How 20th Century Technology Innovations Shaped the Development and Delivery of Real-Time Water-Quality Data

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20th Century Technology Innovations

• Instrument Revolution in Chemistry
• Data Storage Systems
• Communication and Environmental Sensing Satellites
• The Internet
Why Continuous Water Quality Monitoring?

Federal Water Pollution Control legislation created a need for

- Surveillance monitoring under rapidly changing conditions in rivers and estuaries
- Spill detection
- Process control in water and wastewater treatment
From Daily to Continuous Measurements

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Submersible instruments
Instrument Revolution in Chemistry starting in the 1930s Replaced Wet Chemical Methods

(Results in Parts per Million)
A New Generation of Instruments

- Potentiometric Instruments
  - pH, Specific Conductance, Dissolved Oxygen, Redox
  - Ion Selective Electrodes (+/- ions)
- Optical Instruments
  - Turbidimeter
  - Spectrophotometer (plus wet chemical sample preparation)
  - Fluorometer
Key Developments in Optical Instruments and Measurements

- Fluorometers for Dyes, FDOM, and Algal Pigments (*in vivo*)
- Advances in FDOM in vivo measurements in fresh and marine waters
- Optical Nitrate and Diss. Oxygen
- Optical DO sensor

Emergence and Expansion of Continuous Monitoring; 1955-1970

- 8 Federal and 2 Interstate Agencies
- 7 State Agencies
- 2 Local Utilities
- 2 Universities
- Province of Ontario, CAN

USGS 1955-1962 Delaware River Estuary

ORSANCO Spill Monitoring Network
Permanent Field Installations of Water Quality Sensors, 1975-2000
Autonomous Vehicles for Mobile Deployments

2002 MARVIN on pontoons
Bendis, Florida Fish and Wildlife Cons.

2003 Autonomous Underwater Vehicle
Glasgow et al., 2004
Guidelines for Use of Water Quality Monitors

by A. Bruce Gordon and Max Kutzentbach

U.S. Geological Survey
Open-file Report 83-401

Reston, Virginia 1983

Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting

Techniques and Methods 1–03

U.S. Department of the Interior
U.S. Geological Survey
21st Century Modern Stream Gaging Station with Water Quality Sensors

Shoda et al., 2016
Generic GOES Data Relay Pattern

Geostationary Operational Environmental Satellite system (GOES)
Internet Starting in 1990s

- Geostationary Operational Environmental Satellite (GOES)
- Domestic Satellite (DOMSAT)
- Local Readout Ground Station
- NWIS Web
- National Water Information System (NWIS)
- Command and Data Acquisition, Wallops Is, VA
- Sauer and Turnipseed, 2010
Specific Conductance, in $\mu$S/cm
Summary 1930-2000

- Laboratory instruments from physical, chemical, biomedical, and water testing laboratories are the basis of most field sensor technology.
- Data collection and storage systems ranged from analog (strip charts) to computer punch tapes and automated digital recorders.
Summary Continued

- Data retrieval and transmission evolved from site visits only to site visits plus radio, land line, cell phone, and satellite relay systems
- Timeliness of data dissemination improved from periodic to near real time on the Internet
Thank you

Questions?