

Town of Wareham, Massachusetts

Process Monitoring for Optimal Nitrogen Treatment and Outfall Reduction

Project #8618712

Final Report

March 2016

PROJECT FINAL REPORT

Process Monitoring for Optimal Nitrogen Treatment and Outfall Reduction 2016

Town of Wareham
Water Pollution Control Facility

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PREPARED BY:
GHD Inc.

PREPARED FOR:

BUZZARDS BAY NATIONAL ESTUARY PROGRAM
ENV 14 CZM 10
SOUTHERN NEW ENGLAND COASTAL WATERSHED RESTORATION PROGRAM
NUTRIENT MANAGEMENT GRANTS

AND

TOWN OF WAREHAM WATER POLLUTION CONTROL FACILITY

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A. Project Snapshot

Project Number and Title: Process Monitoring for Optimal Nitrogen Treatment and Outfall Reduction

A.1 Project Start Date: March 3, 2015

A.2 Date Closed: March4, 2016

A.3 Segment and Waterbody Information: Agawam River, MA95-29

A.4 Status of Waterbody: Category 5

A.5 Priority Pollutants Targeted: Nitrogen

A.6 Estimated Annual Pollutant Removal:

N: 1,200 lbs per year (if average reduction of N is 0.5 mg/L at 800,000 gpd flow)

A.7 Process Monitoring Equipment Schematic (major items only, a complete list of probes, conduits, hardware and other equipment and service items relating to this project has been included in Appendix A):

Summary of Monitoring Equipment Installed: (detailed probe specifications are included in Appendix B).

Network 1 Headworks: The headworks has two sensors sending three parameters: PH and Carbovis (COD and BOD sensor).

Network 2 Anoxic Tanks, Aeration Basins and Clarifiers: Anoxic Tanks 1 and 2 have optical DO and Varion probes. The Varion probes detect ammonia and nitrate. Each aeration basin has a Varion probe and each clarifier has an IFL probe that detects sludge level.

This Network is partially wireless Bluetooth in that the clarifiers are sending the three sludge level readings up to the aeration tank ethernet module which then sends it to the supervisory control and data acquisition (SDADA) system. Using the Bluetooth reduced installation costs and equipment costs via wirelessly transmitting real time data.

Network 3 Sand Filter and Effluent Building: The sand filter has an optical DO and nitrate sensor, the sand filter effluent building has nitrate sensor and PH sensor.

B. Descriptive Project Summary

Buzzards Bay National Estuary Program

SOUTHERN NEW ENGLAND COASTAL WATERSHED RESTORATION PROGRAM NUTRIENT MANAGEMENT GRANTS

PROJECT TITLE: Process Monitoring for Optimal Nitrogen Treatment and Outfall Reduction

PS CATEGORY: Wastewater Effluent Discharge

INVESTIGATOR: Town of Wareham

LOCATION: Agawam River, Wareham, MA

DESCRIPTION:

The Agawam River, currently listed on the 2012 Integrated List of Waters as a Category 5 water body with a Total Maximum Daily Load (TMDL) for numerous parameters, one of which includes nitrogen, accommodates an abundance of naturalistic resources that play a significant role in the health of this water body, and downstream waterbodies that include the Wareham River, and eventually Buzzards Bay. The importance of the bay to ecological systems, recreational uses, and the local economy demands appropriate planning and assessment of external impacts that may degrade this important resource. Residential development, population increases, and commercial sources all contribute to nitrogen pollution that has several documented impacts to receiving waters. In efforts to reduce the impacts of Nitrogen pollution, several wastewater treatment plants have been constructed to be a centralized cure for densely developed areas, treating nitrogen in some cases to below 3 mg/L in the effluent.

The Wareham WPCF is one of several treatment plants that discharge to either Buzzards Bay or contributing waterways. The goal of this project was to identify a financially feasible method to better monitor the treatment plant's existing processes to help lower nitrogen discharges. With planning efforts identifying additional future flows that are scheduled to bring the Wareham WPCF total flow to 1.5 MGD or more, it has been identified that improved monitoring of the treatment processes may result in a significant reduction in nitrogen discharge to the Agawam River. The discharge permit for the Wareham WPCF requires a discharge limit of under 4 mg/L for nitrogen. While the plant is typically in compliance, the expectation of this effort is to further reduce nitrogen limits over long-term monitoring and modifications to the treatment, using the probes installed under this project as a guide.

This improved monitoring will be achieved through the installation of several probes at selected treatment processes and connection of these to the in-plant SCADA system. This will allow a more detailed look at the treatment plant process and identify areas that the treatment can be adjusted to potentially gain better nitrogen reduction.

The installed probes will communicate with the existing SCADA software at the Wareham WPCF so that the operators can have a streamlined view of the monitoring at each step of the process.

Project Tasks include:

1. Site and Project Kick-Off Meeting
2. Development of Final Monitoring Layout and Design
3. Development of Equipment RFP

4. Purchasing of Selected Equipment
5. Installation of Probes
6. System Start-up

C. Project Finances

Attachment B - Budget

Process Monitoring for Optimal Nitrogen Treatment and Outfall Reduction

AMENDMENT 1/5/16

Expense Items	Grant Amount	Non-Federal Match	Total Amount
Contractor (Charette Services)			$11,269.00
Engineering (GHD Inc.)			$15,000.00
Materials (YSI)			$92,248.51
Other			$4,216.07
Totals	**$75,000.00**	**$47,733.58**	**$122,733.58**

Note:

(1) Total project cost was higher and the difference funded by the Town.

The overall project budget was slightly exceeded by $4,085.58 to accommodate several unforeseen conditions during construction. The Town of Wareham WPCF staff provided all of the installation, site work, and fabrication of brackets to mount the probes purchased under this grant and thus no outside bid for contractual services was placed. This was an ambitious undertaking for the Town WPCF staff and resulted in a very cost-effective project for the Town.

There was a materials bid placed for the probes and associated materials, as these are specialty products. The low bid was awarded to New England Environmental Equipment out of Bedford, Massachusetts.

D. Probes

Headworks. The headworks of the Wareham WPCF is the main point of collection for all incoming sewage. It is, in essence, the start of the treatment process once sewage enters the facility. The probes installed at this point are capable of detecting pH, Biological Oxygen Demand (BOD), and Chemical Oxygen Demand (COD). The intent of monitoring these parameters at this process is to provide an early warning sign of an unusual wastewater load. The plant personnel could make preparations to better accommodate the situation and protect the overall process from negative impacts (such as diverting flow to the emergency holding lagoon).

Anoxic Tanks. After entering the headworks, the sewage flows through two anoxic tanks. These tanks are intended starve the flow of oxygen which in turn forces the bacteria in the water to seek oxygen from the nitrate that is introduced through recycled effluent from the aeration tanks. This is the main denitrification step in the process. The probes installed at this stage of the process will allow the WPCF to monitor dissolved oxygen, nitrate, and ammonium. By knowing the exact levels of dissolved oxygen and nitrate in these tanks, the WPCF could potentially fine-tune the nitrogen recycle flowrate to allow for the optimal nitrogen uptake by the microbes in wastewater.

Aeration Tanks. The next step in the process is where the wastewater is infused with oxygen to convert ammonia to nitrate that will be recycled back to the anoxic tanks. The proper level of oxygen is critical as it will determine the nutrient uptake by the microbes in the anoxic tank. Similar to the anoxic tanks, the aeration tanks are equipped to monitor dissolved oxygen, nitrate, and ammonium. Ensuring the optimal level of oxygen is infused in this step of the process will result in a greater nitrogen reduction in the anoxic phase.

Clarifiers. The clarifiers settle out suspended solids and particles after the wastewater has flowed through the anoxic and anaerobic processes. The flow to be discharged to the Agawam River first travels through the clarifiers; while the remaining flow is recycled within the plant. The solids in these tanks settle to a layer of sludge on the bottom that is rich in microbes. Some of this sludge is disposed of, while other amounts are recycled to keep the biological process of the plant in good health. Probes have been installed in the clarifiers to monitor the sludge levels of the tanks. Monitoring the sludge levels prevents the sludge quantity from getting too high, which could allow solids to pass on to the next process, thereby reducing effectiveness.

Sand Filters and Discharge. As a final polishing and denitrification step, effluent infiltrates through a series of sand filters. The travel of effluent through this media acts as a polishing step; further improving the water quality and clarity, removing nitrogen, and preparing the effluent for discharge. The probes installed at this location will monitor dissolved oxygen and nitrogen both before and after this step to ensure the sand filters are working at their optimal capacity and to potentially allow automation of the methanol feed system to help optimal denitrification.

Downloading Data. Operators can set the interval at which data is captured. For this project, data readings are captured at 1- and 5-minute intervals depending on the probe. The probes are set up so that it is very user-friendly to download information. A series of commands on the touch screen display easily allows operators to download data sets for viewing, compatible in Excel format. In general, there are eight columns that show the downloaded information. These columns show date, time, perimeter, unit, and temperature.

The following is an example of the effluent probe data set in Excel format:

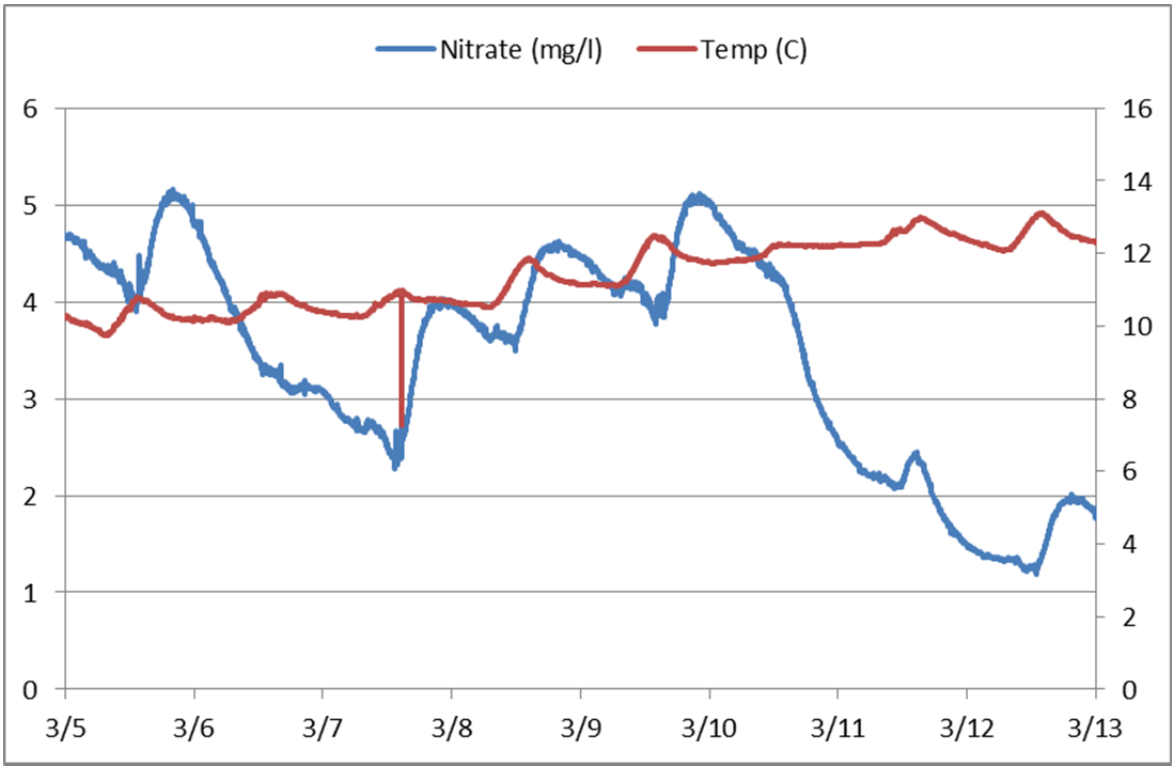
The various columns represent the readings. Column B identifies date and time (for this project we recorded 1-minute intervals). Column D is the reading of the probe. In this example, this reading is the Nitrate levels in the effluent leaving the plant after the final process. Column E identifies the unit of measure for the specific parameter. Column F identifies what the parameter probe is reading. Column H and I identify the temperature and unit of temperature reading.

B	C	D	E	F	G	H	I
S04	NitraLyt+	EFF N03	15391606	3/14/2016 10:57			
3/14/2016 10:57	Valid	2.42746	mg/l	NO3-N	Valid	12.4164	°C
3/14/2016 10:56	Valid	2.43662	mg/l	NO3-N	Valid	12.4192	°C
3/14/2016 10:55	Valid	2.44483	mg/l	NO3-N	Valid	12.425	°C
3/14/2016 10:54	Valid	2.44699	mg/l	NO3-N	Valid	12.4294	°C
3/14/2016 10:53	Valid	2.4579	mg/l	NO3-N	Valid	12.4396	°C
3/14/2016 10:52	Valid	2.45697	mg/l	NO3-N	Valid	12.4453	°C
3/14/2016 10:51	Valid	2.43737	mg/l	NO3-N	Valid	12.4322	°C
3/14/2016 10:50	Valid	2.41957	mg/l	NO3-N	Valid	12.4208	°C
3/14/2016 10:49	Valid	2.40215	mg/l	NO3-N	Valid	12.4192	°C
3/14/2016 10:48	Valid	2.39289	mg/l	NO3-N	Valid	12.4149	°C
3/14/2016 10:47	Valid	2.39142	mg/l	NO3-N	Valid	12.4149	°C
3/14/2016 10:46	Valid	2.36587	mg/l	NO3-N	Valid	12.4149	°C
3/14/2016 10:45	Valid	2.34871	mg/l	NO3-N	Valid	12.4134	°C
3/14/2016 10:44	Valid	2.32305	mg/l	NO3-N	Valid	12.4106	°C
3/14/2016 10:43	Valid	2.32205	mg/l	NO3-N	Valid	12.4134	°C
3/14/2016 10:42	Valid	2.32259	mg/l	NO3-N	Valid	12.4165	°C
3/14/2016 10:41	Valid	2.31466	mg/l	NO3-N	Valid	12.4192	°C

The term “Valid” shows up in columns C and G. This is another tool for operators to indicate if readings are working or if something happened and at what specific minute and day to that sensor. Additional readings in these columns could be:

1. Valid—meaning good reading taken (sensor is in the process of logging and working properly).
2. Invalid—meaning a reading on that particular parameter could not be recorded telling the operator something is wrong.
3. Missing—meaning all data is missing, for example if the probe is off-line for maintenance.

This is one example for the nitrogen readings. Given the multiple probes and the different processes within the Wareham WPCF, and also that readings are either every minute or 5-minutes, the recorded data is extensive. A sample plot of a week of data from one of the probes is shown on the following page. A separate thumb drive that includes the data from each probe over several days has been submitted separate from this report.



Plot of sample nitrate and temperature data from one set of monitoring probes (S04).

E. Reactive Steps for Monitoring

The reactive steps for each probe are shown below:

Influent BOD/COD and pH. If unusual loads are shown through these probes, the plant can bypass flow to the holding lagoons.

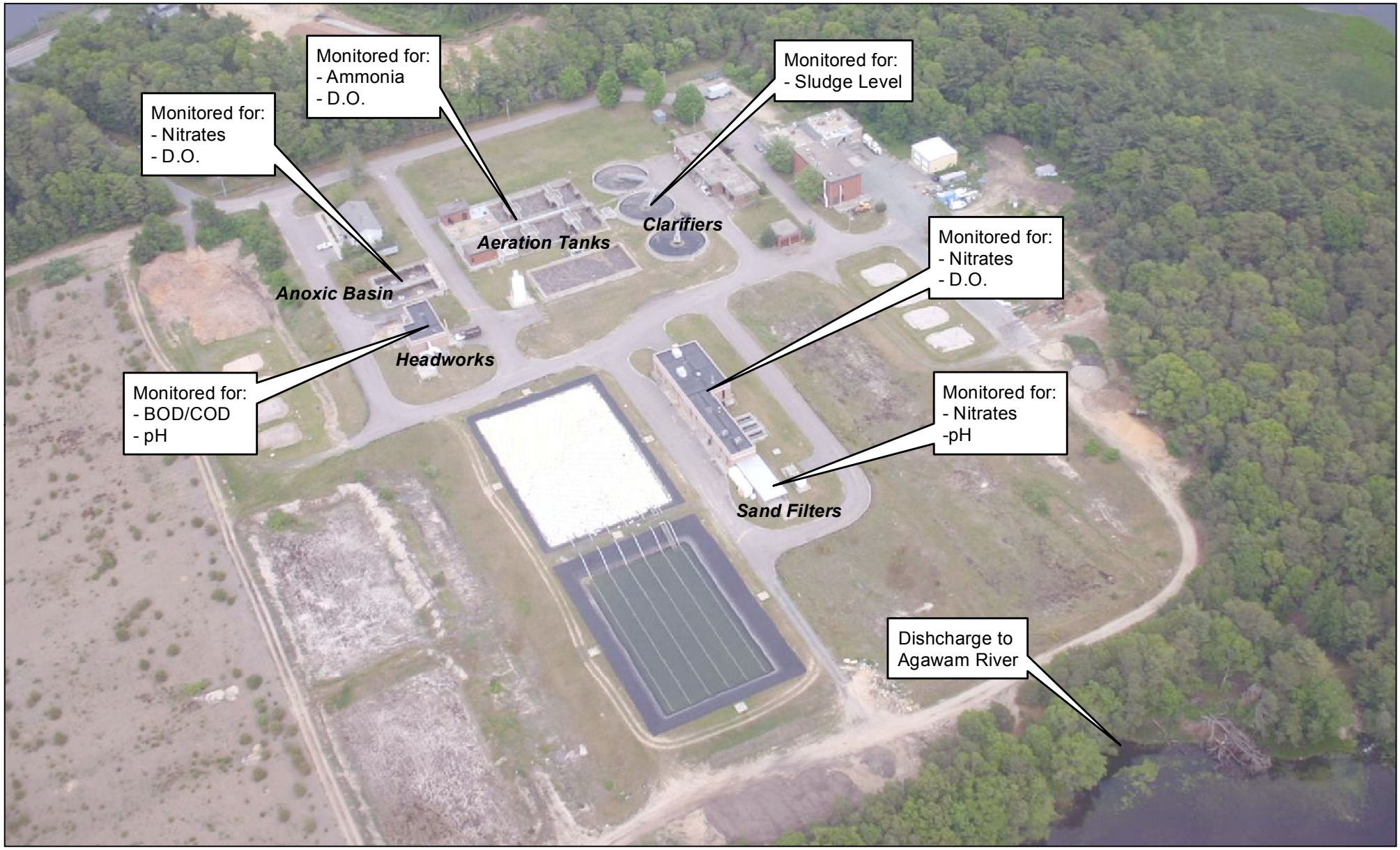
Anoxic Basin DO and Nitrates. Monitoring DO and nitrates will help to optimize recycle rates. If nitrates or DO are high, the flowrate can be reduced to stabilize the rates; the opposite may be performed if nitrates and DO are low.

Aeration Basin. The ammonia and DO will be used to ensure adequate but not excessive oxygen is added to the tanks. DO readings can have a direct impact on air sent via an existing control system. If ammonia levels are low, air levels can potentially be decreased.

Clarifier Sludge Levels. If sludge levels are too high, the plant personnel can troubleshoot the clarifiers to identify the problem.

Sand Filter DO, Nitrate, and pH. These are used to help determine whether or not the methanol dose is adequate. Once determined, adjustments to the pumps can be made.

Figures



Paper Size ANSI A

Not to Scale

Map Projection: Lambert Conformal Conic
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet

N

LEGEND

Town of Wareham, MA

Process Monitoring for Optimal Nitrogen Treatment and Outfall Reduction

AERIAL IMAGE OF WAREHAM WPCF AND PROCESS PROBE LOCATIONS

Job Number	86-18712
Revision	A
Date	06 Jan 2016

Figure 1

N:\US\Hyannis\Projects\86\18712\GIS\Maps\MXD_Deliverables\8618712F03.mxd

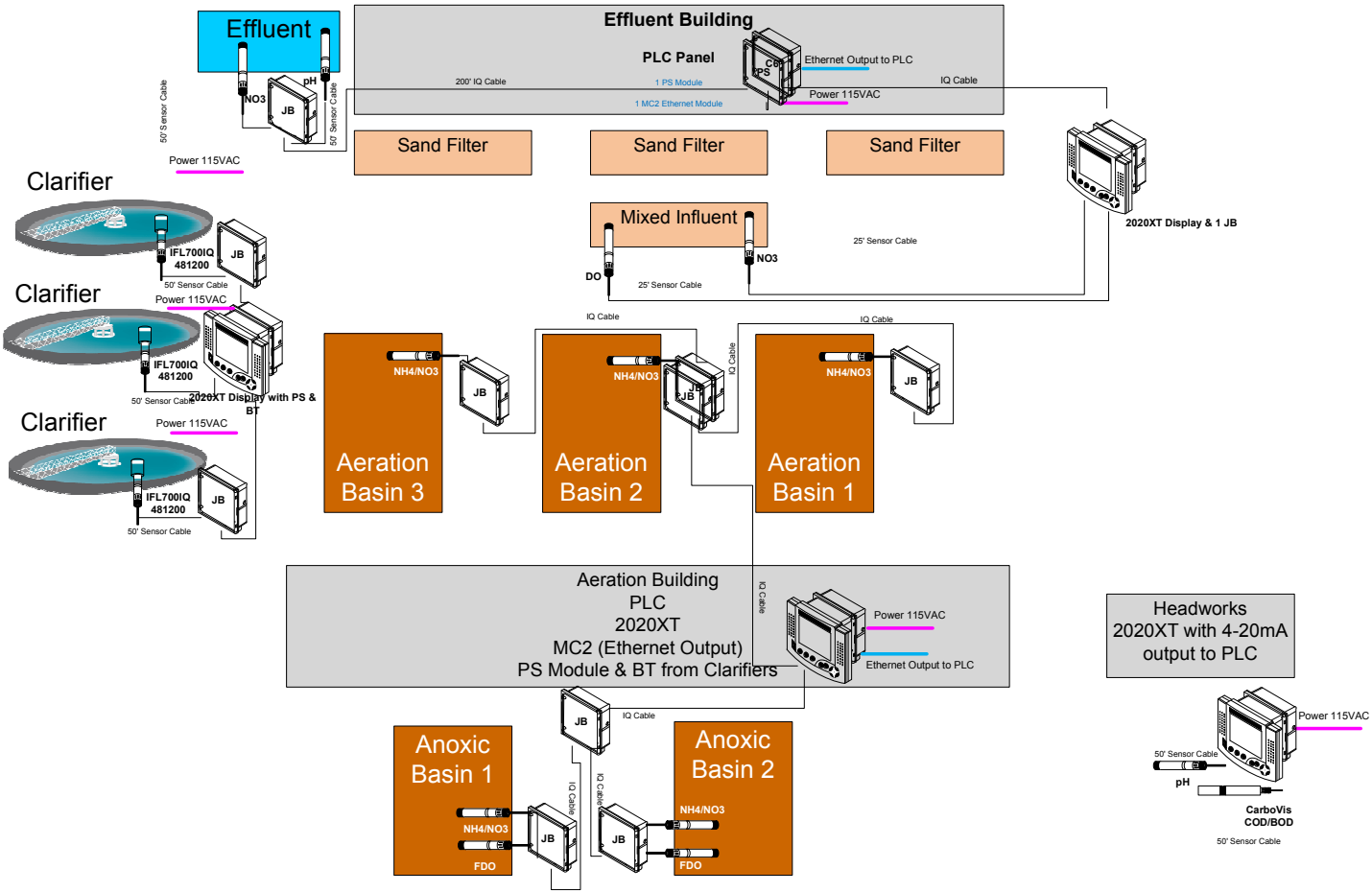
1545 Iyannough Road, Hyannis Massachusetts 02601 USA T 1 508 362 5680 F 1 508 362 5684 E hyamail@ghd.com W www.ghd.com

Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by:jjobrien

Appendices

Appendix A - Process Schematic

Wareham WWTP

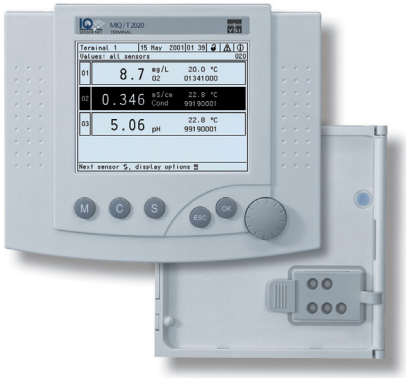


Appendix B - Monitoring Probe Specifications

a xylem brand

SPECIFICATIONS

DOCUMENT #W100



YSI IQ SensorNet 2020 XT

Continuous Water Quality Monitoring for Process Control

Powerful yet simple, the YSI **IQ SensorNet 2020 XT** is a modular water quality system for complete process control designed for wastewater. The 2020 XT network can accept additional sensors easily at any time and grow as your facility grows. Benefits include better network visibility and management, early detection of network failures, improved compliance with regulatory targets, and cost savings (energy, pump/blower maintenance, labor).

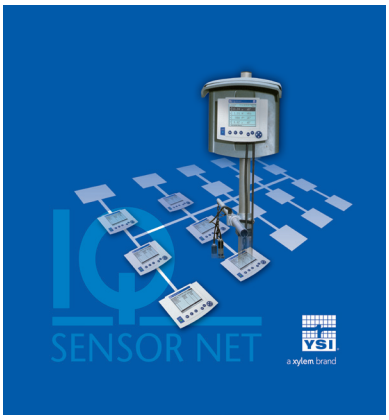
- 3-year instrument warranty
- User-replaceable cables and sensors. Many sensors provide ultrasonic cleaning.
- Centralized power supply along entire network; 2-wire cable provides power and communications
- Lightning protection along network
- 2020 XT provides tactile buttons; easily use while wearing gloves
- Modular expansion from 1 to 20 sensors; ability to extend network with additional modules
- Up to 48 output channels are possible
- LED status light
- Programmable access permission
- System redundancy if two terminals are used; use in one location or move from point to point

Building a system is easy...choose the IQ SensorNet 2020 XT, determine which modules are needed (control, communications, etc.), determine distances for cabling and select parameters.

Parameters:

Dissolved Oxygen (optical or electrochemical)
pH
ORP/Redox
Conductivity/Salinity
Temperature
Turbidity*
TSS (total suspended solids)*
Ammonium
Nitrate
Potassium
COD (chemical oxygen demand)*
TOC (total organic carbon)*
DOC (dissolved organic carbon share of TOC)*
SAC (spectral absorption coefficient)*
BOD (biochemical oxygen demand)*

* ultrasonic cleaning for sensors



YSI.com/IQSN2020

IQ SensorNet 2020 XT Terminal/Controller Specifications

Certifications	ETL, cETL (conforms with relevant UL and Canadian standards), CE
Electromagnetic Compatibility	EN 61326, Class B; FCC Class A, EMC for indispensable operation
Integrated Lightning Protection	According to EN 61326 enhanced over-voltage protection for *entire system*, implemented in each component
Cable	2-wire with shield for power supply and communications; resistant to polarity reversal; comprehensive EMC shield control; cable topology within network can be in the form of a line, tree, star or multiple star Total cable length max. = 1000 m (3280 ft) without signal amplifying; with signal amplifying module MIQ/JBR add an additional 1000 m
Radio	Radio transmission Class 1 with a range of 100 m (328 ft); max 300 m (984 ft)
Module Coupling at Rear	Combined mechanical and electrical connection for rapid coupling to modules; no wiring required
USB Interface	USB-A (host)
Display	Graphic display; resolution 320 x 240 pixels; visible area 114 x 86 mm (4.49 x 3.39 in); backlit
Control Keys/Buttons	5 operation keys: 3 master keys for Measurement (M), Calibration (C), Set/System settings (S) 2 function keys for confirmation/switching menu OK (OK) and Escape (ESC) 4 directional button for quick selection of software functions and input of alphanumeric values
Datalogger	MIQ/TC 2020 XT; data memory for up to 525,600 data sets
Electrical	Directly via the IQ SensorNet when coupled to an MIQ module
Temperature Conditions	Operating Temperature: -4 to 131 °F (-20 to 55 °C) Storage Temperature: -13 to 149 °F (-25 to 65 °C)
Enclosure	Material: ASA (Acrylonitrile-Styrene-Acryloesterpolymer) Rating: IP-66, equivalent to NEMA 4X (not suitable for conduit connection) Dimensions: 210 W x 170 H x 40 D mm (8.27 W x 6.69 H x 1.57 D in) Weight: 0.7 kg (1.54 lbs) Warranty: 3 years

IQ SensorNet 2020 XT Module (MIQ) Specifications

Module Coupling at Front	Combined mechanical and electrical connection for rapid docking and removal of the terminal and docking additional modules
Module Coupling at Rear	Combined mechanical and electrical connection for docking additional modules; a total of 3 modules as a stacked mounted unit
Cable Feeds	4 screw cable glands M 16 x 105
Terminal Connections	Screw terminal strips; terminal area for solid connectors 0.2 to 4.0 mm for flexible connectors 0.2 to 2.5 mm; accessible through cover Used for connecting sensors or as an input/output or for looping through/branching of the IQ SensorNet cable
Additional Functions	Two LEDs (yellow and red) for monitoring the operating voltage; lightning protection; connection resistant to reversed polarity; integrated local identity; integrated switchable terminal resistor (SN terminator)
Enclosure	Material: PC 20% GF (Polycarbonate with 20% fiberglass) Rating: IP-66, equivalent to NEMA 4X (not suitable for conduit connection) Dimensions: 144 W x 144 H x 52 D mm (5.67 W x 5.67 H x 2.05 D in) Weight: 0.5 kg (1.1 lbs) Warranty: 3 years

IQ SensorNet 2020 XT Ordering Information (order 2020 XT, modules, cables, sensors separately)

MIQ/TC 2020 XT Item #470 000Y	Central terminal/controller unit only. Required to be installed once at any point, remains in the system and cannot be removed. Operation mode is shown through status LED. Up to 20 sensors can be connected.
MIQ/TC 2020 XT-H3 #470 016Y	Multiparameter system consisting of 2020 XT, MIQ/CR3 (3 analog and 3 relays) and MIQ/PS (power supply). Up to 20 sensors Item can be connected.
MIQ/TC 2020 XT-H3 C6 #470 017Y	Multiparameter system consisting of 2020 XT, MIQ/C6 (6 analog outputs) and MIQ/PS (power supply). Up to 20 sensors can Item be connected.

YSI
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YSI.com

Printed in the USA. W100 January, 2012

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a xylem brand

SPECIFICATIONS

DOCUMENT #W107

YSI 701/705 IQ CarboVis® UV/VIS Sensor

Carbon/TSS UV/VIS Measurement for the IQ SensorNet System

The CarboVis® is a reagentless, optical-based spectrophotometer built into a rugged, corrosion-resistant field probe for the IQ SensorNet system. The CarboVis can report up to 5 parameters including: COD (total and soluble), BOD, UVT-254, TOC, DOC, SAC (total and soluble) and TSS (optional). The CarboVis probe scans 256 wavelengths per measurement between 200 and 720 nm to provide the most accurate measurements with precise compensation for interferences such as turbidity. The CarboVis provides continuous data to help operational improvement decisions. The probe's built-in UltraClean ultrasonic cleaning technology reduces routine maintenance requirements.

Parameters:

COD (total and soluble)

BOD

UVT-254

TOC

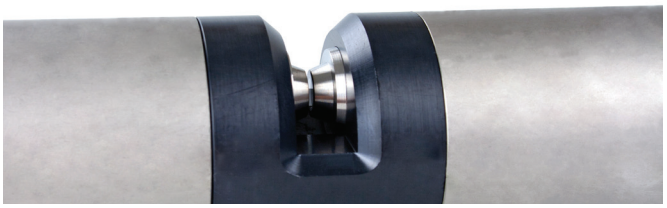
DOC

SAC 254 (total and soluble)

TSS (optional)

- 256 wavelength scans per measurement results in better accuracy and better compensation for interferences
- UVT-254 measurement used to determine required UV light intensity and contact time for disinfection, lowering a facility's disinfection costs
- Factory calibrated
- 2-year warranty
- Two options available - one ideal for effluent applications and one ideal for influent/aeration/effluent applications
- Maintenance free ultrasonic cleaning with UltraClean technology built-in; prevents biofouling from taking place. Built-in air holes for added air cleaning in high fouling applications.

A 5 mm gap YSI UV/VIS sensor deployed after one week with UltraClean technology. No fouling observed.



UV/VIS probes are rugged, accurate and designed to withstand field conditions. The optics are kept clean with UltraClean technology and the sensor's 256 wavelength scan provides unmatched accuracy. A 1 mm gap sensor is pictured.

CarboVis 701/705 IQ Technical Specifications

Measurement Method	UV/VIS spectral measurement (200-720 nm)	
Measurement Range	CarboVis 701 (influent/aeration/effluent)	CarboVis 705 (effluent)
COD (total)	0 to 20,000 mg/L (influent) 0 to 4,000 mg/L (effluent)	0.0 to 800.0 mg/L
COD (soluble)	0 to 12,500 mg/L (influent/aeration) 0 to 4,000 mg/L (effluent)	0 .0 to 800.0 mg/L
BOD	0 to 8,000 mg/L (influent) 0 to 2,500 mg/L (effluent)	0.0 to 500.0 mg/L
TOC	0 to 20,000 mg/L (influent) 0 to 2,500 mg/L (effluent)	0.0 to 500.0 mg/L
DOC	0 to 12,500 mg/L (influent/aeration) 0 to 2,500 mg/L (effluent)	0.0 to 500.0 mg/L
UVT-254	0.0 to 100.0 % (influent/aeration/effluent)	0.0 to 100.0 %
SAC 254 (total)	0 to 5,000 1/m (influent/aeration) 0 to 3,000 1/m (effluent)	0.0 to 600.0 1/m
SAC 254 (soluble)	0 to 3,000 1/m (influent/aeration/effluent)	0.0 to 600.0 1/m
TSS (optional)	0.00 to 15.00 g/L (influent) 0 to 4,500 mg/L (effluent)	0.0 to 900.0 mg/L
Resolution (range dependent)	1 mg/L, 1 1/m, 0.1 %, 0.01 g/L (TSS), 1 mg/L (TSS)	0.1 mg/L, 0.1 1/m, 0.1% 0.1 mg/L (TSS)
Measuring gap	1 mm	5 mm
Operating Temperature	0 to 45 °C (32 to 113 °F)	Storage Temperature -10 to 50 °C (14 to 122 °F)
Warranty	2-years	
Flow Rate	≤ 3 m/s (~1 ft/s)	
pH range	4 to 12 units	
Cleaning System	UltraClean, ultrasonic cleaning system built directly into the sensors; air cleaning also available	
Dimensions	Length 802 mm (31.5 in); diameter 59.9 mm (2.35 in); weight ~ 4 kg (8.8 lbs)	
Certifications	CE, cETLus	
Protection Class	Sensor with SACIQ cable connected: IP68	
Pressure Resistance	1 bar (14.5 psi)	
Lightning/Voltage Protection	Yes	
Electrical	Power Consumption: 8 W, Two wire shielded IQ cable provides power and communication	
Materials	Housing: Titanium 3.7035, PEEK Window: Sapphire glass	

CarboVis 701/705 IQ Digital Sensor Ordering Information (must be used with the YSI IQ SensorNet, sensor cable sold seperately)

CarboVis 701 IQ Item #481 048Y	1 mm gap UV/VIS spectral carbon sensor for water/wastewater monitoring and control; influent, aeration tank or effluent; integrated UltraClean technology provides ultrasonic cleaning; includes protective guards
CarboVis 701 IQ TS Item #481 049Y	1 mm gap UV/VIS spectral carbon and TSS sensor for water/wastewater monitoring and control; influent, aeration tank or effluent; integrated UltraClean technology provides ultrasonic cleaning; includes protective guards
CarboVis 705 IQ Item #481 050Y	5 mm gap UV/VIS spectral carbon sensor for water/wastewater monitoring and control; effluent; integrated UltraClean technology provides ultrasonic cleaning; includes protective guards
CarboVis 705 IQ TS Item #481 051Y	5 mm gap UV/VIS carbon and TSS sensor for water/wastewater monitoring and control; effluent; integrated UltraClean technology provides ultrasonic cleaning; includes protective guards

Visit YSI.com/IQ for additional information on the entire IQ SensorNet system.

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YSI.com @YSIinc facebook.com/myYSI

Printed in the USA. W107 October, 2013

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a xylem brand

SPECIFICATIONS

DOCUMENT #W102

YSI IQ SensorNet FDO®

Optical Dissolved Oxygen Sensor

The FDO is an optical, luminescent based DO sensor for the IQ SensorNet system. During the biological nutrient removal process at wastewater treatment plants, continuous and precise measurement of dissolved oxygen concentration is of vital importance for optimal performance and trouble-free operation. Efficiency and energy demand is mainly determined by the performance of the aeration control system. The FDO is a reliable, proven, long-term solution for continuous DO data that can help optimize your process and lower energy costs.

Parameters:

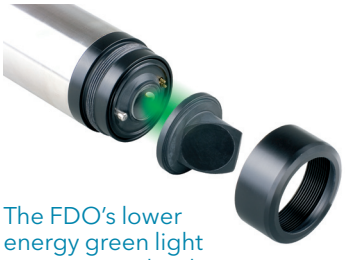
Dissolved Oxygen (optical)

Temperature

- **Intelligent Sensor Cap**
  The sensor cap is individually factory calibrated. Calibration data is stored on a chip that is embedded in the sensor cap. No need to enter calibration coefficients. When a new cap is installed, the coefficients are recognized and sent directly to the controller terminal eliminating the need to manually enter information.

- **Equal Path Reference System**
  The optical measurement and reference paths are identically designed. This allows for identical aging of the components which enables accurate compensation and eliminates calibrations. That's correct, there is no calibration required.

- **Green Light Technology**
  Softer, low-intensity excitation light increases the lifetime of the cap. This translates into a two year warranty on the standard cap.



The FDO's lower energy green light excitation technology extends the sensor cap lifetime.

Learn More:

Scan with a smart phone or tablet, to see the FDO angled sensor tip allow bubbles to pass by.

YSI.com/FDO

IQ SensorNet FDO Optical Dissolved Oxygen General Specifications

Sensor Cap Replacement	Yes; the cap, can be replaced. Automatic recognition by the sensor of the cap including the factory calibration.	
Calibration Capability	Yes; not required, factory calibrated	
Interferences	None	
Minimum Flow Rate	None; no flow requirement	
Response Time at 25 °C	700 IQ and 700 IQ SW - T90 = <150 seconds; T95 = <200 seconds	
	701 IQ and 701 IQ SW - T90 = <80 seconds	
Signal Output	Digital	
Lightning Protection	Yes	
Power Consumption	0.7 watts	
Maximum Pressure	10 bars (145 psi); with sensor connection cable	
Electrical Connections	2-wire shield cable with quick sensor connection	
Conformance/Certifications	EN 61326, Class B, FCC Class A; Intended for indispensable operation, CE, cETLus	
Temperature Conditions	Operating Temperature:	23 to 122 °F (-5 to 50 °C)
	Storage Temperature:	-13 to 122 °F (-25 to 50 °C)
Sensor	Material:	Housing - VA steel 1.4571; Sensor Cap and Locking Cap - POM (Polyoxmethylene), PVS, silicone, PMMA
	Rating:	IP-68; waterproof
	Dimensions:	400 L x 40 D mm (15.75 L x 1.57 D in)
	(length x diameter)	400 L x 59.5 D mm (15.75 L x 2.34 D in) Salt Water version
	Weight:	900 g (1.98 lbs)
		1,500 g (3.31 lbs) Salt Water version
	Warranty:	2 years

IQ SensorNet FDO Optical Dissolved Oxygen Technical Specifications

Dissolved Oxygen Range		
	Concentration	0 to 20.00 mg/L
	Saturation	0 to 200.0%
Dissolved Oxygen Resolution		
	Concentration	0.01 mg/L
	Saturation	0.1%
Temperature		
	Measurement	23 to 140 °F (-5 to 60 °C)
	Compensation	32 to 140 °F (0 to 60 °C)

IQ SensorNet FDO Ordering Information (order 2020 XT terminal, modules, cables, sensors separately)

FDO 700 IQ (#201 650Y)	Optical DO sensor for monitoring and control; includes 1 factory calibrated sensor cap.
FDO 700 IQ SW (#201 652Y)	Salt Water Design Optical DO sensor for monitoring and control; includes 1 factory calibrated sensor cap.
FDO 701 IQ (#201 660Y)	Optical DO sensor for monitoring and control; faster response time; includes 1 fast response factory calibrated cap.
FDO 701 IQ SW (#201 653Y)	Salt Water Design Optical DO sensor for monitoring and control; faster response time; includes 1 fast response factory calibrated cap.
SC-FDO 700 (#201 654Y)	Replacement; universal factory calibrated sensor cap for FDO 700 IQ and FDO 700 IQ SW
SC-FDO 701 (#201 655Y)	Replacement; fast response factory calibrated sensor cap for FDO 701 IQ and FDO 701 IQ SW

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SPECIFICATIONS

DOCUMENT #W103

YSI 700 IQ IFL Sensor

Interface/Sludge Level Measurement for the IQ SensorNet 2020 XT System

The IFL is an ultrasonic, interface level measurement sensor for the IQ SensorNet system. During the wastewater treatment process, the measurement of the interface level between liquids is of vital importance for optimal performance and trouble-free operation. The 700 IQ IFL provides continuous data to help operational efficiency improvement decisions. Simply connect it to the 2020 XT IQ SensorNet system.

Parameters:

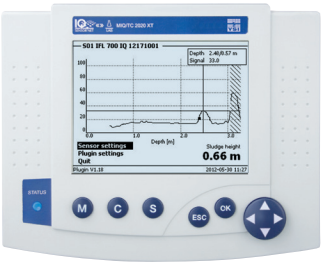
Interface sludge level

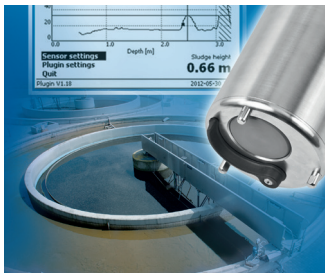
Applications:

Wastewater treatment (municipal and industrial); primary and secondary clarifiers and gravity thickeners

Water Treatment pre-sedimentation clarifiers and flocculator clarifiers

- Intelligent signal processing - filters out undesired signals caused by floating sludge, internal fittings, or moving skimmers
- Simple system configuration with the IQ SensorNet
- Detailed display of echo profile (density of reflecting particles) for graphical visualization
- Maintenance free non-contact cleaning system
- 2-year sensor warranty
- Advanced settings for demanding application





IFL 700 IQ Technical Specifications

Measurement Method	Ultrasound echo measurement (ultrasonic)
Measurement Range	0.4 to 15 m (1.32 to 49.21 ft)
Resolution	0.01 m (0.03 ft)
Accuracy	0.1 m (0.3 ft)
Signal Filters	Yes
Flow Speed	Max. 4 m/s (~13 ft/s)
Cleaning System	Automatic, non-contact wiper (optional)
SensCheck	Alarm; humidity sensor
Dimensions	Length 442 mm (17.4 in); max. diameter 105 mm (4.13 in)
Weight	Approx. 3.6 kg (~8 lbs)
Immersion Depth	Min. 5 cm (1.97 in); max. 3 m (9.8 ft)
Protection Class	Sensor with SACIQ cable connected: IP68; 0.3 bar (4.3 psi)
Pressure Resistance	The sensor with connected SACIQ cable complies with the requirements of article 3(3), 97/23/EU guideline. 0.3 bar (4.3 psi)
pH range	4 to 12 units
Operating Temperature	0 to 50 °C (31 to 122 °F)
Storage Temperature	-5 to 50 °C (23 to 122 °F)
Materials	Shaft and baseplate: stainless steel 1.4571 Plug head and transition unit: POM Ultrasound unit: PVC-C Cleaning system: Grade 2 Titanium (shaft) and Grivory
Equipment Safety, Standards	EN 61010-1; UL 61010-1; CAN/CSA C22.2#61010-1
Electrical	Nominal voltage 24 VDC, provided by the IQ SensorNet system
Power Consumption	2.8 W
Certifications	CE, cETL, ETL
System Compatibility	YSI IQ SensorNet system 2020 XT

IFL 700 IQ Digital Sensor Ordering Information (must be used with the YSI IQ SensorNet 2020 XT)

IFL 700 IQ Item #481 200Y	Digital ultrasound interface level sensor with automatic cleaning system
IFL 700 IQ Item #481 201Y	Digital ultrasound interface level sensor
IFL -D Item #481 205Y	Sensor mount with deflector for IFL 700 IQ for use with moving surface skimmers
IFL -RM Item #481 207Y	Rail mounting for IFL 700 IQ (works with IFL-D)

Visit YSI.com/IQ for additional information on the entire IQ SensorNet system.

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SPECIFICATIONS

DOCUMENT #W111

YSI Digital VARiON® Ammonium/Nitrate/Potassium/ Chloride for the IQ SensorNet System

The VARiON is a rugged, online probe for measuring Nitrate and Ammonium concentrations with Ion Selective Electrodes (ISEs) in wastewater process applications.

The VARiON probe is used within the IQ SensorNet system and can therefore be networked with other probes and parameters for a complete process monitoring and control system. It can measure, report and control off of the ammonium and/or nitrate measurements with automatic compensation for potassium (for ammonium) or chloride (for nitrate).

The VARiON is the ideal probe for quantitative measurement of nitrogen in a wastewater treatment plant. The efficient control of Nitrogen in wastewater relies on the ability to take the measurements directly in the process. This direct ISE measuring technology is possible with the VARiON sensor, enabling optimization of a plant in respect to process efficiency and energy consumption.

Parameters:

Nitrate

Ammonium

Potassium (compensation & can be reported)

Chloride (compensation only)

- Single- or dual- measurement of ammonium and nitrate; measurement of potassium or chloride for automatic compensation
- Individually, user-replaceable electrodes and reference
- VARiON reference system is very stable over long periods of time
- Electrodes are recognized automatically
- Factory calibrated with optional in-situ calibration for improved accuracy
- 2-year warranty on the probe, 1-year on electrodes

The VARION probe provides continuous ISE data to help control & optimize the wastewater process.

VARION Plus 700 IQ Technical Specifications

Parameter	Measuring Range	Resolution	
NO_3	.5 to 450.0 mg/L	0.5 mg/L	
	5 to 4500 mg/L	5 mg/L	
NO_3-N	0.1 to 100.0 mg/L	0.1 mg/L	
	1 to 1000 mg/L	1 mg/L	
mV (Nitrate)	-2000 to 2000 mV	1 mV	
NH_4	0.1 to 129.0 mg/L	0.1 mg/L	
	1 to 1290 mg/L	1 mg/L	
NH_4-N	0.1 to 100.0 mg/L	0.1 mg/L	
	1 to 1000 mg/L	1 mg/L	
mV (Ammonium)	-2000 to 2000 mV	1 mV	
K	1 to 1000 mg/L	1 mg/L	
mV (Potassium)	-2000 to +2000 mV	1 mV	
Cl (compensation only)	1 to 1000 mg/L	1 mg/L	
mV (Chloride)	-2000 to 2000 mV	1 mV	
Temperature	-5 to 60 °C (23 to 140 °F)	0.1 °C	Accuracy=± 0.5 °C
Operating & Compensation Range Temperature	0 to 40 °C (32 to 104 °F)	Storage Temperature	0 to 40 °C (32 to 104 °F)
Warranty	2 years on probe, 12 months on electrode		
pH range	4 to 8.5 for Ammonium, 4 to 11 for Nitrate		
Dimensions	Length 392 mm (15.43 in); diameter 55 mm (2.17 in); weight (without sensor cable)~ 670 g (1.5 lbs)		
Certifications	CE, cETLus		
Protection Class	Sensor with SACIQ cable connected: IP68		
Pressure Resistance	0.2 bar (2.9 psi); maximum deployment depth = 2 meters		
Lightning/Voltage Protection	Yes		
Electrical	Power Consumption: 0.2 W, Two wire shielded IQ cable provides power and communication		
Materials	Housing: Stainless Steel 1.4571, POM (for electrode material see product manual)		

VARION Plus 700 Electrode Specifications

Electrode - NH_4, NO_3, K, Cl, Ref	
Measured at 20° C (68° F) and concentration change of..	NH_4, Cl = 10 to 100 mg/L NO_3, K = 5 to 50 mg/L
Response time T_{90}	< 3 min

VARION Plus 700 IQ Sensor Ordering Information

107040Y	VARiONPlus 700 IQ. Robust digital probe for the ion-selective measurement (in-situ) of ammonium and nitrate, for use with the IQ SensorNet system. Supplied with: Probe VARiONPlus 700 IQ with 4 blind plugs, guard and calibration vessel. Order electrodes separately.
107042Y	VARiON Ref. Reference electrode for mounting into VARiONPlus 700 IQ, NitraLyt Plus or AmmoLyt Plus probe.
107044Y	VARiON Plus NH_4. Ammonium electrode for VARiON Plus 700 IQ and AmmoLyt Plus, measuring range: 0.1 - 1000 mg/l NH_4-N.
107045Y	VARiON Plus NO_3. Nitrate electrode for VARiON Plus 700 IQ and NitraLyt Plus/NitraLyt, Measuring range: 0.1 - 1000 mg/l NO_3.
107046Y	VARiON Plus K. Potassium electrode for VARiON Plus 700 IQ and for AmmoLyt Plus, measuring range: 1 - 1000 mg/l K+.
107047Y	VARiON Plus Cl. Chloride electrode for VARiON Plus 700 IQ and for NitraLyt Plus, measuring range: 1-1000 mg/l Cl- .

Visit YSI.com/IQ for additional information on the entire IQ SensorNet system

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IQ SensorNet Sensors

SensoLyt
pH/ORP

- SensCheck function monitors sensors
- electrodes are protected
- easily replace electrodes without tools as needed
- pre-amplified sensors
- digital sensors store calibration
- 2-year warranty (6-months electrodes)

ysi.com/sensolyt

SensoLyt Sensor

Operating Temperature	32 to 140°F (0 to 60°C)			
Electrode Type	SEA and SEA-HP pH (gel-polymer solid electrolyte with double pinhole diaphragm; AgCl free and resistant to sulfides)	DWA pH (modified gel electrolyte with single pinhole diaphragm)	ECA pH (gel electrolyte with single pinhole diaphragm)	PtA mV (gel-polymer solid electrolyte with double pinhole diaphragm
Range	2 to 12 pH units and 4 to 12 pH units	0 to 14 pH units	2 to 12 pH units	± 2000 mV (depends on terminal)

Wireless communication within the IQ Sensor Net

WITH THE NEW RADIO MODULE MIQ/WL PS

WTW
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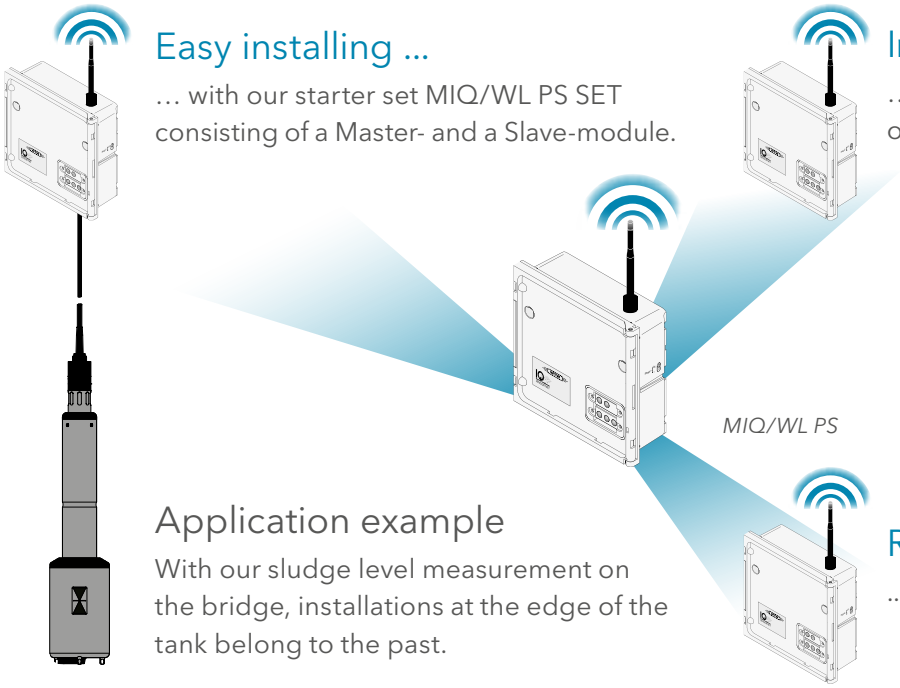
Easy, individual, reliable

- The right measurement at the right location – without cables, easy installed
- 1 Master, several Slaves – save costs with every additional measuring point
- Compatible for IQ Sensor Net System 182 and System 2020



Easy installing ...

... with our starter set MIQ/WL PS SET consisting of a Master- and a Slave-module.

Individual Expansion ...

... of additional radio connections with our extension module MIQ/WL PS.

Application example

With our sludge level measurement on the bridge, installations at the edge of the tank belong to the past.

Reliable communication ...

... by coded data transfer.

Technical data

Number of Slaves/radio connections	Limitation only by spatial situation (if needed, install new radio network by new Master-module)
Max. distance from Master- to Slave-module	100 m (328 ft.)
Radio frequency	2,4 GHz ISM band
Power supply	via IQ Sensor Net or 100 … 240 V AC or 24 V DC

Order information

Model	Description	Order No.
MIQ/WL PS SET*	2 MIQ/WL PS radio modules, pre-configured as Master- and Slave-module, ready to use	480 025
MIQ/WL PS*	1 MIQ/WL PS radio module, pre-configured as Slave for extension of a radio network	480 023

*Not compatible with MIQ/Blue PS SET

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999160US July 2015

Appendix C – Project Photographs

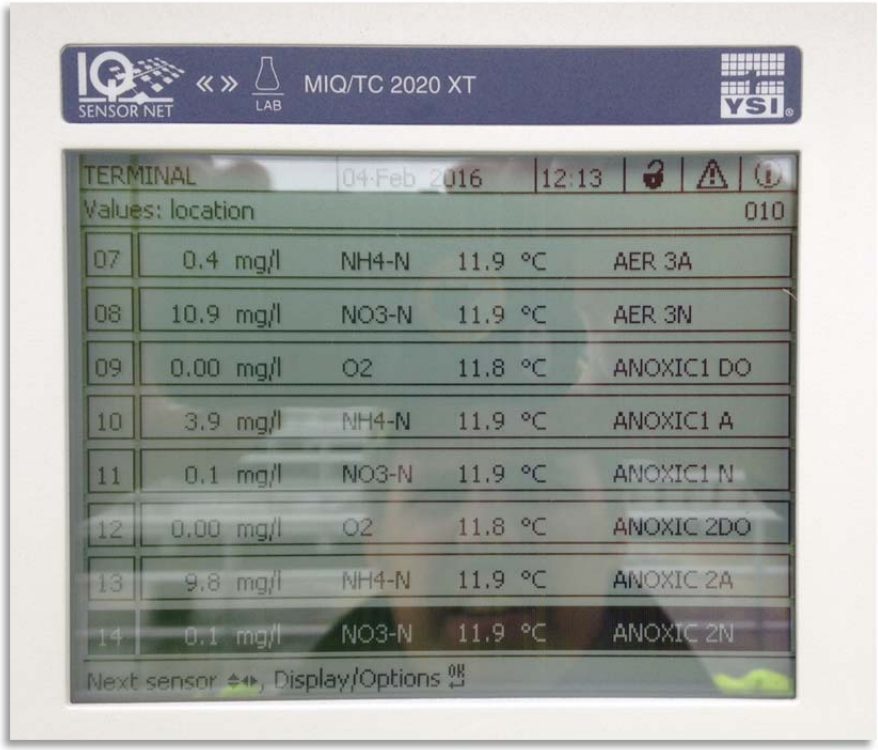
Headworks. Detects pH, BOD, and COD. Photograph shows probe installed in main influent channel. This probe serves as an early warning indicator of irregular spikes in BOD that may be problematic for the downstream process.

Anoxic Tanks. These probes will monitor dissolved oxygen, nitrate, and ammonium. By knowing the exact levels of dissolved oxygen and nitrate in these tanks, the WPCF could potentially fine-tune the nitrogen recycle flowrate to allow for the optimal nitrogen uptake by the microbes in wastewater.

Clarifiers. Probes have been installed in the clarifiers to monitor the sludge levels of the tanks. Monitoring the sludge levels prevents the sludge quantity from getting too high, which could allow solids to pass on to the next process, thereby reducing effectiveness.

Sand Filters and Discharge. The probes installed at this location will monitor dissolved oxygen and nitrogen both before and after this step to ensure the sand filters are working at their optimal capacity and to potentially allow automation of the methanol feed system to help optimal denitrification.

Wireless Communication. The three network centers include (1) the headworks, (2) the anoxic tanks, aeration tanks, and clarifiers, and (3) sand filters and UV disinfection. All communicate with the main WPCF office through Bluetooth technology, note the small antenna on top of each network display.



Display Centers. The three network centers provide a clear and user-friendly readout for operators to manage.

GHD Inc.

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