Project Profile Information Form

**Project Title:** Design of Early Warning and Predictive Source-Water Monitoring Systems

**Project Number:** 2527

**Principal Investigators:**
- Walter M. Grayman
- Rolf A. Deininger
- Richard M. Males

**Objectives:**
1) Catalog and assess the existing situation relative to early warning systems
2) Inventory existing monitoring options and explore emerging monitoring technologies
3) Inventory existing water quality models and develop a general purpose early warning stream modeling system
4) Develop and apply a risk-based analysis approach of early warning systems.
5) Develop general guidelines for design and operation of an early warning system

**Background:**
The Safe Water Drinking Act (SDWA) Amendments of 1996 stressed the importance of source water assessment and protection programs as a means of safeguarding our water supplies. An important component of a source water protection program is an early warning system and associated monitoring systems. An early warning system is used to provide timely information on the quality of the source water so that knowledgeable decisions can be made concerning treatment and operations decisions.

**Highlights:**
1. An integrated approach that considers all parts of the water delivery system should be adopted in designing and operating an early warning system.
2. A general purpose one-dimensional spill model for use in rivers was developed and applied to the Ohio River and can be easily adapted for use in a wide range of rivers.
3. A systematic method for designing and operating early warning systems that considers the highly variable, probabilistic nature of many aspects of the system has been developed and demonstrated.
4. Emerging monitoring techniques that may have future applicability in source water monitoring have been identified.

**Approach:**
1. The research approach included a utility survey, an extensive literature review, site visits and development of case studies of advanced early warning systems around the world, and the development and application of computer modeling of components of an early warning system.
2. A systematic method for designing and operating early warning systems that considers the highly variable, probabilistic nature of many aspects of the system was identified.
and a risk-based model using Monte Carlo simulation techniques, was developed and demonstrated.

3. A general purpose one-dimensional spill model for use in rivers has been developed and applied to the Ohio River.

Results/Findings:

1. An effective early warning system includes the following components: (a) detection mechanisms; (b) a means of confirming and characterizing contamination events; (c) an institutional framework; (d) communication linkages; and (e) mechanisms for responding to the presence of contamination in the source.

2. Biomonitors (devices that use living organisms to measure the stresses placed on the organisms by the presence of toxic materials) are conceptually ideal for monitoring water bodies with a wide range of contaminants, have been in use for almost 20 years, but still have limitations and is still an emerging technology.

3. Spill events are highly probabilistic occurrences and a systematic method for designing and operating early warning systems that considers the highly variable, probabilistic nature of many aspects of the system is needed. A risk-based model using Monte Carlo simulation techniques has been developed and demonstrated.

4. A general-purpose one-dimensional spill model for use in rivers, the Riverine Spill Modeling System (RSMS), has been developed and applied to the Ohio River. It can be easily adapted for use in a wide range of rivers.

5. Emerging monitoring techniques that may have future applicability to source water monitoring include electronic noses, and methods for rapid detection of bacteria and other microorganisms.

Impact:
Benefits of the research;

1. Provided a detailed review of advanced early warning systems around the world that can be used by utilities in developing their own early warning system.

2. Established an integrated framework for evaluating early warning systems and a risk-based, probabilistic model for studying the impacts of alternative early warning systems and associated source water monitoring systems.

3. Developed a general-purpose one-dimensional spill model for use in rivers.

4. Provided a detailed assessment of existing monitoring options and emerging monitoring technology for use in early warning systems.

5. Developed general guidelines for design and operation of an early warning system.

Participating Utilities:
East Bay Municipal Utility District
Cincinnati Water Works
American Water Works Service Company, Inc.