



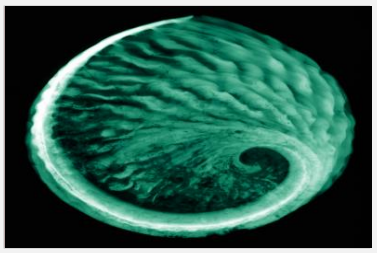

Hong Kong Offshore LNG Terminal Project

Methodology for Baseline Study on Phytoplankton, Zooplankton and Benthic Organisms

13 August 2019

Project No.: 0505354

The business of sustainability

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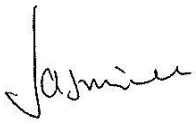
Hong Kong Offshore LNG Terminal Project

Methodology for Baseline Study on Phytoplankton, Zooplankton and Benthic Organisms



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1. METHODOLOGY FOR BASELINE STUDY ON PHYTOPLANKTON, ZOOPLANKTON AND BENTHIC ORGANISMS

This Methodology for Baseline Study on Phytoplankton, Zooplankton and Benthic Organisms presents the details of proposed baseline study on phytoplankton, zooplankton and benthic organisms for the Hong Kong Offshore LNG Terminal Project (the Project) as stipulated in Condition 2.13 of the Environmental Permit (EP-558/2018). The proposed survey methodologies for phytoplankton, zooplankton and benthic organisms are discussed below.

1.1 Phytoplankton Survey

1.1.1 Survey Locations

The phytoplankton survey will be conducted at three (3) locations in southern Lantau waters as presented in *Figure 1*. These locations cover areas in the vicinity of the proposed Offshore LNG Terminal, i.e. the seawater intake and discharge points of the FSRU vessel, and a reference area. Actual survey locations will be recorded using global positioning system (GPS) and water depth will be measured using portable sonar system.

1.1.2 Survey Frequency

The survey will be undertaken at all locations twice in each of the wet (between April and October) and dry (between November and March) seasons during daytime (ie 08:00 – 16:00) prior to the commencement of the marine construction works of the Project. The proposed survey frequency has taken into account the seasonality in phytoplankton assemblages [(1)] [(2)], and allows replication within each season given the dynamic nature of these assemblages while maintaining the timing of sampling within a day which may influence survey results, and is thus considered to be adequate for the purpose of this survey.

1.1.3 Survey Methodology

Considering the proposed seawater intake and discharge locations of the FSRU vessel (~10m below water surface), it is proposed to monitor both shallow (1-2m below water surface) and deep (~10m below water surface) water zones in the phytoplankton survey.

The survey methodology follows published scientific literature and has also been adopted in similar studies in the region [3] [4] [5]. A Van Dorn Bottle Sampler (~2L) (Model 1920-H62, Wildco or equivalent; *Annex A1*) will be used to collect phytoplankton samplesat shallow and deep water zones. The sampler will firstly be opened by raising both end seals, and then lowered to the proposed sampling depth; a physical messenger will be sent to trigger a mechanism which will close the end seals. At each depth, three replicates of 6L of seawater will be collected. Each replicate will be filtered through a 10µm mesh

[1] Huang L, Jian W, Song X, Huang X, Liu S, Qian P, Yin K, Wu M (2004) Species diversity and distribution for phytoplankton of the Pearl River estuary during rainy and dry seasons. Marine Pollution Bulletin, 49:588-596.

[2] Chiu HMC, Hodgkiss IJ, Chan BSS (1994) Ecological studies of phytoplankton in Tai Tam Bay, Hong Kong. Hydrobiologia, 273:81-94

[3] Kraberg A, Metfies K, Stern R (2017) Sampling, Preservation and Counting of Samples I: Phytoplankton, Marine Plankton: A Practical Guide to Ecology, Methodology, and Taxonomy. Oxford University Press. 91-103.

[4] Verlencar XN (2004) Phytoplankton Identification Manual. National Institute of Oceanography, Dona Paula, Goa.

[5] Lie AAY, Wong CK, Lam JYC, Liu JH, Yung YK (2011) Changes in the nutrient ratios and phytoplankton community after declines in nutrient concentrations in a semi-enclosed bay in Hong Kong. Marine Environmental Research 71:178-188.

to collect the phytoplankton samples and they will be immediately preserved by 4% Lugol's solution or 4% borax-buffered formalin in labelled bottles after collection.

In addition to the phytoplankton sampling, other relevant data will also be recorded, including time, weather conditions, sea conditions, special phenomena (if any), and other activities undertaken around the survey areas that may influence the survey results.

1.1.4 Laboratory Analyses

The phytoplankton of each replicate will be sorted and identified to the lowest taxonomic level where practical based on morphology [6] and number counted under inverted microscope in the laboratory using the Utermöhl method [7]. The abundance of phytoplankton will be presented in density, i.e. number of cells/ Litre.

1.2 Zooplankton Survey

1.2.1 Survey Locations

The zooplankton survey will be conducted at three (3) locations in southern Lantau waters as presented in *Figure 1*. These locations cover areas in the vicinity of the proposed Offshore LNG Terminal, i.e. the seawater intake and discharge points of the FSRU vessel, and a reference area. Actual survey locations will be recorded using GPS and water depth will be measured using portable sonar system.

1.2.2 Survey Frequency

The survey will be undertaken at all locations twice in each of the wet (between April and October) and dry (between November and March) seasons during daytime (ie 08:00 – 16:00) prior to the commencement of the marine construction works of the Project. The proposed survey frequency has taken into account the seasonality in zooplankton assemblages [8], and allows replication within each season given the dynamic nature of these assemblages while maintaining the timing of sampling within a day which may influence survey results, and is thus considered to be adequate for the purpose of this survey.

1.2.3 Survey Methodology

Considering the proposed seawater intake and discharge locations of the FSRU vessel (~10m below water surface), it is proposed to monitor both shallow (1-2m below water surface) and deep (~10m below water surface) water zones in the zooplankton survey.

The survey methodology follows published scientific literature and has also been adopted in similar studies in the region [9] [10] [11]. A bongo plankton net of 50cm mouth diameter and 300µm mesh (Aquatic research Instruments, USA or equivalent; *Annex A2*) will be deployed to collect zooplankton at shallow and deep water zones at each survey location. A flow meter (Model 2030R, General Oceanics Inc.,

[6] Verlencar XN (2004) *Op Cit.*

[7] Edler L and Elbrächter M (2010) The Utermöhl method for quantitative phytoplankton analysis. Microsopic and Molecular Methods for Quantitative Phytoplankton Analysis. UNESCO. 13-20.

[8] Tan Y, Huang L, Chen Q, Huang X (2004) Seasonal variation in zooplankton composition and grazing impact on phytoplankton standing stock in the Pearl River Estuary, China. Continental Shelf Research 24:1949-1969.

[9] Hwang J, Souissi S, Tseng L, Seuront L, Schmit, FG, Fang L, Peng S, Wu C, Hsiao S, Twan W, Wei T, Kumar R, Fang T, Chen Q. Wong CK (2006) A 5-year study of the influence of the northeast and southwest monsoons on copepod assemblages in the boundary coastal waters between the East China Sea and the Taiwan Strait. Journal of Plankton Research, 28:943-958

[10] UNESCO (1968) Zooplankton Sampling, <https://unesdoc.unesco.org/ark:/48223/pf0000071517> Assessed on 1 August 2019.

[11] Santhanam P, Pachiappan P, Begum A (2019) A Method of Collection, Preservation and Identification of Marine Zooplankton. Basic and Applied Zooplankton Biology. 1-44.

USA or equivalent; *Annex A3*) will be fitted at mouth of the net to record the volume of water filtered. At each depth, three replicate tows will be conducted, and each tow with a duration of at least 5 minutes at a speed of ~2 knots. The zooplankton collected at the cod-end will be immediately fixed in 4% borax-buffered formalin in labelled bottles after collection and then transferred into 75% ethanol for subsequent preservation in the laboratory.

In addition to the zooplankton sampling, other relevant data will also be recorded, including time, weather conditions, sea conditions, special phenomena (if any), and other activities undertaken around the survey areas that may influence the survey results.

1.2.4 Laboratory Analyses

The zooplankton will be sorted and identified to the lowest taxonomic level where practical based on external morphology [12]. The abundance of zooplankton will be reported in density, i.e. number of individuals per 1000m^3, and their biomass will be reported in wet weight, i.e. wet weight per 1000m^3 according to the following procedure in the laboratory [13].

The abundance of zooplankton will be counted under microscope. Common zooplankton taxa (ie protozoans, cladocerans, copepods, decapod larvae, mysids etc.) and their species will be enumerated in subsample or aliquot of 10% to 25%. The percentage of aliquot can be increased or decreased depending on the abundance of zooplankton in the sample. For rare taxa, the total counts of specimens in the samples shall be made. The biomass of zooplankton will be measured by gravimetric method. Subsamples will be filtered to remove the interstitial water by blotting paper and the wet weight of zooplankton will be determined.

1.3 Benthic Organism Survey

1.3.1 Survey Locations

The benthic organism survey will be conducted at three (3) locations in southern Lantau waters as presented in *Figure 1*. These locations cover areas in the vicinity of the proposed Offshore LNG Terminal, i.e. the seawater intake and discharge points of the FSRU vessel, and a reference area. Actual survey locations will be recorded using global positioning system (GPS).

1.3.2 Survey Frequency

Benthic organism surveys will be conducted once in each of the wet (between April and October) and dry (between November and March) seasons, prior to the commencement of the marine construction works of the Project. As indicated in the EIA study of this Project, benthic assemblages are quite homogenous in nature. The proposed survey frequency has already taken into account the seasonality in benthic assemblages and is thus considered to be adequate for the purpose of this survey.

1.3.3 Survey Methodology

The survey methodology follows that of the EIA study of this Project. Sediment sample will be collected at each survey location using a modified Van Veen grab sampler (960 cm^2 sampling area; 11,000 cm^3 capacity; *Annex A4*) with a supporting frame attached to a swiveling hydraulic winch cable. Duplicate sediment grab samples will be obtained at each survey location. The sediment samples will be evaluated for acceptance based upon the degree of disturbance, penetration depth, and amount of

[12] Santhanam et al. (2019) Op Cit.

[13] Goswami SC (2004) Zooplankton Methodology, Collection & Identification – a field manual. National Institute of Oceanography, Dona Paula, Goz.

leakage from the grab. In the following cases, a sediment sample would be rejected and another sample collected:

- The sediment sampler doors open in recovery, causing possible surface washout.
- Half sample obtained where the sediment sampler had not struck a flat area of seabed, or improper deployment of benthic grab, or half sample of sediment.
- Disruption of the sample by heavy shaking or contamination (these can occur when a sample is badly handled or if the sediment sampler strikes the side of the vessel during operations).
- The sample represents less than 30% of the sediment sampler's total capacity (i.e. less than 15 cm penetration).
- Grab deployment location deviates from the designated position [14].

Before sieving each sample on site, the grab, frame and sample containers will be washed with seawater to avoid cross contamination of samples.

Sediments for biological analysis will be sieved on board the survey vessel. The sediments will be washed into a sieve stack (comprising 1 mm and 500 µm meshes) and gently rinsed with seawater to remove all fine materials. Following rinsing, any material remaining on the two screens will be combined and carefully rinsed using a minimal volume of seawater into pre-labelled thick triple-bagged ziplock plastic bags. A 5% solution of borax-buffered formalin containing Rose Bengal in seawater will then be added to the bag to ensure tissue preservation. Samples will be sealed in plastic containers for transfer to the taxonomy laboratory for sorting and identification.

In addition to the sediment sampling, other relevant data will also be recorded, including time, weather conditions, sea conditions, special phenomena (if any), and other activities undertaken around the survey areas that may influence the survey results.

1.3.4 Laboratory Analyses

The laboratory will perform sample re-screening after the samples have been held in formalin for a minimum 24 hours to ensure adequate fixation of the organisms. Individual samples will be gently rinsed with fresh water into a 250 μm^2 sieve to remove the formalin from the sediments. Sieves will be partially filled while rinsing a specific sample to maximize washing efficiency and prevent loss of material. All material retained on the sieve will be placed in a labeled plastic jar, covered with 70% ethanol, and lightly agitated to ensure complete mixing of the alcohol with sediments. Original labels will be retained with the re-screened sample material.

Standard and accepted techniques will be used for sorting organisms from the sediments. Small fractions of a sample will be placed in a petri dish under a 10-power magnification dissecting microscope and scanned systematically with all animals and fragments removed using forceps. Each petri dish will be sorted at least twice to ensure removal of all animals. Organisms representing major taxonomic groups, such as Polychaeta, Arthropoda, Mollusca and miscellaneous taxa will be sorted into separate, labeled vials containing 70% ethanol.

Taxonomic identifications will be performed using stereo dissecting and high-power compound microscopes to determine the species diversity and abundance of benthic organisms of each sample. These are generally to the species level except for unidentified taxa, which will be identified to genera as far as practical. The careful sampling procedure employed minimizes fragmentation of organisms. If breakage of soft-bodied organisms occurred, only anterior portions of fragments will be counted, although all fragments will be retained and weighed for biomass determinations (wet weight).

[14] Concerns about positional errors must be weighed against the aims of the survey. Horizontal accuracies to within 30 metres are acceptable distance

1.4 Proposed Survey Programme

The Project is scheduled to commence construction by mid-2020. Therefore, the baseline monitoring is proposed to be conducted between 2019Q3 and 2020Q1 prior to the marine construction works of the Project.

The tentative monitoring programme is presented in Table 1. It should be noted that the baseline monitoring programme may be subject to change depending on the weather and sea conditions.

Table 1 Tentative Programme for Phytoplankton, Zooplankton and Benthic Organism Surveys

Survey	Method	Location	Survey Programme
Phytoplankton Survey	Sampling by Van Dorn Bottle Sampler	Three locations in southern Lantau waters (see *Figure 1*)	Wet season: Once in August 2019 and once in September 2019 Dry season: Once in December 2019 and once in January 2020
Zooplankton Survey	Sampling by bongo plankton net	Three locations in southern Lantau waters (see *Figure 1*)	Wet season: Once in August 2019 and once in September 2019 Dry season: Once in December 2019 and once in January 2020
Benthic Organism Survey	Grab Sampling	Three locations in southern Lantau waters (see *Figure 1*)	Wet season: Once in August 2019 Dry season: Once in December 2019

1.5 Reporting

In accordance with Condition 2.13 of the Environmental Permit (EP-558/2018), the *Baseline Study Report on Phytoplankton, Zooplankton and Benthic Organisms*, which will include the details of the methodology and findings of the surveys, will be submitted to Environmental Protection Department no later than one month before commencement of marine construction work.

Legend

- Boundary of HKSAR
- Proposed Route of BPPS Pipeline
- Proposed Route of LPS Pipeline
- Proposed Site for LNG Terminal
- Proposed LNG Terminal Safety Zone
- Proposed Phytoplankton, Zooplankton & Benthic Organism Survey Location

Soko Island

Shek Kwu Chau

Cheung Chau

X: 814353.915
Y: 802070.000

X: 814112.700
Y: 801632.958

X: 808449.304
Y: 801086.160

N

Kilometres

0 1 2

Overview Map

Figure 1

Proposed Locations for Phytoplankton, Zooplankton and Benthic Organism Surveys

File: T:\GIS\CONTRACT\0505354\mxd\0505354_Phytopplankton_Zooplankton_Benthic_Organism.mxd
Date: 18/7/2019

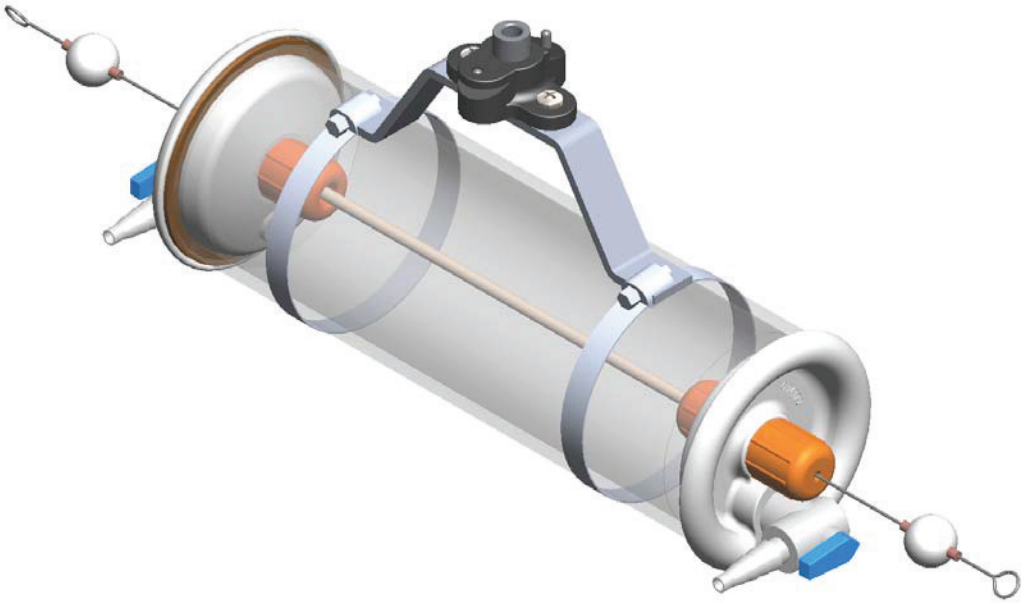
Environmental Resources Management

ERM

ANNEX A DETAILS OF PROPOSED EQUIPMENT

ANNEX A1 VAN DORN BOTTLE SAMPLER

BETA BOTTLES 2.2-4.2 LITERS (1920-1940)



Kits contain Beta Bottle, polyester line, messenger, and a carry case. Bottles sold separately need an 11 ounce messenger to operate.

1920-1940 Horizontal Bottles & Kits:

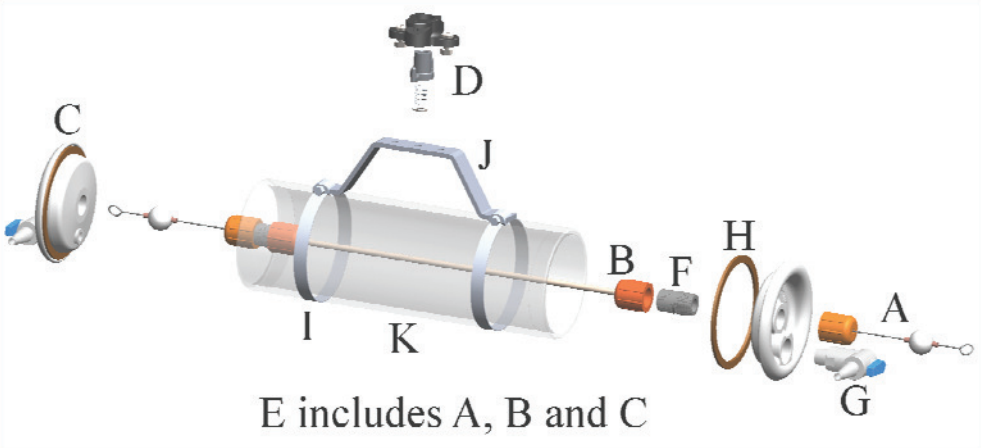
Catalog #	Type	Tube diameter, length
1920-G62	2.2L Acrylic	4.5” x 13.5”
1930-G62	3.2L Acrylic	4.5” x 18.5”
1940-G62	4.2L Acrylic	4.5” x 22-5/8”
1920-H62	2.2L PVC	4.5” x 13.5”
1930-H62	3.2L PVC	4.5” x 18.5”
1940-H62	4.2L PVC	4.5” x 22-5/8”

1920-1940 Vertical Bottles & Kits:

Catalog #	Type	Tube diameter, length
1920-G62	2.2L Acrylic	4.5” x 13.5”
1930-G62	3.2L Acrylic	4.5” x 18.5”
1940-G62	4.2L Acrylic	4.5” x 22-5/8”
1920-D62	2.2L PVC	4.5” x 13.5”
1930-D62	3.2L PVC	4.5” x 18.5”
1940-D62	4.2L PVC	4.5” x 22-5/8”

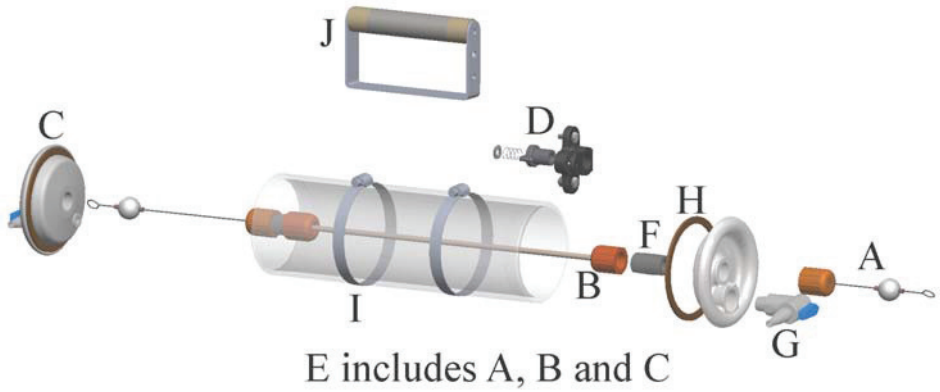
1920-1940 Beta Bottle Replacement Parts and Accessories:
Parts are available for all bottles and are easily installed by the user. **Note:** If your bottle was purchased before the year 2000, the current parts may not work. However, we still make parts for many older bottles. Please call us for more information.

1920-1940 <u>Horizontal</u> Beta Bottle Replacement Parts:



	Description	2.2L part #	3.2L part #	4.2L part #
A	Cable assembly, 2 pack	1920-L127	1930-L127	1940-L127
B	Tubing Assembly	1920-L130	1930-L30	1940-L130
C	Seals with valves, 2 pack	1920-L115	1920-L115	1920-L115
D	Trip Assembly	1120-L40	1120-L40	1120-L40
E	Center assembly with cable, tubing, seals.	1920-L135	1930-L135	1940-L135
F	Connectors, 2 pack	1120-L112	1120-L112	1120-L112
G	Air/drain valves, 2 pack	1920-L112	1920-L112	1920-L112
H	Gasket Kit, 2 pack	1920-L129	1920-L129	1920-L129
I	Clamps, 2 pack	1120-L17	1120-L17	1120-L17
J	Bail (Handle)	1120-L28	1120-L28	1120-L28
K	Main Tube, Acrylic	1920-L118	1930-L118	1940-L118
K	Main Tube, PVC	1920-L120	1930-L120	1940-L120

1920-1940 <u>Vertical</u> Beta Bottle Replacement Parts:



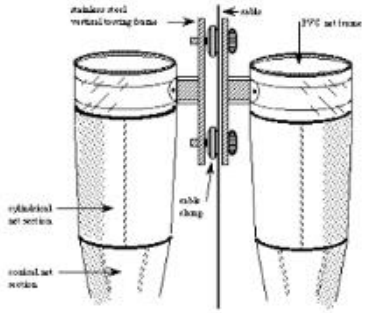
	Description	2.2L part #	3.2L part #	4.2L part #
A	Cable assembly, 2 pack	1920-L125	1930-L125	1940-L125
B	Tubing Assembly	1920-L130	1930-L130	1940-L130
C	Seals with valves, 2 pack	1920-L115	1920-L115	1920-L115
D	Trip Assembly	1120-L130	1120-L130	1120-L130
E	Center assembly with cable, tubing, seals.	1920-L137	1930-L127	1940-L137
F	Connectors, 2 pack	1120-L112	1120-L112	1120-L112
G	Air, drain valves, 2 pack	1920-L112	1920-L112	1920-L112
H	Gasket kit, 2 pack	1920-L129	1920-L129	1920-L129
I	Clamps, 2 pack	1120-L17	1120-L17	1120-L17
J	Handle	1120-L122	1120-L122	1120-L122
K	Main Tube, Acrylic	1920-L118	1930-L118	1940-L118
K	Main Tube, PVC	1920-L120	1930-L120	1940-L120

ANNEX A2 BONGO PLANKTON NET

Bongo Plankton Nets

- Ichthyoplankton and zooplankton production studies
- Oblique and vertical towing applications
- Spatially correlated plankton studies

Bongo Ring Net



Bongo "Ring" Net Frame x 50 cm Diameter

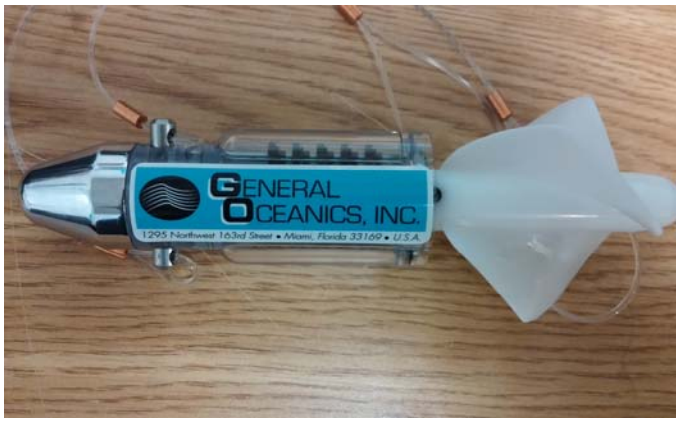
- Simple strong and ergonomic
- 50 cm diameter paired rings with triple tie bars (5/16" SS x SS316 rod stock)
- Free swiveling polyethylene towing yoke with opposing forged lifting eyes (requires scrap metal or cannonball ballast weight not included)
- Plankton nets are laced directly on frame rings
- **Complete $700**

ANNEX A3 FLOW METER

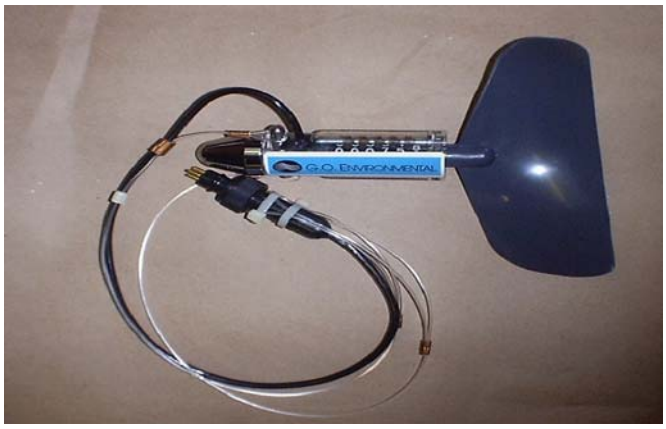
GENERAL OCEANICS

1295 N.W. 163rd Street
Miami, FL 33169
(305)621-2882
www.generaloceanics.com
sales@generaloceanics.com

FLOWMETERS



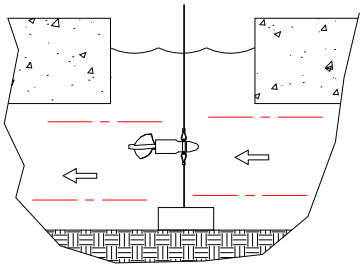
Model 2030R Mechanical Flowmeter
With High-speed Impeller



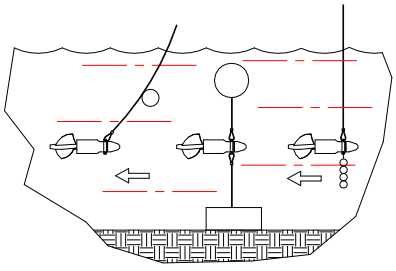
Model 2031HR6 Electronic Flowmeter
With Low-speed Impeller

Small and lightweight general purpose impeller instruments for use in open channel applications including rivers, estuaries, canals, sewage outfalls, pipes, harbor entrances, offshore sites and in association with plankton nets and other samplers. These flowmeters have been used as towed speed logs by some America's Cup contenders. Corrosion-free operation. Ballasted for dynamic *in situ* operation. Unlimited depth capability.

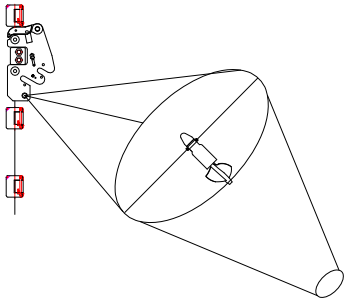
The Model 2030R is a standard flowmeter. The Model 2031H uses magnets to actuate a solid-state hall effect generator, creating a signal for processing by the readout.



Open channel use with optional memory module



Installations in open areas



Flowmeter mounted in mouth of CC5100 series plankton net system

GENERAL OCEANICS

1295 N.W. 163rd Street
Miami, FL 33169
(305)621-2882
www.generaloceanics.com
sales@generaloceanics.com

Basic models, 2030 series:	**Basic models, 2031 series:**
2030R – Standard mechanical flowmeter	2031H – Standard, with hall sensor & cable
2030R6 - Low-speed impeller	2031HR6 – Low-speed impeller
2030RC – One-way clutch	2031HRC– One-way clutch
2030R6C - Low-speed impeller and one-way clutch	2031HR6C - Low-speed impeller and one-way clutch

SPECIFICATIONS

Data readout - Six 10-digit counter wheel reading 000000 to 999999. Ten counts per rotor revolution, non-resetting. Read by noting difference in beginning and end readings. Counter advances through 000000.
999999 counts equals approximately 14.5 nautical miles.
Speed range – With standard rotor, approx. 10cm/sec (1/5 knot) to 7.9 meters/sec (15 knots).
With low-speed rotor, approx. 6cm/sec (3/25 knot) to 100cm/sec (2 knots).
Mounting – Universal bridle allowing single-point connection for towing or two-point connection within net mouth. 3-point connection ring is also available as an option.

High-speed impeller rotates clockwise, low-speed impeller rotates counterclockwise.

Weight in air – 225 grams (8 ounces).
Weight in water – 113 grams (4 ounces).
Materials - Polycarbonate body, Celcon impeller, nickel-plated brass nose cone, Armalloyed stainless steel rotor and idler gear shafts. PVC low-speed impeller available as an option.

Dimensions - 21.3cm (8 3/8") overall length. Standard rotor diameter is 6.98cm (2 3/4"). Low-speed rotor diameter is 16.5cm (6 1/2").
Depth rating – Unlimited (free flooding).

Standard order of a 2030 series flowmeter includes universal bridle, standard or low-speed rotor.
Standard order of a 2031 series flowmeter includes universal bridle, standard or low-speed rotor and pigtail (short length of cable and underwater connector for connection to readout cable.

Readouts and other options to be ordered separately.

OPTIONS

Low-speed impeller – High resolution rotor for low-speed applications.
One-way clutch – Prohibits backward motion of rotor.
2030W – Wading rod for open-channel use.
2030CF- Spin resistance tester for monitoring performance of counter mechanism.
20307 - 7-digit counter, increases range to approx. 145 nautical miles.
2135 – Data acquisition readout, RS232 compatible.
2135D – Interface module with cable and Flow-soft application software.
2031HCXX – Extension cable, "XX" denotes length in meters.

For prices and delivery please e-mail sales @generaloceanics.com.
Technical data subject to change without notice.

ANNEX A4 VAN VEEN GRAB SAMPLER

VAN VEEN BRAB SAMPLER

1. INTRODUCTION

The Van Veen grab is a lightweight sampler designed to take large samples in soft bottoms. Its long lever arms and the sharp cutting edges on the bottom of the scoops, enable it to cut deeply into the softer bottoms. The Van Veen grab sampler is manufactured in numerous sizes from stainless steel. The weighted jaws, chain suspension, and doors and screens allow flow-through during lowering to the bottom and assure vertical descent where strong underwater current exist. The relatively large surface area and the strong closing mechanism allow the jaws to excavate relatively undisturbed sediment. When the powering cable is slowly made taut, the chains attached at the top of the release exert great tension on the long arms extending beyond the jaws, causing them to lift, dip deeper into the sediment, and trap material as they tightly close.

2. SPECIFICATIONS

EGS has three sizes of Van Veen grab samplers as details below: