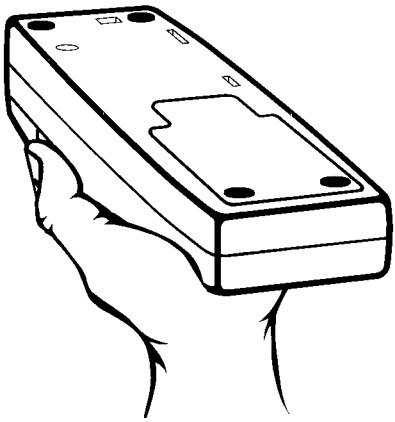
**7.** Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.



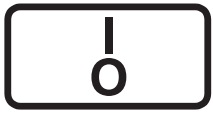
**8.** With your thumb, firmly slide the assembly forward until it stops. Again, push firmly against the tab to make sure the lamp is seated correctly.



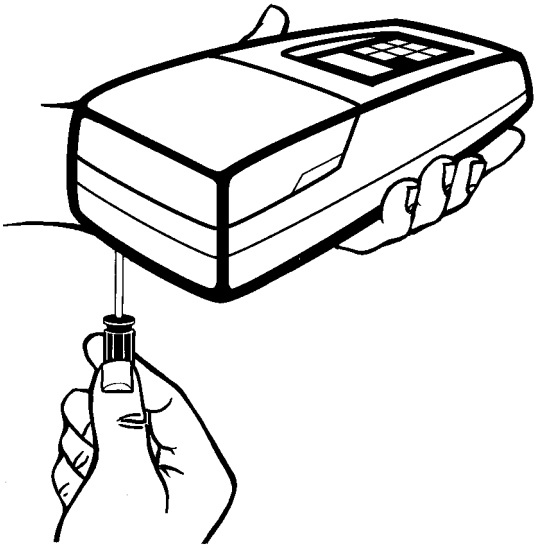
**9.** Replace the battery(s) and battery cover.



**10.** Insert the 800 NTU formazin standard into the sample cell. Press and hold **READ**. Then press **I/O**. Release the **READ** key after the software version number disappears from the display (for models with serial numbers less than 920300000800, **2100** disappears).

**11.** Adjust the scattered light amplifier output by inserting a small flat-bladed screwdriver into the trimpot hole (located on bottom). Adjust the display to read 2.5 ± 0.3 volts (2.0 volts for models that display **2100** when turned on).



**12.** Press **I/O** to exit gain adjust mode.

**13.** Perform a formazin calibration according to *Section 3.6.3* on page *44* or *Section 3.6.3.1* on page *48*.

# SECTION 5 TROUBLESHOOTING

## 5.1 Using the Diagnostic Functions Key

Enter the diagnostic mode by pressing the **DIAG** key. Exit this mode at any time by pressing the key again. The diagnostic mode allows access to information about instrument function which may be useful for servicing and troubleshooting.

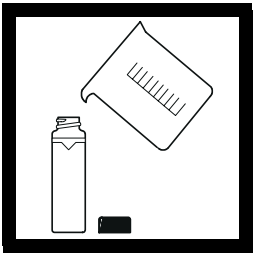
### 5.1.1 Basic Diagnostic Codes

The diagnostic codes are:

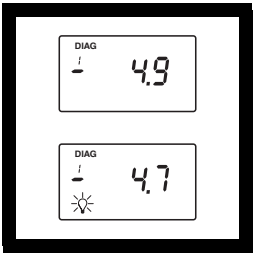
| Code | Description |
|---|---|
| 1 | Checks the battery voltage with the lamp on, then with the lamp off. This is a dual diagnostic code. |
| 2 | Displays calibration coefficient $a_o$ |
| 3 | Displays calibration coefficient $a_1$ |
| 4 | Displays calibration coefficient $b_o$ |
| 5 | Displays calibration coefficient $b_1$ |
| 6 | Displays the lamp voltage (about 3 volts) |
| 7 | Displays the dark voltage of the transmitted light detector amplifier with the lamp off and the detector amplifier voltage with the lamp on. |
| 8 | Displays the high gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.* |
| 9 | Displays the low gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on. |

* Samples with turbidity >10 NTU may display **- - -** for the lamp-on amplifier voltage.

## 5.2 The Diagnostic Procedure

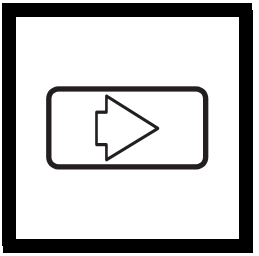


**1.** Fill a clean sample cell to the line with clear water, cap the cell and place it in the cell compartment. Press the **READ** key and wait until the reading is finished.

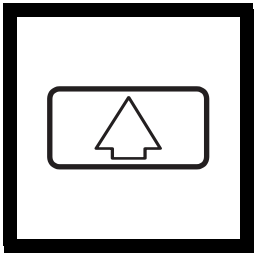



**2.** Press: **DIAG**

The **DIAG** icon will turn on and **1** will be displayed below the icon. The instrument will measure the battery voltage with the lamp off and display the result in volts (V). Then the lamp icon will turn on and the instrument will measure the voltage with the lamp on. The value is briefly displayed before defaulting to the lamp-off reading. To repeat the measurement, press **READ**.



**3.** To continuously display the lamp-on voltage, press →. The lamp icon will flash. Press → to turn the lamp icon off (the lamp is not on during this display).



**4.** Press the ↑ key to scroll through the other diagnostics. Each press of the key increments the digit in the small numerical display below the **DIAG** icon and the result of the diagnostic measurement is then displayed. Each press of the **READ** key updates the value. For measurements made with the lamp off and again with the lamp on, the measurement with the lamp off is displayed when the diagnostic is entered. To see the second measurement with the lamp on, press the → key (only works with diagnostic codes 1, 7, 8, & 9). The lamp icon will flash and the lamp-on measurement will be displayed in volts. Press → to turn the lamp icon off.

***Note:*** *DIAG 8 will display* ***----*** *for the lamp-on voltage if a of >10 NTU is placed in the cell compartment.*

## 5.3 Other Instrument Diagnostics

### 5.3.1 Display Test

Pressing and holding the **I/O** key turns on all the display icons and elements so you can determine if all the elements and icons are functioning. The display test sequence will cycle as long as the key is held down.

## 5.4 Error Messages

Error messages indicate sample interferences and/or instrument malfunction.

### 5.4.1 Flashing Numeric Display

If the highest value in the range selected is flashing in the display, the sample is too turbid (or overrange) for the selected range. In automatic or manual range, **1000** flashes if the sample is over the instrument's range. In manual range mode, select the next higher range mode if **9.99** or **99.9** flashes. See *Section 2.3.6* on page *31* for measuring overrange samples. The display will stop flashing if a sample within range is inserted and read.

### 5.4.2 E Messages

An error message indicates either an instrument failure or an operation cannot be performed. **An error message can be cleared by pressing DIAG** (display will return to previous measurement or calibration value). The meter continues to operate as best it can. If the message occurs during a calibration, calibration can continue. If the error message occurs when a calibration is being calculated, the instrument will discard the new calibration and retain the old calibration. Error messages and corrective actions are listed below.

### 5.4.3 CAL?

A flashing **CAL?** appears when the instrument is using the default calibration programmed at the factory. It will appear if the analyst has erased the user-entered calibration using the procedure to restore the default calibration or after and E 4 error is cleared by pressing DIAG. Recalibrate as soon as possible when **CAL?** appears. **CAL?** (not flashing) appears when a calibration has questionable validity.

| Message* | Probable Cause | Corrective Action |
|---|---|---|
| E1 | Dilution water is ≥ 0.5 NTU. | Start calibration over with better quality dilution water or use a membrane filter to filter the water before use. |
| E2 | Two standards have the same value or their difference is less than 60 NTU.<br>Not all standards were read during the calibration.<br>Standard 1 is too low (<10 NTU). | Recheck preparation of standards and repeat calibration. |
| E3 | Low light error. | Re-read measurement.<br>Check lamp**<br>Check for obstructed light path.<br>Dilution may be necessary. |
| E4 | EEPROM malfunction. | Check sum failed. Press **I/O**. If E 4 reappears, call Hach service. If **CAL?** appears, recalibrate. |
| E5 | A/D overrange. | Check for obstructed light path.<br>Call Hach Service. |
| E6 | A/D underrange. | Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service. |
| E7 | Light Leak. | Close lid before pressing **READ** key. |
| E8 | Bad lamp circuit. | Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service. |

* Error messages 4, 5, and 6 may indicate a failure in the internal electronics.
** Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing READ. Light should be visible on the inserted object.

# GENERAL INFORMATION

**At Hach Company, customer service is an important part of every product we make.**

**With that in mind, we have compiled the following information for your convenience.**

# Replacement Parts & Accessories

## REPLACEMENT PARTS

| Description | Cat. No. |
|---|---|
| StablCal Calibration Set for 2100P, Sealed Vials: <0.1 NTU, 20 NTU, 100 NTU, and 800 NTU | 26594-05 |
| AA Batteries, 4/pkg | 19380-04 |
| Battery Door | 46005-00 |
| Carrying Case | 46506-00 |
| Gelex® Standards, set (includes standards and 3 sample cells) | 24641-05 |
| Instrument Manual | 46500-88 |
| Lamp Assembly, with leads | 46539-00 |
| Mounting Feet, 4/pkg | 41093-00 |
| Oiling Cloth | 47076-00 |
| Sample Cells, 1 inch, with cap, 6/pkg | 24347-06 |
| Silicone Oil, 15 mL | 1269-36 |

## OPTIONAL ACCESSORIES AND REAGENTS

| | |
|---|---|
| Deionized Water, 3.78 L | 272-17 |
| Bath, Ultrasonic, 2.8 L (0.75-gal), w/heater | 24895-00 |
| Battery Charger, 120 V | 46479-00 |
| Battery Charger, 230 V | 46479-01 |
| Battery Eliminator, 120 V | 46079-00 |
| Battery Eliminator, 230 V | 46080-00 |
| Filter, 0.2 micron, 10/pkg | 23238-10 |
| Formazin, 4000 NTU, 500 mL | 2461-49 |
| Formazin, 4000 NTU,100 mL | 2461-42 |
| Hexamethylenetetramine, 100 g | 1878-26 |
| Hexamethylenetetramine, 500 g | 1878-34 |
| Hydrazine Sulfate, 20 g | 742-46 |
| Hydrazine Sulfate, 100 g | 742-26 |
| NiCad Rechargeable Battery (4 required) | 16077-00 |
| Pipet, serologic, 1.00 mL | 532-35 |

### OPTIONAL ACCESSORIES AND REAGENTS, continued

| Description | Cat. No. |
|---|---|
| Pipet, TenSette®*, 1-10 mL | 19700-10 |
| Pipet Tips, for 1-10 mL TenSette Pipet, 50/pkg | 21997-96 |
| Pipet Tips, for 1-10 mL TenSette Pipet, 1000/pkg | 21997-28 |
| Pipet, Volumetric, Class A, 1.00 mL | 14515-35 |
| Pipet, Volumetric, Class A, 5.00 mL | 14515-37 |
| Pump, Vacuum, Hand-Operated | 14283-00 |
| Pump, Vacuum, 115 V, 60 Hz | 14697-00 |
| Pump, Vacuum, 230 V, 50 Hz | 14697-02 |
| Sample Degassing Kit | 43975-00 |
| Sample Filtration and Degassing Kit | 43975-10 |
| StablCal® Calibration Set for 2100P Turbidimeter | |
| <0.1, 20, 100, 800 NTU, 500 mL each | 26594-00 |
| <0.1, 20, 100, 800 NTU, 100 mL each | 26594-10 |
| <0.1 NTU** StablCal®*** Stabilized | |
| Formazin Standard,100 mL | 26597-42 |
| 20 NTU StablCal® Stabilized Formazin Standard, 100 mL | 26601-42 |
| 100 NTU StablCal® Stabilized Formazin Standard, 100 mL | 26602-42 |
| 800 NTU StablCal® Stabilized Formazin Standard, 100 mL | 26605-42 |
| Triton-X Solution, 118 mL (4 oz) | 14096-32 |
| Volumetric Flask, 100 mL | 14574-42 |
| Volumetric Flask, 200 mL | 14574-45 |

* TenSette™ is a Hach Company trademark.

** <0.1 NTU StablCal® Standard is used in place of dilution water standard when performing a calibration.

*** StablCal® is a registered trademark of Hach Company.

# HOW TO ORDER

**By Telephone:**

6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
**By FAX:** (970) 669-2932

**By Mail:**

Hach Company
P.O. Box 389
Loveland, CO 80539-0389
U.S.A.

**Ordering information by E-mail:** orders@hach.com

## Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

## Technical and Customer Service (U.S.A. only)

Hach Technical and Customer Service Department personnel are eager to answer questions about our products and their use. Specialists in analytical methods, they are happy to put their talents to work for you. Call **1-800-227-4224** or E-mail **techhelp@hach.com**.

## International Customers

Hach maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to **intl@hach. com** or contact:

**In Canada, Latin America, Africa, Asia, Pacific Rim:**
Telephone: (970) 669-3050; FAX: (970) 669-2932

**In Europe, the Middle East, or Mediterranean Africa:**
**HACH** Company, c/o
Dr. Bruno Lange GmbH
Willstätterstr. 11
D-40549 Düsseldorf
Germany
Telephone: +49/[0]211.52.88.0
Fax: +49/[0]211.52.88.231

# REPAIR SERVICE

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the HACH Service Center serving your location.

**In the United States:**
Hach Company
100 Dayton Avenue
Ames, Iowa 50010
(800) 227-4224 (U.S.A. only)
Telephone: (515) 232-2533
FAX: (515) 232-1276

**In Canada:**
Hach Sales & Service Canada Ltd.
1313 Border Street, Unit 34
Winnipeg, Manitoba
R3H 0X4
(800) 665-7635 (Canada only)
Telephone: (204) 632-5598
FAX: (204) 694-5134
E-mail: canada@hach.com

**In Latin America, the Caribbean, the Far East, the Indian Subcontinent, Africa, Europe, or the Middle East:**
Hach Company World Headquarters
P.O. Box 389
Loveland, Colorado, 80539-0389
U.S.A.
Telephone: (970) 669-3050
FAX: (970) 669-2932
E-mail: intl@hach.com

# WARRANTY

Hach warrants most products against defective materials or workmanship for at least one year from the date of shipment; longer warranties may apply to some items.

**HACH WARRANTS TO THE ORIGINAL BUYER THAT HACH PRODUCTS WILL CONFORM TO ANY EXPRESS WRITTEN WARRANTY GIVEN BY HACH TO THE BUYER. EXCEPT AS EXPRESSLY SET FORTH IN THE PRECEDING SENTENCE, HACH MAKES NO WARRANTY OF ANY KIND WHATSOEVER WITH RESPECT TO ANY PRODUCTS. HACH EXPRESSLY DISCLAIMS ANY WARRANTIES IMPLIED BY LAW, INCLUDING BUT NOT BINDING TO ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

**LIMITATION OF REMEDIES:** Hach shall, at its option, replace or repair nonconforming products or refund all amounts paid by the buyer. **THIS IS THE EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.**

**LIMITATION OF DAMAGES: IN NO EVENT SHALL HACH BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND FOR BREACH OF ANY WARRANTY, NEGLIGENCE, ON THE BASIS OF STRICT LIABILITY, OR OTHERWISE.**

This warranty applies only to Hach products purchased and delivered in the United States.

Catalog descriptions, pictures and specification, although accurate to the best of our knowledge, are not a guarantee or warranty.

For a complete description of Hach Company's warranty policy, request a copy of our Terms and Conditions of Sale for U.S. Sales from our Customer Service Department.

# Appendix C. Fish and Invertebrate Tissue Sampling Procedures

## C.1 Sampling Procedures

Processing of fish and invertebrates for tissue/stomach samples, subsequent handling, chain of custody, and transport to the analytical laboratory will follow procedures outlined in the QAPP (NDM, 2005b) and as described in this FSP.

### C.1.1 Tissue Sampling

At the sampling sites, one or more key fish species will be selected for each monitoring site and sampled for tissue metals analysis. In most cases, juvenile salmonid species will be selected as key species based on abundance and catchability. A total of 10 discrete whole body samples will be collected for individual analysis at each site to provide an adequate measure of variability. Individual fish will be a minimum of 75 mm in length to provide adequate tissue mass to complete the required analyses. Each fish will be placed into an individual plastic ZipLoc bag and immediately placed on ice within a clean cooler with ice packs. Samples will then be frozen as soon as possible in the shipboard freezer.

Collection personnel will use powder-free surgical gloves to handle fish samples. Handling of fish will be minimized to the extent possible. Fish will be measured inside the collection bag. A field blank will be prepared for each collection day by rinsing an empty sample bag with DI water in the field and collecting the rinsate in an acid preserved sample jar.

For large fish (i.e., >155 mm or 6 inches TL), liver and muscle tissues will be dissected; all dissections will take place in a clean indoor location on an uncontaminated surface such as aluminum foil. Tissue samples will be placed in individually labeled ZipLoc plastic bags and frozen as soon as possible. Procedures for sample labeling, washing tools, work surfaces and preparing QC equipment blanks will follow the QAPP (NDM, 2005b). Specific steps to be taken in processing the dissected samples are as follows:

- Immediately upon capture, the animal will be rinsed in clean potable fresh water to remove any extraneous debris and then placed in a clean plastic bag. The bag will be sealed and then placed on gel packs in a freshly washed cooler.

- Dissection will take place as soon as possible on the same day as captured, at an indoor location onboard ship. Be sure that the area is out of the wind and that no other forms of contamination are in the area e.g., ship engine exhaust; dust; grease from ship winches cables, or gear; water runoff from boat roof or ledges due to rain or other boat operations; spilled fuel, etc.

- The cutting surface will be washed with soap and water, rinsed with potable fresh water followed by deionized (DI) water, and covered with heavy-duty aluminum foil. The aluminum foil-cutting surface will be replaced between each dissection. (Note: the DI

water used during this procedure will always be the water provided by the analytical laboratory for this purpose; distilled water, such as the type purchased from grocery stores, will NOT be used as a rinse in fish dissection procedures.)

- Stainless steel disposable scalpels and/or high quality stainless steel knives will be used for dissection. The blades/knives will have no visible rust spots on them.
- Scalpel blades will be replaced between dissections and knives will be washed with soap and water and rinsed with DI water between uses. Cleaned knives will be stored in a clean, sealed Zip Loc bag until their next use and will never be placed on any surface except inside the clean Zip Loc bag.
- Personnel handling or dissecting fish will wear powder free surgical gloves and the gloves will be changed between each dissection.

### C.1.2 Tissue Sample Handling and QA

- A sample of liver and muscle tissue (with no skin attached) will be extracted from each fish and placed in an individually labeled Ziploc bag. Label will include sample ID and suffix of "M" for muscle and "L" for liver tissue; the matrix code will be "TF." Where possible, a minimum of 50 grams of tissue (wet weight) will be included with each sample.
- Labeled tissue samples will immediately be placed in the shipboard freezer.
- An equipment blank will be prepared before each set of dissections by rinsing the foil cutting surface and the knife with DI water and collecting the rinsate in an acid-preserved sample jar. DI water for use in blanks will be provided by the analytical laboratory to assure the purity needed for low-level mercury analyses.
- Frozen tissue samples will be packaged in a clean cooler with ice packs as specified in the QAPP (NDM, 2005b) and as summarized in this FSP and will be sent to Shaw in Iliamna or in Anchorage using the specified handling/packaging/shipping recommendations. A fully completed and signed Sample Transfer Form (Appendix Figure A-4) will accompany EACH cooler so that Shaw personnel can complete the electronic Chain-of-Custodies (COCs) for all samples.
- A field blank will be prepared for each sample day at the field collection site by rinsing an empty plastic fish bag with DI water and collecting the rinsate in an acid preserved sample jar.
- COC procedures will be followed by filling out the Sample Transfer Form (Appendix Figure A-4) and keeping the completed form with the samples at all times. In addition, for each tissue sample collected, an entry will be made on the Specimen Log Form (Appendix Figure A-3) so that the necessary information is collected/recorded to meet the ADF&G Fish Collection Permit reporting requirements (see Appendix D).
- Any fish (or invertebrate) found to be lacerated/damaged by sampling gear (e.g., skin gashed, carapace/shell crushed) will be discarded and not used for contaminant analyses. The sacrificed animal will be recorded in the Specimen Log Form (Appendix

Figure A-3), noting that it was collected and sacrificed under the ADF&G Fish Collection Permit (Appendix D), and under Other Comments that it was not used for chemical analyses due to damage.

- To ensure that sufficient tissue is collected when animals are small in size, during the first day of sampling, extra animals will be collected and weighed to assist in estimating how many are needed to comprise a 50g sample (wet weight) of soft tissue. In the case of animals with hard exterior shells (e.g., mussels), the shells will be removed and the soft tissue weighed on a portable digital scale; this material will then subsequently be discarded. The sacrificed animals used in this QA procedure will be recorded in the Specimen Log Form (Appendix Figure A-3), noting that they were sacrificed under the ADF&G Fish Collection Permit (Appendix D) for this QA purpose. This practice will ensure that the minimum weight requirements are met for subsequent tissue samples.

### C.1.3 Sampling Equipment Decontamination

Where stainless steel disposable scalpels are used for dissection, a fresh scalpel blade will be used for each fish. All knives will be washed with soap (Alconox) and water and rinsed with DI water between uses. All cutting surfaces will be washed with soap and water, rinsed with clean potable fresh water and DI water, and covered with heavy-duty aluminum foil. Be sure that the DI water used is the purer grade provided by the laboratory and not general purpose distilled water (the type purchased in grocery stores).

### C.1.4 Stomach Sampling

Stomach dissection and sampling methods are modified from Nielson and Johnson (1983). For large fish (i.e., >155 mm or 6 inches TL), the fish stomach will be extracted and preserved in the field. For small fish (<155 mm or 6 inches TL), the fish stomach will remain in the fish, using the methods detailed in Section C.1.4.2.

#### *C.1.4.1 Removal of the Fish Stomachs*

Before dissection, kill the fish by severing the spinal column or applying a sharp blow to the head. Open the coelom to expose the viscera (do for all fish collected). Fish stomachs will be removed from large fish (i.e., >155 mm or 6 inches TL). For small fish, the coelom will be opened, but the stomach will be retained in the fish to avoid inadvertent loss of stomach contents.

- For large fish, to remove the stomach, use blunt scissors, sever the esophagus, the last few millimeters of the intestine, and the mesentery at its dorsal point of attachment. This allows the visceral mass to he lifted out of the coelom and into a plastic Ziploc bag for subsequent preservation.

#### *C.1.4.2 Fixing and Preserving Stomach Contents*

- Ten-percent formalin is fully adequate as a fixative. Wear plastic gloves and work in a well-ventilated area to minimize exposure to formaldehyde. Formaldehyde is suspected of being a carcinogen and can cause permanent damage to fingernail growth areas and sinus tissues so minimize your exposure as much as possible. See the Marine Studies Health and Safety Plan (BEESC, 2005) for additional information on the handling of formaldehyde and other chemicals during this field program.
- Add sufficient quantity of fixative to the Ziploc bag to fully bathe the stomach

contents. Be sure to make a small incision in the stomach to allow for the preservative to enter the stomach and bathe the contents as well. Because the fixative rapidly hardens prey tissues, partly digested prey are more likely to stay intact and, thus, are easier for the taxonomic laboratory to identify.

- Prior to sealing the Ziploc bag, remove as much air from the bag as possible so that all areas of the bag are bathed in fixative. Place an internal label (e.g., plastic tag or DuraRite paper showing sample identification information). Then seal the bag and place it into a second Ziploc bag with the exterior of the second bag clearly labeled in waterproof ink (i.e., Sharpie pen).

The availability of field time and facilities usually determines when gut contents are removed and fixed. It is best to remove and fix gut samples immediately after capture. This minimizes post-capture digestion and avoids difficulties associated with dissection of hardened fish tissues. When tens or hundreds of fish are captured at one time, however, it is necessary to fix the gut contents *in situ* with the least investment of time possible. If done in warm air temperatures, hold fish on ice if more than a few minutes will elapse before fixation. In order to halt post-capture digestion, slit the coelom or inject formaldehyde directly into the coelom. For larger fish, it is usually more efficient to fix only the digestive tract.

Concomitant fish data (length, weight, sex, etc.) should be recorded on the Fish Catch Record Form (Appendix Figure A-5) as well as the Specimen Log Form (Appendix Figure A-3), **with information filled out as completely as possible when applicable.**

When the samples reach the taxonomic laboratory, they will be examined in detail. Laboratory personnel will remove excess formaldehyde by soaking the samples in several changes of water. After excess formaldehyde is removed, the samples will be preserved in a 45 to 70% aqueous solution of alcohol (methanol, ethanol, and isopropanol are all satisfactory).

# APPENDIX D
# ALASKA DEPARTMENT OF FISH AND GAME
# FISH RESOURCE PERMIT

# STATE OF ALASKA
# DEPARTMENT OF FISH AND GAME

P.O. Box 25526
JUNEAU, ALASKA 99802-5526

**Permit No. CF-05-055**

**Expires 12/31/2005**

## FISH RESOURCE PERMIT
(For Scientific/Educational Purposes)

This permit authorizes **Mark Madden** (*whose signature is required on page 2 for permit validation*)
person
of **Bristol Environmental and Engineering Services Corporation at**
agency or organization
**2000 W. International Airport Rd, #C-1, Anchorage, AK 99502-1117**
address
to conduct the following activities from **April 1, 2005** to **December 31, 2005** in accordance with AS 16.05.930 and AS 16.05.340(b).

**Purpose:** To conduct site-specific biological sampling at the Pebble Project's proposed port facility location and surrounding marine habitat in and adjacent to the proposed shipping channel. These collections will assist in assessing future project impacts and will add to the pre-existing biological data available for the project area.

**Location:** Cook Inlet – Iniskin Bay, Cottonwood Bay, and Iliamna Bay.

**Species Collected:** 50 basket cockles, 50 soft shell clams, 50 horse mussels, 50 horsehair crabs, 50 fusitriton snails, 50 lyre crabs, 100 macoma clams, 50 blue mussels, 50 neptune snails, 50 surf clams – all samples to be sacrificed for contaminant analysis. 325 salmonids (25 adult & 300 juvenile), 50 sculpins, 50 greenlings, 300 Pacific sand lances, 50 gunnels, 25 rockfish, 25 flounder, 100 Pacific herring – up to 40% of the fish collected will be sacrificed for containment analysis, the remaining will be measured and released.

**Method of Capture:** SCUBA dive, van Veen grab, beach seine, shrimp/crab pot, hook and line, shovel, hand collection, "try-net" otter trawl (see **Contingencies** section).

REPORT DUE **January 31, 2006**. The report shall include species, numbers, dates, and locations of collection and disposition, and if applicable, sex, age, and breeding condition, and lengths and weights of fish. The report shall also include other information as may be required under the contingencies section.

**GENERAL CONDITIONS, EXCEPTIONS AND RESTRICTIONS**

1. This permit must be carried by person(s) specified during approved activities who shall show it on request to persons authorized to enforce Alaska's fish and game laws. This permit is nontransferable and will be revoked or renewal denied by the Commissioner of Fish and Game if the permittee violates any of its conditions, exceptions or restrictions. No redelegation of authority may be allowed under this permit unless specifically noted.
2. No specimens taken under authority hereof may be sold or bartered. All specimens must be deposited in a public museum or a public scientific or educational institution unless otherwise stated herein. Subpermittees shall not retain possession of live animals or other specimens.
3. The permittee shall keep records of all activities conducted under authority of this permit, available for inspection at all reasonable hours upon request of any authorized state enforcement officer.
4. Permits will not be renewed until detailed reports, as specified above, have been received by the department.
5. UNLESS SPECIFICALLY STATED HEREIN, THIS PERMIT DOES NOT AUTHORIZE the exportation of specimens or the taking of specimens in areas otherwise closed to hunting and fishing; without appropriate licenses required by state regulations; during closed seasons; or in any manner, by any means, at any time not permitted by those regulations.

**Division of Commercial Fisheries**

**Deputy Director**
**Division of Commercial Fisheries**

**CF-05-055** ***continued (page 2 of 2)***

**Authorized Personnel:** The following personnel may participate in collecting activities under terms of this permit:

Lee Ann Gardner; Stephen Jewett; Gerald Douthit; Jon Houghton; Sandra Lindstrom; Shawn Harper; Heloise Chenelot; Jim Starkes; Dennis Lees; Mark Madden; Cathy Gardner; Max Hoberg; Larry Pedersen.

**Contingencies:**

1) **Charlie Trowbridge** (Division of Commercial Fisheries, Homer, 907-235-8191) must be notified **prior** to you engaging in transport activities. Area Biologists have the right to specify methods for collecting, as well as limiting the collections of any species, and the number of specimens collected by time and area.

2) All unattended collecting gear must be labeled with the permittee's name, telephone number, and permit number.

3) Permits will indicate the number of specimens that may be taken, by species and life stage. Sampling or collecting activities must stop when the maximum allowable number of specimens is obtained. All live fish, shellfish, and aquatic plants collected in excess of the number specified on the permit must be released immediately and unharmed at the capture location, unless otherwise specified in the permit.

4) Collection of King Crab is **NOT** permitted in these areas due to low stock abundance. Both commercial and non-commercial harvest is prohibited.

5) All bycatch incidentally captured during sampling will be identified, recorded and released unharmed if possible. Bycatch data should be included in the collection report.

6) Invertebrates, especially sessile invertebrates, should be collected over a broad geographical area to avoid local depletion and disruption of local ecosystems.

7) A valid sport fishing license must be in the possession of each person collecting fish with a hook and line or clams with a shovel.

8) *A copy of this permit, including any amendments, must be made available at all field collection sites and project sites for inspection upon request by a representative of the department or a law enforcement officer.*

9) **A report of collecting activities, referenced to this fish resource permit number, must be submitted to the Alaska Department of Fish and Game, Division of Commercial Fish, PO Box 25526, Juneau, AK 99802-5526, attention Sara Larsen (465-4724; sara_larsen@fishgame.state.ak.us), within 30 days after the expiration of this permit.** This report must summarize the number of fish captured by date and by species, and include documentation of any mortalities. A report is required whether or not collecting activities were undertaken. A report must also be sent to the Biologist(s) listed under number 1 in this Contingencies section.

10) **PERMIT VALIDATION requires permittee's signature agreeing to abide by permit conditions before beginning collecting activities:**

_____
**Signature of Permittee**

cc: Sean Palmer
Charlie Trowbridge
Lee Hammarstrom
Tom Vania
CF Division Files
Alaska Bureau of Wildlife Enforcement-Homer

**STATE OF ALASKA**

**DEPARTMENT OF FISH AND GAME**
**JUNEAU, ALASKA**

**Permit No. CF-05-055**

**Expires 12/31/05**

# FISH RESOURCE PERMIT AMENDMENT

## Amendment #1

Mark Madden
Bristol Environmental and Engineering Services Corp.
2000 W. International Airport Rd., #C-1
Anchorage, AK 99502-1117

**Fish resource permit CF-05-055 is amended to include:**

**Species Collected:** 3,000 Pacific herring, and 1,000 juvenile salmon.

This amendment was requested by Jim Starks on August 8, 2005.

**All other terms and conditions of the permit remain the same and are still valid. This amendment must be attached to the original permit.**

**Division of Commercial Fisheries**

**Deputy Director**
**Division of Commercial Fisheries**
**Alaska Department of Fish and Game**

# STATE OF ALASKA
# DEPARTMENT OF FISH AND GAME
## Fish Resource Permit Application
## — Email Form —

A **FISH RESOURCE PERMIT** is required to take, possess, hold alive, or tag FISH AND THEIR EGGS (except goldfish and decorative tropical fish) FOR SCIENTIFIC OR EDUCATIONAL PURPOSES.

(in order to use this form over again as a "blank form" first re-name and save this as a new document)

| | |
|---|---|
| Mark Madden | Bristol Environmental & Engineering Services Corporation |
| (Name of Applicant) | (Organization or School) |

2000 W. International Airport Road, #C-1, Anchorage, AK 99502-1117

(type in complete mailing address including City, State, and Zip Code)

| | | |
|---|---|---|
| (907) 563-0013 | (907) 563-6713 | mmadden@beesc.com |
| (your Telephone Number) | (Fax Number) | (Email Address) |

Northern Dynasty Mines Inc., 3201 C. Street, Suite 604, Anchorage, AK 99503

(type in the name and address of the organization with which you are under contract)

**I am making application to capture fish of the following species and number for the specified disposition** (example: identify and release, measure and release, genetic sample and release, tag and release, sacrifice, transport, hold alive, etc.)**:**

| Species Common Name | Species Scientific Name | Life Stage | Number * | Disposition** |
|---|---|---|---|---|
| Basket Cockle | *Clinocardium nuttalli* | Adult | 50 | Sacrifice |
| Soft Shell Clam | *Mya* spp. | Adult | 50 | Sacrifice |
| Horse mussel | *Modiolus* spp. | Adult | 50 | Sacrifice |
| Horsehair crab | *Telmessus cheiragonus.* | Adult | 50 | Sacrifice |
| Lyre crab | *Hyas spp.* | Adult | 50 | Sacrifice |
| Fusitriton snail | *Fusitriton oregonensis* | Adult | 50 | Sacrifice |
| Surf clam | *Mactromeris* spp. | Adult | 50 | Sacrifice |
| Macoma clam | *Macoma* spp. | Adult | 100 | Sacrifice |
| Blue Mussel | *Mytilus* spp. | Adult | 50 | Sacrifice |
| Neptune snail | *Neptunea* spp. | Adult | 50 | Sacrifice |
| Salmonids | Family Salmonidae | Juvenile | 300 | 80% measure/release<br>20% sacrifice |
| Salmonids | Family Salmonidae | Adult | 25 | 90% measure/release<br>10% sacrifice |
| Sculpin | Family Cottidae | Adult | 50 | 60% measure/release<br>40% sacrifice |
| Greenling | *Hexagrammos* spp. | Adult | 50 | 90% measure/release<br>10% sacrifice |
| Pacific Sand Lance | *Ammodytes hexapterus* | Adult | 300 | 90% measure/release<br>10% sacrifice |
| Gunnel | *Pholis* spp. | Adult | 50 | 90% measure/release<br>10% sacrifice |
| Rockfish | *Sebastes* spp. | Adult | 25 | 80% measure/release<br>20% sacrifice |
| Flounder | Family Bothidae and/or | Adult | 50 | 60% measure/release |

| | | | | |
|---|---|---|---|---|
| | Pleuronectidae | | | 40% sacrifice |
| Pacific herring | *Clupea harengus* | Adult/Juvenile | 3,000 | 90% measure/release<br>10% sacrifice |

* Note that it is currently anticipated that fewer than the 18 species or groups listed above will be collected for contaminant analyses—the actual selection of species will be done in the field based on their ubiquity, availability, and if of sufficient size/biomass for the analyses. For *Mytilus*, the number estimated is the estimated number of samples, each approximating 25 grams of tissue; the actual number of animals within each of the up to 50 samples will vary due to the variable size of the mussels in the area.

**For multiple sample locations give detail of species and number and disposition in your study plan

**I understand permits are only valid for dates within a calendar year; I am requesting this permit for the following period:** (a new application is required each year)

| 2005 | April 1 | December 31 |
|---|---|---|
| **Year:** (2005) | **From:** (month and day) | **To:** (month and day) |

**I wish to obtain the above fish [finfish, shellfish, amphibians] by means of:**

SCUBA diver, van Veen grab, beach seine, shrimp/crab pot, hook and line, shovel and hand collection, "try-net" otter trawl.

(Specify gear type(s): minnow traps, hoop traps, fyke nets, gillnets, dip nets, spat collectors, etc.)

**from the following location(s):**

Iniskin Bay, Cottonwood Bay, and Iliamna Bay on west side of Cook Inlet. Hard copy of study area map can be forwarded to you via fax because the .pdf file is too large to e-mail (please make fax request to Mark Madden via e-mail or telephone).

(Specify location(s), i.e., X River at latitude/longitude, or ESE of Pt. Barrow, or on Kodiak Island, etc.)

**The purpose of the activities for which a permit is being requested:** (a brief purpose statement)

To conduct site-specific biological sampling at the Pebble Project's proposed Port facility location and surrounding marine habitat in and adjacent to the proposed shipping channel. These collections will assist in assessing future project impacts and will add to the pre-existing biological data available for the project area.

(this area and other boxes will expand as you type)

☞ **NOTE: A STUDY PLAN or RESEARCH PROPOSAL explaining the purpose and need, the objectives, and the procedures you will use must be included in/with this permit application:**

2005 Marine Biological Sampling Plan for the Pebble Project (attached as separate .pdf file)

(Study Plan)

**Final disposition of collected specimens* not to be released live at the site of capture will be:**

Animals collected for contaminant analyses will be frozen and then transported to a pre-designated analytical laboratory for analysis (i.e., Columbia Analytical Services, Inc., Kelso, WA ; North Creek Analytical, Inc., Beaverton, OR; and/or University of Alaska Fairbanks, Fairbanks, AK). Some animals may be archived (frozen) for future analysis at the analytical laboratory and/or retained as voucher specimens. Approximately 160 fish specimens will be selected and preserved for stomach content analysis. Sediment infauna samples, unusual specimens, and voucher specimens will be preserved with formalin and then stored in alcohol at the UAF laboratory (see attached Sampling Plan). Any unneeded tissues/samples will be disposed of in an appropriate manner at the analytical laboratory.

*(specimens may not be consumed, sold, traded, or bartered, or used in any commercial manner)

**The following people will participate in field collections under terms of this requested permit:**

| The following subcontractors to BEESC, except as noted: | Other Comments | |
|---|---|---|
| Lee Ann Gardner | Has held prior collection permits | |
| Stephen Jewett | Has held prior collection permits | |
| Gerald Douthit | | |
| Jon Houghton | Has held prior collection permits | |
| Sandra Lindstrom | | |
| Shawn Harper | | |
| Cathy Gardner | | |
| Jim Starkes | | |
| Max Hoberg | | |
| Heloise Chenelot | | |
| Dennis Lees | | |
| Larry Pedersen | BEESC Personnel | |
| Mark Madden | BEESC Personnel | |
| | Should additional personnel be identified, their names will be provided to ADF&G, and the permit amendment received, prior to collection of any samples by them. | |

**I certify that all statements entered on this application are true, that I will abide by all conditions and restrictions of a permit if issued, and promise to submit a report of activities carried out under terms of such permit within 30 days of its expiration date:**

| N/A | Mark G. Madden | Project Manager | 4/4/2005 |
|---|---|---|---|
| (Latest Fish Resource Permit number, if any) | (Name: First. Middle Initial, Last) | (Title) | (Date) |

(If applicant is representing a corporation or institution, a certification of affiliation may be required which must be notarized and attached to this application). **NOTE: This certification can be provided, upon request, by contacting Mark Madden (e-mail: mmadden@beesc.com).**

( completed application must be submitted to ):

**Email Address:**

Freshwater and estuarine environment collections (Division of Sport Fish):\
sandy_sonnichsen@fishgame.state.ak.us

Marine environment collections (Division of Commercial Fisheries):
frpermits@fishgame.state.ak.us

*or*

**Mailing Address:**

Freshwater & estuarine environment collections: **Anchorage, AK 99518-1599**

**Alaska Department of Fish and Game**
**Division of Sport Fish-RTS/FR Permits**
**333 Raspberry Road**

Marine environment collections and permits involving propagation:

**Alaska Department of Fish and Game**
**Division of Commercial Fisheries-Permits**
**P.O. Box 25526**
**Juneau, AK  99802-5526**

Bristol
ENVIRONMENTAL & ENGINEERING
SERVICES CORPORATION

2000 W. International Airport Road, #C-1
Anchorage, AK 99502-1117
907-563-0013 Phone
907-563-6713 Fax

# M E M O

DATE: April 5, 2005

TO: Alaska Department of Fish and Game
Division of Commercial Fisheries

FROM: Mark Madden

RE: 2005 Fish Resource Permit
**Marine Biological Sampling Plan Summary for the Pebble Project**

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Northern Dynasty Mines Inc. (NDM) will be conducting environmental baseline studies to support development of the proposed Pebble Project, a copper-gold deposit in the Iliamna Lake region near the village of Iliamna. The proposed project would require development of a Port facility and road to facilitate development of the movement of goods to and from the proposed project site. Bristol Environmental & Engineering Services Corp. has been contracted by NDM to conduct baseline studies for this port facility. The project study area is shown on Figure 1.

To evaluate the potential impacts of port development alternatives on marine resources, it is necessary to understand what specific resources are present in the areas that would be affected by project alternatives under consideration. Biological sampling is proposed near the potential port site and surrounding marine habitat. This sampling will establish baseline conditions with site-specific data. These collections will assist in assessing future project impacts and will add to the pre-existing biological data available for the project area.

**General Background**

Our project team has documented the marine intertidal biota of several areas within Iniskin and Illiamna Bays (Lees et al. 1980; Pentec 1996; Lees, pers. comm. 2004; CIRCAC ShoreZone mapping) and identified important habitat types and resources. However, specific intertidal habitats at potential project sites have not been recorded and little information has been developed for subtidal habitats in either Iniskin or Illiamna Bay. Planned surveys will examine intertidal and subtidal habitats that may be impacted by potential port and road alternatives and collect data on existing contaminant levels for metals and hydrocarbons in waters, sediments, and biota.

The goals of 2004 studies are to:

- Supplement the considerable knowledge already available from long-term study sites with a broader understanding of the ecology of the Iniskin/Illiamna estuary (IIE).
- Gather new information on the specific habitats that may be at risk from port development.
- Identify environmentally-sensitive habitats/resources (e.g., kelp and eelgrass beds, stream mouth marshes, shellfish resource areas, threatened or endangered species habitats, etc.).
- Obtain samples to establish baseline levels of metals and hydrocarbon contaminants in sediments, water, and biota, focusing on currently proposed port sites and other project areas of interest.

The 2005 field work will consist of an onshore Shoreline Assessment and an Offshore Assessment.

**Shoreline Assessment**

The Shoreline Assessment will consist of the following tasks:

- Intertidal habitat mapping and characterization
    - Description of typical assemblages on major habitat types and in the several vertical zones or "biobands"
    - Comparison of current conditions with conditions documented in earlier work in the area
    - Collection of infauna samples for possible future analysis
- Fish use of littoral, intertidal, and shallow subtidal areas (beach seining/otter trawling)
- Collection of littoral sediment and animal tissues for laboratory analysis of baseline metals and hydrocarbon concentrations.

**Offshore Assessment**

The Offshore Assessment will consist of the following tasks:

- Subtidal habitat characterization diver transects including information on biota, substrate type, and water depth
- Collection of sediment samples with van Veen grab for laboratory analysis of baseline metals and hydrocarbon concentrations, and infauna samples for analysis and/or archiving
- Collection of water samples (with a Niskin or Van Dorn sampler) and animal tissues for laboratory analysis of baseline metals and hydrocarbon concentrations
- Otter trawling with "try-net in soft-bottom areas

## 2005 Field Survey

The 2005 marine biological field survey will be conducted off of various vessels capable of transporting and housing up to 10 scientists. The field program is planned to occur periodically between late April and early September 2005.

The following sections describe, in brief, our approach to specific tasks required to meet the project goals. Shoreline Assessment work will be broken into four subtasks:

**Habitat mapping:** Under this subtask, we will complete the mapping of intertidal habitat types present at project-specific sites around the IIE, building on the base information available from CIRCAC. Emphasis will be placed on areas of potential project disturbance, specifically, the west side of Iniskin Bay and the east side and head (Williamsport area) of Illiamna Bay. Where they differ significantly, dominant substrate types in the upper, middle and lower intertidal will be mapped separately. Changes in habitat types laterally along the beach will be located with GPS for later incorporation into the project GIS basemap.

**Intertidal ecology:** Under this subtask, we will provide detailed qualitative characterization of intertidal assemblages. Dominant species will be identified along with less numerically abundant but ecologically important "keystone species". A detailed species list will be compiled for each habitat type and elevation. This work will be completed with at least two intertidal ecologists each with over 25 years of experience in Alaska and with prior work experience in the IIE.

In key elevation zones, a limited number of quadrat counts will be made to provide a quantitative baseline for future comparisons and for comparisons with the baseline data available from previous work in IIE. On sandy or muddy substrates, these counts will include excavations to enumerate large infauna and for collections of organisms (most likely *Mya*) for tissue analysis.

**Infaunal and sediment collections:** In soft bottom habitats (sand or mud), stations will be established for sampling of infauna. Station location will be marked by GPS, rebar stake, or other means (e.g., large boulder) for future relocation. At each station, five replicate infauna samples will be taken with an 80-$cm^2$ by 15-cm deep hand corer. At each infaunal core location, two, 2-cm deep sediment samples will be taken to form three composite samples; one for analysis of sediment grain size, one for analysis of total organic carbon (TOC) and total kjeldahl nitrogen (TKN), and one for analysis of metals and petroleum hydrocarbon concentrations.

**Beach seining:** An important function of the littoral zone is its role as a nursery for juvenile salmonids and other forage fish, as well as several important invertebrates. Beach seining will be conducted using a standard 37-m, fine-mesh seine for at least two locations along low gradient, fine sediment beaches in each of Iniskin, Illiamna, and Cottonwood Bays. Catch will be identified to species and a representative number of each cohort will be measured to establish dominant size classes using this shallow water habitat. Selected specimens will be retained for tissue contaminant analyses (e.g., fish muscle and liver tissues).

Offshore Assessment work will include the following subtasks:

**Subtidal habitat characterization:** The offshore subtidal areas of the IIE are the least characterized of the marine habitats present there. SCUBA divers a will be used to obtain video and still photography of bottom habitats when visibility and tidal conditions allow. Diver and/or ROV transects will be used in primary areas of interest, e.g., areas of potential project disturbance and areas of ecologically-important habitat (e.g., eelgrass beds) to record data on biota, substrate type, and water depth.

**Infaunal and sediment collections:** Sediment samples will be collected with a van Veen grab, focusing on areas of potential project disturbance. Samples will be collected for laboratory analysis of baseline metals and hydrocarbon concentrations, and infauna samples for analysis and/or archiving. Infauna sampling will be stratified by water depth, and where possible, by substrate type. At each infauna sampling location, samples will be collected for grain size, TOC, TKN, and contaminants. Areas found to have larger infauna (e.g., clams or polychaetes) will be collected for laboratory analysis of baseline metals and hydrocarbon concentrations.

**Water sampling:** Water samples will be collected with a Niskin or Van Dorn sampler at selected infauna sampling stations.

**Otter trawling:** A 3-m "try net" will be used in soft bottom, subtidal areas (to be determined by divers and underwater video surveys), or flooded low intertidal soft bottom areas (identified during low tides), to sample demersal fish and large invertebrates that may be missed by other sampling protocols. Catch will be identified to species and a representative number of each cohort will be measured to establish dominant size classes using this shallow water habitat. Selected specimens will be retained for tissue contaminant analyses (e.g., fish muscle and liver tissues).

**Other Sampling:** Crab pots and hook and line sampling may be used to collect subtidal species. Selected specimens will be retained for tissue contaminant analyses (e.g., fish muscle and liver tissues).

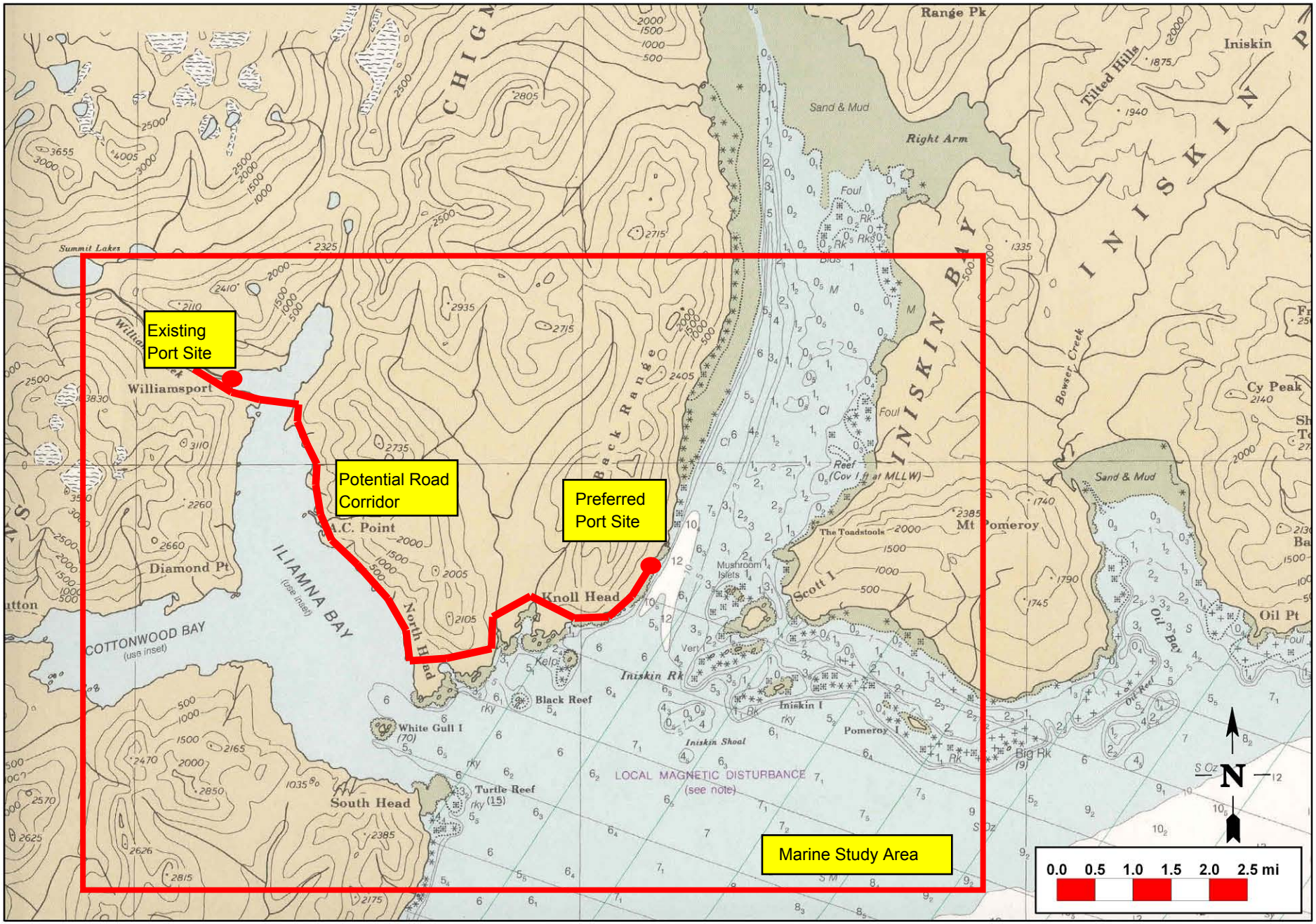
**Alaska Department of Fish and Game Fish Resource Permit Requirements**

In anticipation of Alaska Department of Fish and Game (ADF&G) Fish Resource Permit requirements, the project team expects to take the following actions to remain in compliance with its permit:

- All pots and nets used on this project will have an aluminum tag affixed to it with the ADF&G Fish Resource Permit number, along with the permit holder name, "BEESC," clearly labeled on it.
- A copy of the Fish Resource Permit will be affixed in a sealed Zip-Loc bag on the inside lid of each bait cooler used on this project.
- Any specimens collected and retained for shipment to the University of Alaska Institute of Marine Science (UAF/IMS) laboratory in Fairbanks, Alaska or to other analytical laboratories will be entered into a specimen log sheet, including the permit-prescribed

information for each specimen. If this information cannot be obtained in the field (e.g., positive species identification), this will be determined in the laboratory and be subsequently provided by specimen number to the Field Team Manager. A copy of the specimen log sheet will accompany all shipped samples; a copy will be provided to the BEESC Project Manager; and the original will be placed in a loose-leaf ringed binder maintained onboard the primary support boat. After the field program is completed, this binder will be retained by the Field Team Manager to assist in field data write-ups and reporting.

- A copy of the ADF&G Fish Resource Permit will be affixed in a sealed Zip-Loc bag on the inside the lid of each cooler being shipped to the laboratories along with a chain-of-custody form.
- The Field Team Leader will keep a running tally of the number of specimens retained to ensure that no permit limits are exceeded on a species by species basis. With these procedures, requests can be sent by the Field Team Leader to ADF&G to amend the permit, if necessary.
- Any person conducting fishing with hook and line will have a valid State of Alaska fishing license on their person.

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|---|---|---|---|
| Bristol ENVIRONMENTAL & ENGINEERING SERVICES CORPORATION | 2005 MARINE STUDY AREA | Date: April 5, 2005 | Figure 1 |
| | | Drawn by: ME / Checked By: MM | Project No: 25011 |

# APPENDIX E
# SAMPLE LOCATION COORDINATES

**Table E-1**
**Pebble Project**
**2005 Marine Studies**
**Study site location Coordinates**

| | Coordinates | | | |
|---|---|---|---|---|
| **Station** | **Latitude** | **Longitude** | **Sample type** | **Notes:** |
| MBS1 | N59 38 36.4 | W153 34 38.5 | Beach seine | |
| MBS1A | N59 39 11.6 | W153 35 54.5 | Beach seine | |
| MBS3 | N59 39 56.6 | W153 36 13.4 | Beach seine | |
| MBS3A | N59 39 56.6 | W153 36 13.4 | Beach seine | |
| MBS4 | N59 40 56.0 | W153 37 33.5 | Beach seine | |
| MPS1 | N59 38 36.3 | W153 28 44.2 | Beach seine | |
| MPS1A | N59 38 16.5 | W153 29 55.1 | Beach seine | |
| MPS1B | N59 38 55.1 | W153 28 25.5 | Beach seine | |
| MPS1C | N59 39 03.5 | W153 28 10.9 | Beach seine | |
| MPS4A | N59 37 49.2 | W153 33 48.6 | Beach seine | |
| MPSE | N59 40 29.7 | W153 37 24.4 | Beach seine | |
| MPSE1 | N59 40 00.9 | W153 37 43.4 | Beach seine | |
| MPS3 | N59 38 38.3 | W153 38 15.7 | Beach seine | |
| MPS1T | N59 38 36.9 | W153 28 23.9 | Trawl | |
| MPS2T | N59 39 02.3 | W153 26 56.5 | Trawl | |
| MPS2TA | N59 39 42.5 | W153 27 05.5 | Trawl | |
| MPS2TB | N59 40 54.2 | W153 26 23.4 | Trawl | |
| MTR1 | S59 38 16.7 | W153 36 03.0 | Trawl | |
| MTR1A | N59 38 10.2 | W153 35 52.3 | Trawl | |
| MTR2 | N59 37 28.6 | W153 34 15.0 | Trawl | |
| MHALI | N59 39 34.1 | W153 26 35.8 | Iniskin Anchor point | Hook and line sampling |
| MPS1 | N59 38 19.5 | W153 29 05.3 | Intertidal | |
| PS1 | N59 38 05.2 | W153 30 43.5 | Intertidal | |
| PS2ARCH | N59 39 34.5 | W153 27 51.9 | Intertidal | |
| SCOTT MID | N59 38 06.2 | W153 26 27.1 | Intertidal | |
| MBS1A | N59 39 09.3 | W153 35 51.4 | Intertidal | |
| MPS4A | N59 37 47.2 | W153 33 48.5 | Infauna/sediment sample | Cores |
| MPS2 | N59 39 32.6 | W153 27 49.3 | Infauna/sediment sample | Cores and 1/4m infauna |
| MPSE | N59 40 38.3 | W153 37 17.8 | Infauna/sediment sample | Cores |
| MBSA1 | N59 39 19.4 | W153 36 00.5 | Infauna/sediment sample | Cores |
| MPS3 | N59 38 36.7 | W153 37 37.0 | Infauna/sediment sample | Cores and 1/4m infauna |
| MPS3 | N59 38 35.3 | W153 37 38.8 | Infauna/sediment sample | 1/4 m infauna |