# National Ground Water Monitoring Framework -- Update

**Presented By**

**David R. Wunsch**
**Subcommittee on Ground Water (SOGW)**
**Network Design Work Group**
**National Water Quality Monitoring Council (AASG rep)**


**NWQMC Meeting**
**Reston, VA**
**December 9, 2008**

# Today's Presentation

- History
- Mission
- NGWMN Framework Document
- Progress/Schedule
- Questions?

# History of SOGW

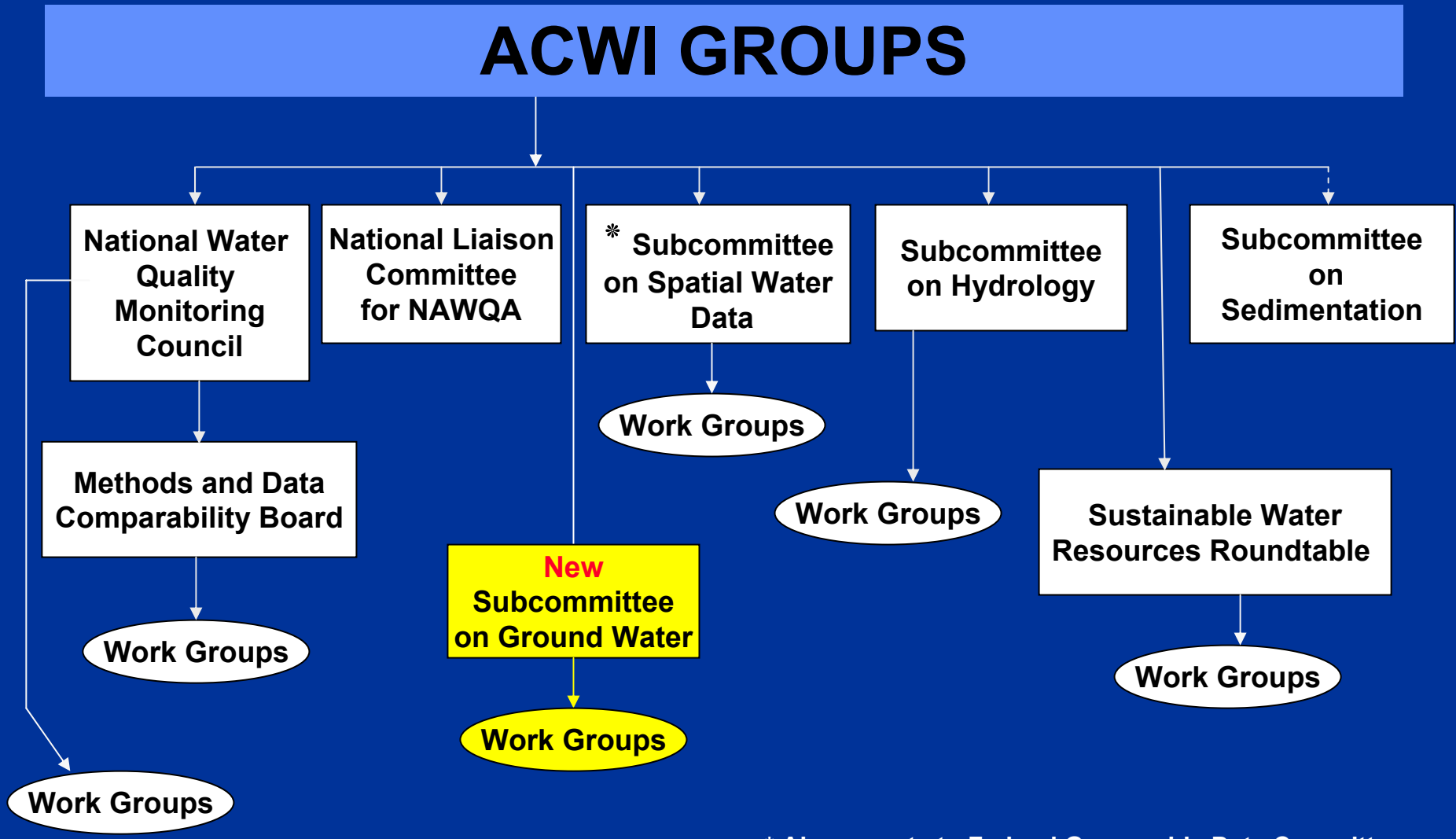
- Jan. 2006:  Suggested formation of ACWI ground water subgroup

- May 2006:  Discussed at NWQMC
- Aug. 2006:  Formed Ad Hoc Steering Committee (SC)
- Sept. 2006: Began drafting Terms of Reference
- Jan. 2007: ACWI approved SOGW
- Currently drafting recommendations to ACWI

WICP Water Information Coordination Program

ACWI Advisory Committee on Water Information

# ACWI GROUPS

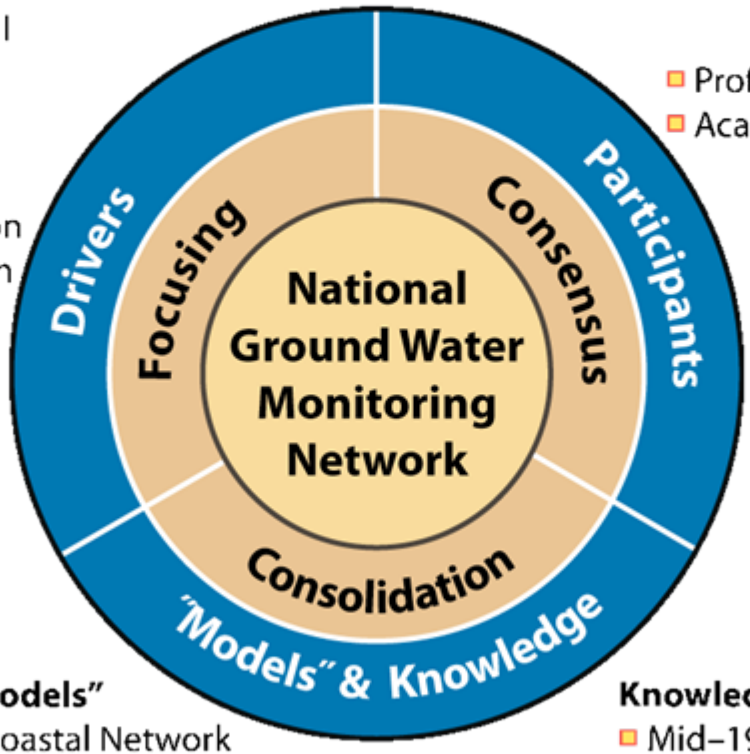



* Also reports to Federal Geographic Data Committee

# ACWI – SOGW Overview

**Drivers**
- FACA
- White House - OSTP/NSTC
- National Water Census
- SECURE Water Bill
- Global Warming
- Droughts
- Sustainability
- Saltwater Intrusion
- CO2 Sequestration

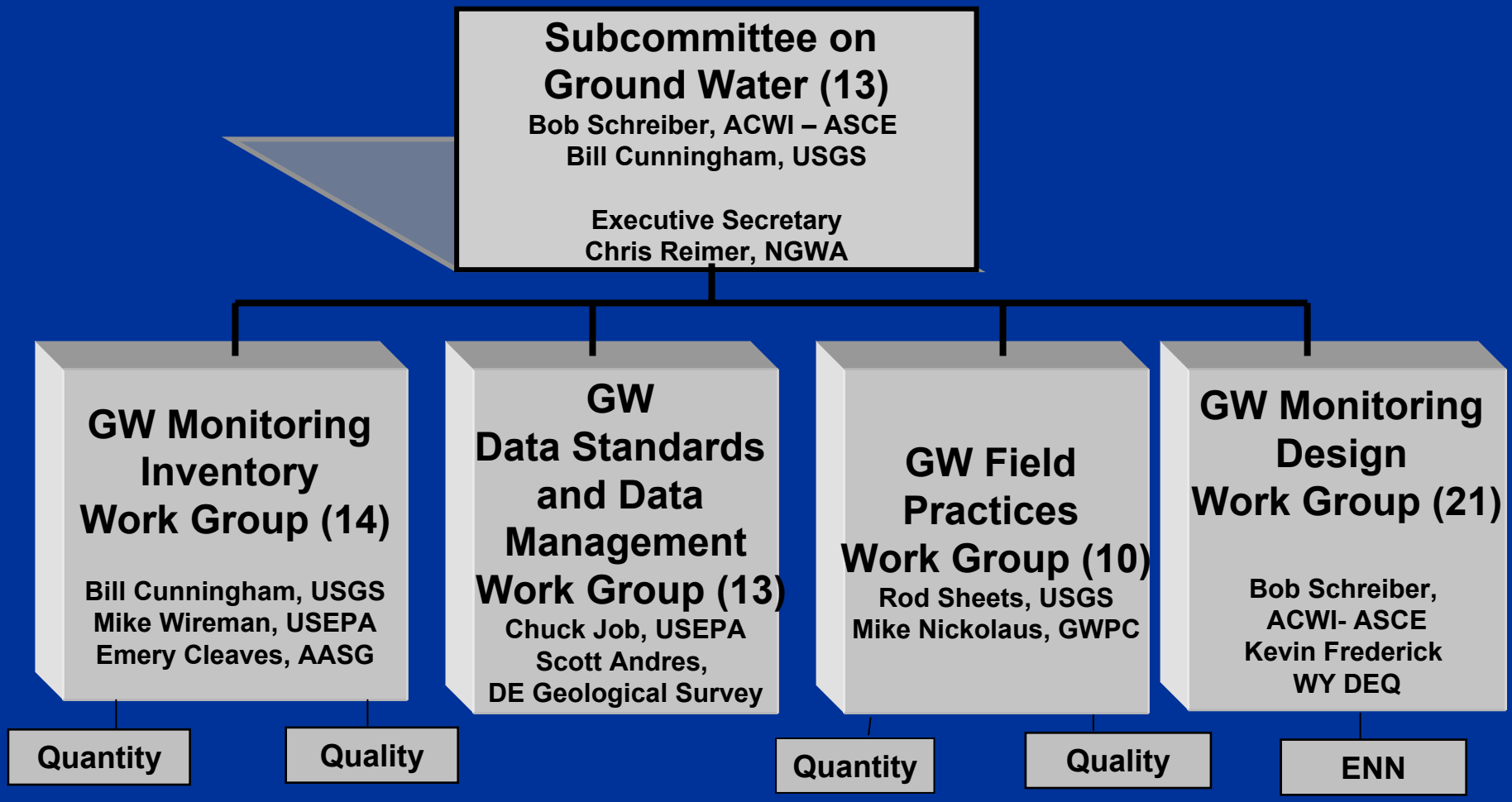
**Participants**
- States
- USGS
- USFS
- USEPA
- Other Federal Agencies
- Professional Organizations
- Academia




**"Models"**
- Coastal Network
- EU/WFD
- USGS (NAWQA, Climate)
- State (FL, IL, MT, NJ, PA, etc.)
- Regional (Ogallala)

**Knowledge**
- Mid–1990s Committee
- ACWI/NWQMC Subcommittees & Products
- CUAHSI
- ASTM
- EDSC

# Work Groups


Subcommittee on Ground Water (13)
Bob Schreiber, ACWI – ASCE
Bill Cunningham, USGS
Executive Secretary
Chris Reimer, NGWA
GW Monitoring Inventory Work Group (14)
Bill Cunningham, USGS
Mike Wireman, USEPA
Emery Cleaves, AASG
GW Data Standards and Data Management Work Group (13)
Chuck Job, USEPA
Scott Andres,
DE Geological Survey
GW Field Practices Work Group (10)
Rod Sheets, USGS
Mike Nickolaus, GWPC
GW Monitoring Design Work Group (21)
Bob Schreiber,
ACWI- ASCE
Kevin Frederick
WY DEQ
Quantity
Quality
Quantity
Quality
ENN

# SOGW Goal

- To develop and encourage implementation of a nationwide, long-term ground-water quantity and quality monitoring framework

- To provide information necessary for the planning, management, and development of ground water supplies to meet current and future water needs, and ecosystem requirements.

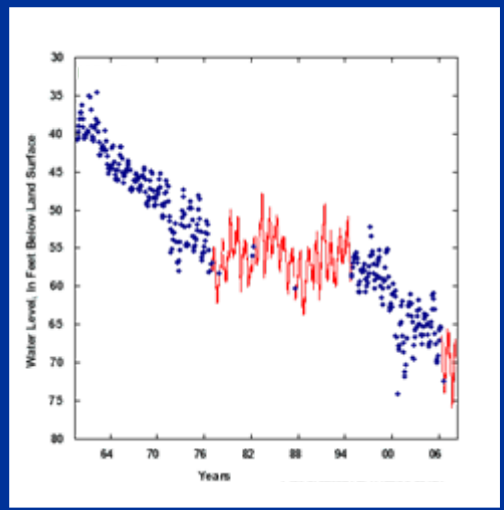
# SOGW Scope

- Assist in water supply and use assessments of the quantity of U.S. ground water reserves, as constrained by ground water quality
- Assess potential ecological impacts caused by changes in ground water quantity and quality

# Benefits of National Network

## Respond to Natural & Man-Made Drivers:

- Drought
- Climate change
- Population increases
- Eco-habitat loss
- Energy development
- Agricultural demand



# Network Benefits, continued

- Answer important questions on:
  - Resource sustainability
  - Water quality trends / constraints
  - Ground Water quantity/storage
- Difficulties answering:
  - Very few nationwide programs
  - Variety of State/Regional networks
  - Significant data gaps
  - No nationwide directives

# APPRAISING GRACE

## **Twin satellites** provide a new way to track changes in the Earth

By Richard A. Lovett

On a GRACE satellite map, the Earth looks like a warty ball, with red bumps highlighting some areas and deep blue holes in others.

The red spots represent places where the Earth's gravity field is unusually strong. The blue ones are where it's weak.

Not that the force of gravity itself varies. Rather, it's an indication that the Earth's mass distribution isn't quite uniform. Mountain-building processes in South America and the Himalayas produce dense red zones; elsewhere, tectonic movements produce thin blue ones.

All of this gives geologists a new way to visualize global processes. But even more intriguing is the fact that the map changes over time.

Some of the changes are geological. For example, much of Canada, centered around Hudson Bay, is undergoing "post-glacial rebound" as the continental crust slowly rises after being depressed, thousands of years ago, by the weight of Ice Age glaciers.

But other fluctuations are related to changes in the distribution of water. Melting ice sheets, heavy rains, changes in soil moisture: All of these shift around enough water to make discernible changes in the Earth's gravitational field.

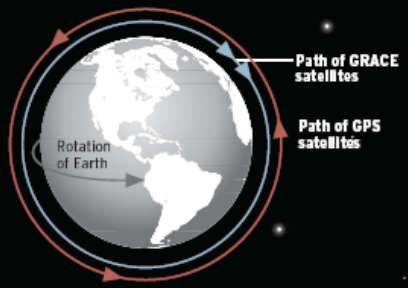
SEE GRACE, E3

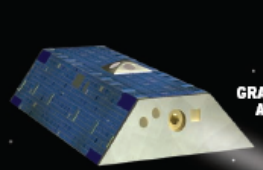
## Studying Earth's gravity

GRACE, Gravity Recovery and Climate Experiment, involves two satellites launched in 2002. They provide the most accurate global map of Earth's gravity and how it changes as the planet's mass shifts. Data also provide a better understanding of how changes in Earth's ice sheets affect the global sea level.

### ORBIT

The two satellites share the same orbit, with GRACE B flying about 130 miles in front of its twin, GRACE A. Gravity pulls both satellites toward the Earth at varying strengths as they fly about 300 miles above the rotating planet.





### MEASURING GRAVITY FROM SPACE

As the GRACE crafts encounter areas with varying gravitational intensity, one can be pulled at a different rate than the other, affecting the speed and distance between the two crafts. An exchange of microwave signals between the crafts measures their variations in distance. A Global Positioning System satellite tracks the locations of the crafts and where these variations occur.

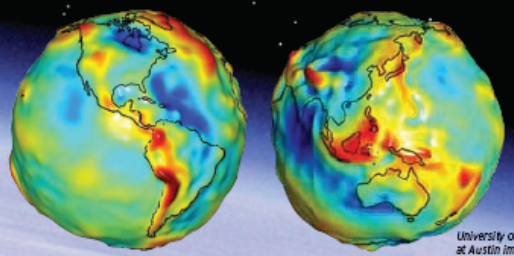
Microwave signals

GRACE B

GPS tracking lens

### CREATING A GRAVITY-FIELD MAP

Approximately once a month, GRACE and GPS data are calculated to produce a map of the Earth's changing gravity field.



University of Texas at Austin images

Variations in the strength of gravitational force

Most — Least

# A National Framework for Ground-Water Monitoring in the United States

Prepared by

The Advisory Committee on Water Information
and
the Subcommittee on Ground Water

Report Final Draft (71 p.) plus Appendices

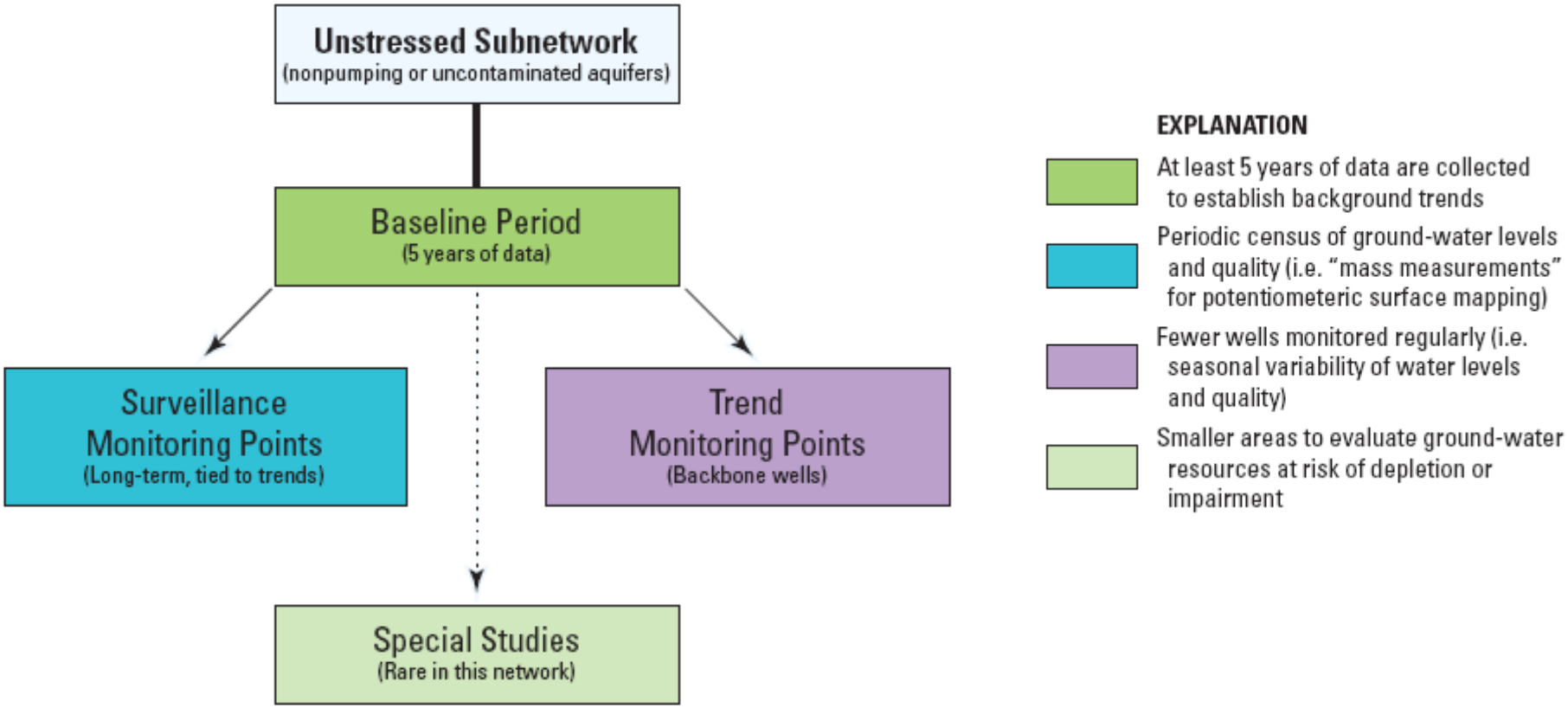
Executive Summary

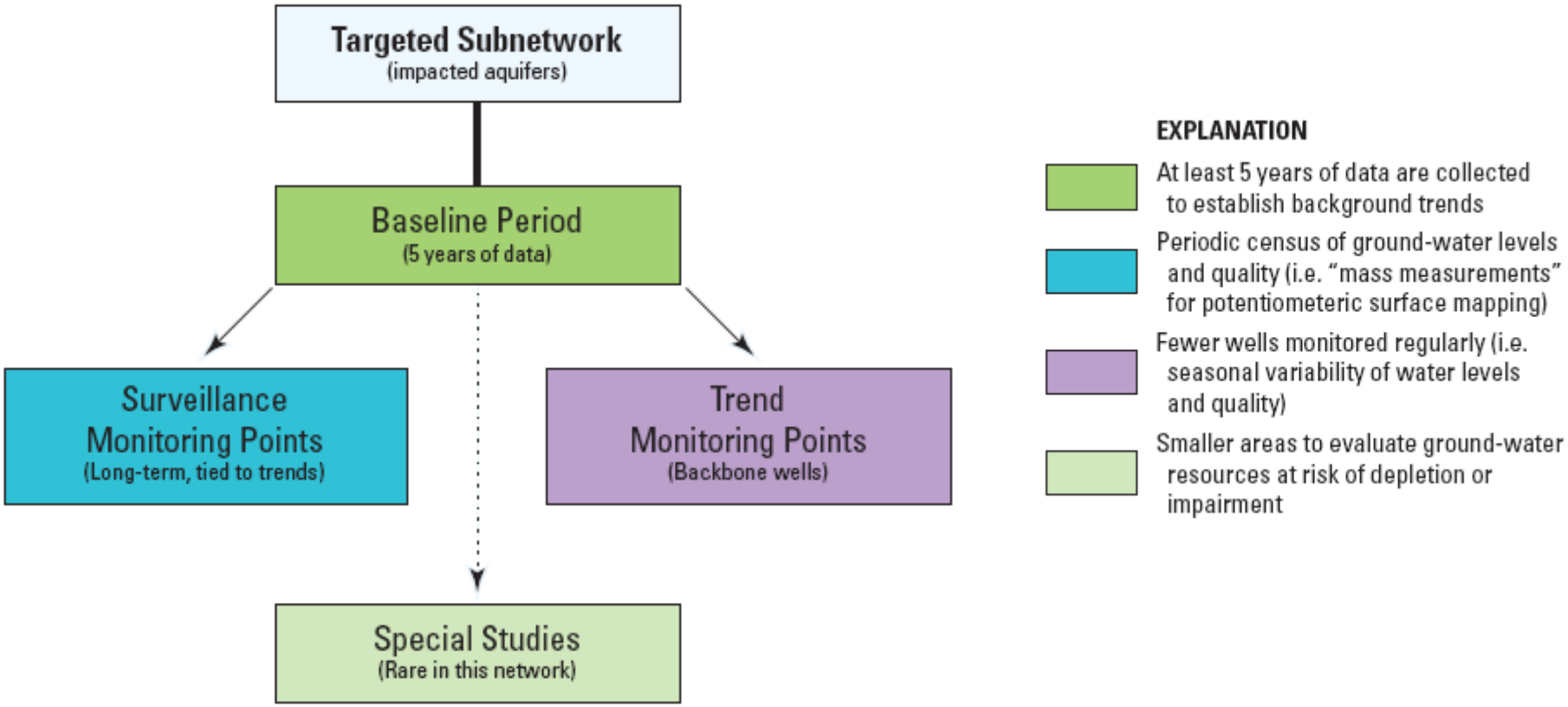
Chapter 1 – Introduction

- 1.1 Background
- 1.2 Purpose and Scope
- 1.3 Network Design Features
  - 1.3.1 Guidance
  - 1.3.2 Network-of-Networks
  - 1.3.3 Unstressed and Targeted Monitoring Networks
    - 1.3.3.1 Unstressed Network
    - 1.3.3.2 Targeted Network
  - 1.3.4 Network Types and Monitoring Categories
    - 1.3.4.1 Baseline Monitoring
    - 1.3.4.2 Surveillance Monitoring
    - 1.3.4.3 Trend Monitoring
    - 1.3.4.4 Special Studies Monitoring
    - 1.3.4.5 Subnetwork and Monitoring Category Summary
  - 1.3.5 Ground-Water Management and Decision Making
- 1.4 Network Limitations
- 1.5 Organization of This Report

# Design

1. Basis: “Network of Networks”
2. Scope: “Questions to Answer”
3. Model: EU / Water Framework
4. Lessons Learned: Selected State and Federal examples


Unstressed Subnetwork
(nonpumping or uncontaminated aquifers)
Baseline Period
(5 years of data)
Surveillance
Monitoring Points
(Long-term, tied to trends)
Trend
Monitoring Points
(Backbone wells)
Special Studies
(Rare in this network)
EXPLANATION
At least 5 years of data are collected to establish background trends
Periodic census of ground-water levels and quality (i.e. "mass measurements" for potentiometeric surface mapping)
Fewer wells monitored regularly (i.e. seasonal variability of water levels and quality)
Smaller areas to evaluate ground-water resources at risk of depletion or impairment


Targeted Subnetwork
(impacted aquifers)
Baseline Period
(5 years of data)
Surveillance
Monitoring Points
(Long-term, tied to trends)
Trend
Monitoring Points
(Backbone wells)
Special Studies
(Rare in this network)
EXPLANATION
At least 5 years of data are collected to establish background trends
Periodic census of ground-water levels and quality (i.e. "mass measurements" for potentiometeric surface mapping)
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Smaller areas to evaluate ground-water resources at risk of depletion or impairment

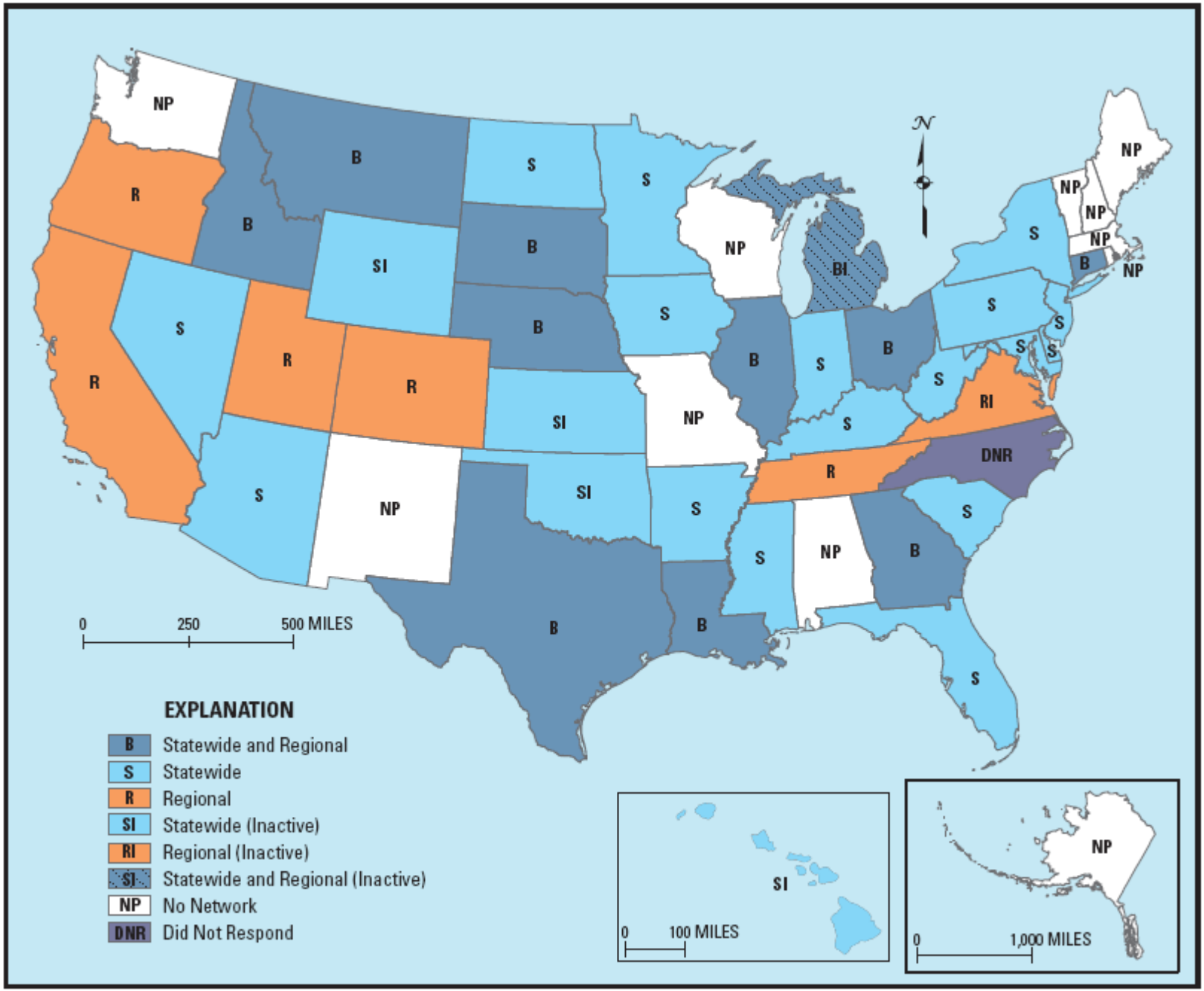
# Inventory Work Group

**Goal: Develop picture of current ground-water level and ground-water quality monitoring**

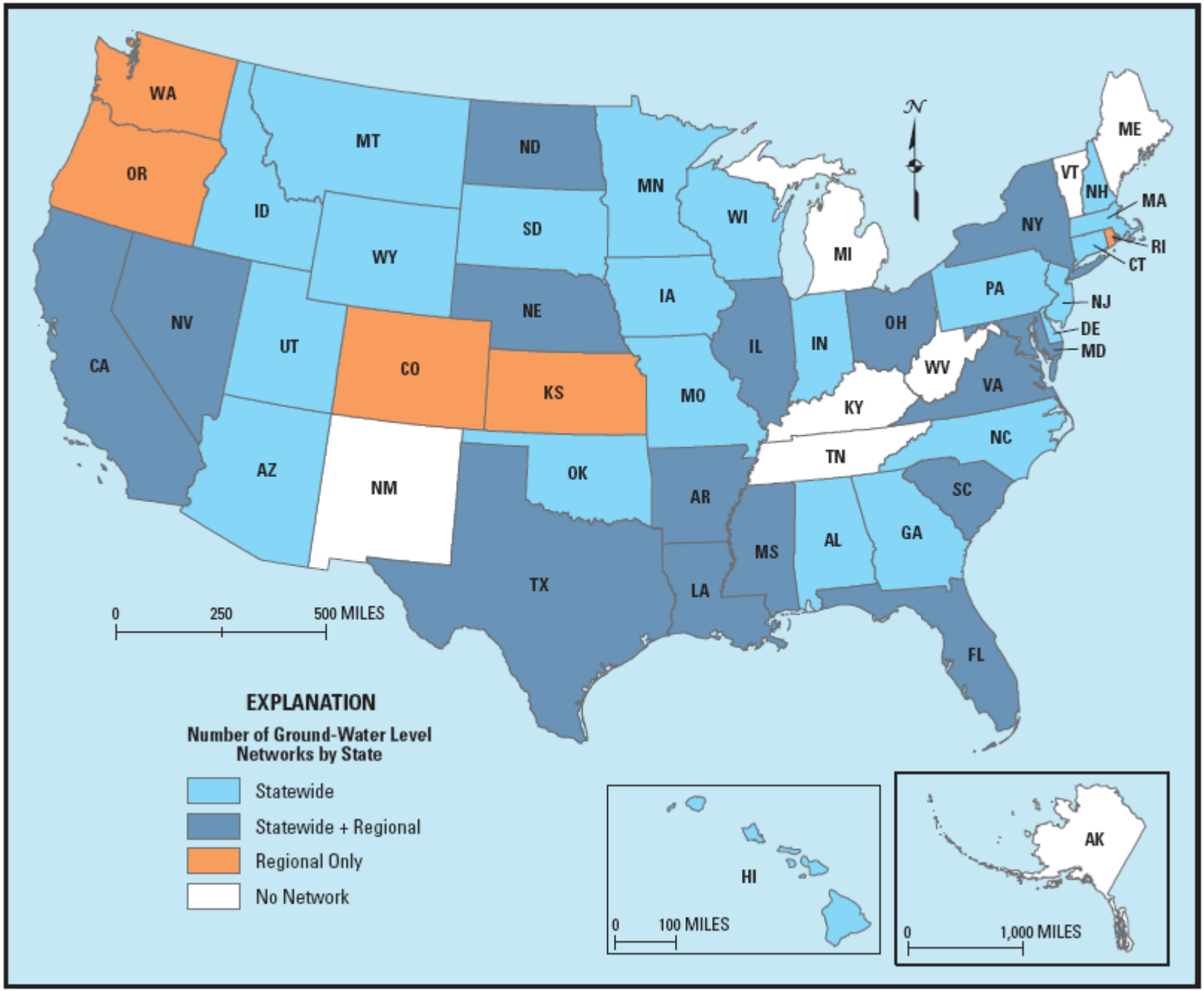
- **Federal and State / Regional**
- **Survey by AASG, GWPC, ICWP, and NGWA**

## Chapter 2 – A Summary of Statewide, Regional, and National Ground-Water Monitoring Programs in the United States, 2007

- **2.1 Ground-Water-Level Monitoring Programs**
  - 2.1.1 Ground-Water-Level Data Gaps
- **2.2 Ground-Water-Quality Monitoring Programs**
  - 2.2.1 Ground-Water-Quality Data Gaps
- **2.3 Federal Ground-Water Monitoring Programs**
- **2.4 Key Concepts and Recommendations**




**Water Quality Monitoring by State**


WA
OR
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KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
ME
VT
NH
MA
RI
CT
NJ
DE
MD
0 250 500 MILES
EXPLANATION
Number of Ground-Water Level Networks by State
Statewide
Statewide + Regional
Regional Only
No Network
HI
0 100 MILES
AK
0 1,000 MILES

# Ground Water Monitoring Design Work Group

## Goal - Develop draft network design

- Identified questions
- Research designs
- Defined important discriminators

## Chapter 3 – Network Goals, Objectives, and Management Issues

- **3.1 Network Goals and Objectives**
  - 3.1.1 Define Status and Trends of Nationwide Ground-Water Availability
  - 3.1.2 Identify Potential Problem Areas where Additional Monitoring is Needed
  - 3.1.3 Provide Data to Support Multiple-Scale Management Actions
  - 3.1.4 Provide a Data Management Framework to Store, Retrieve, and Distribute Data
  - 3.1.5 Network Design as Related to Network Objectives
  - 3.1.6 Goals and Assessment
- **3.2 Key Concepts and Recommendations**

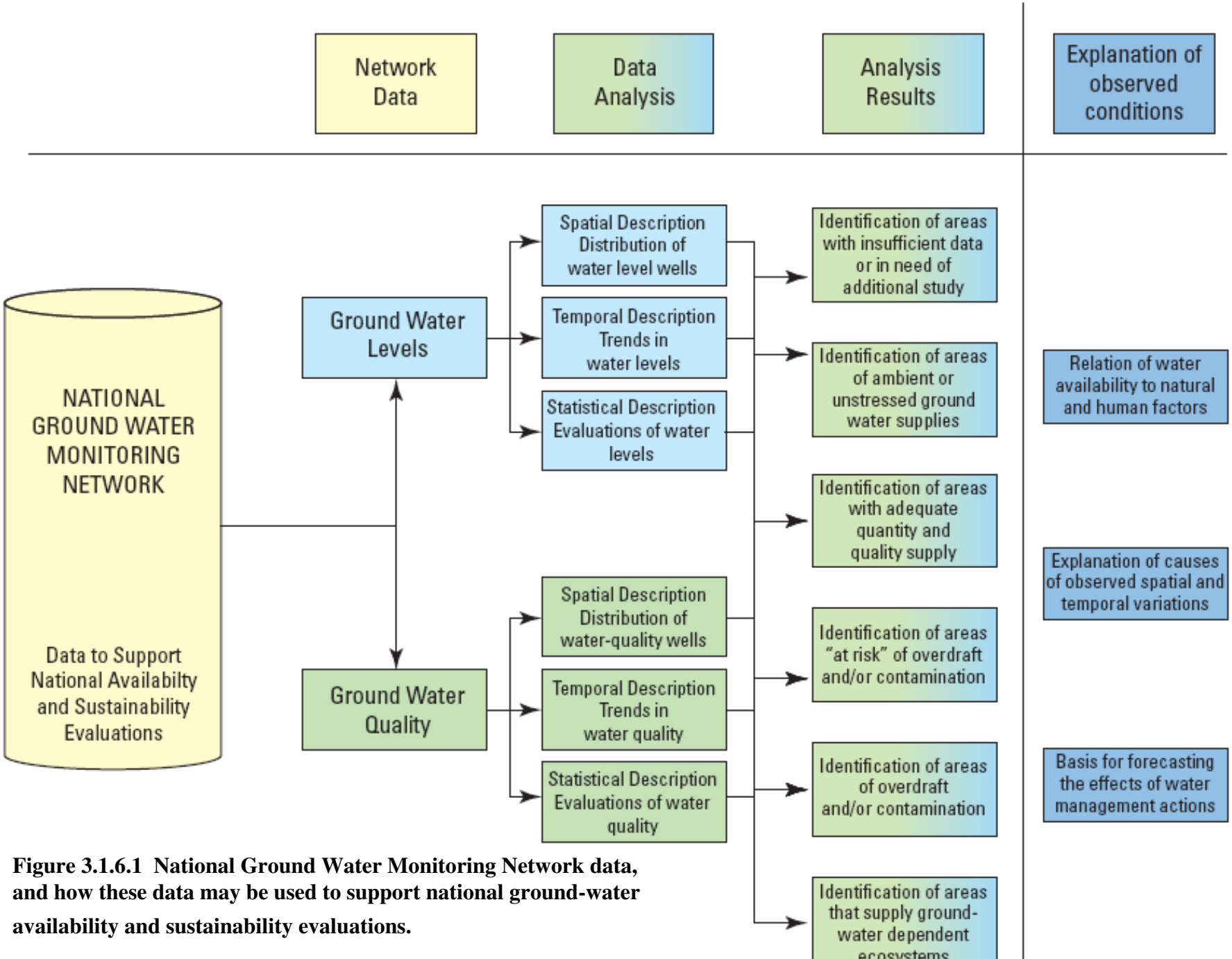
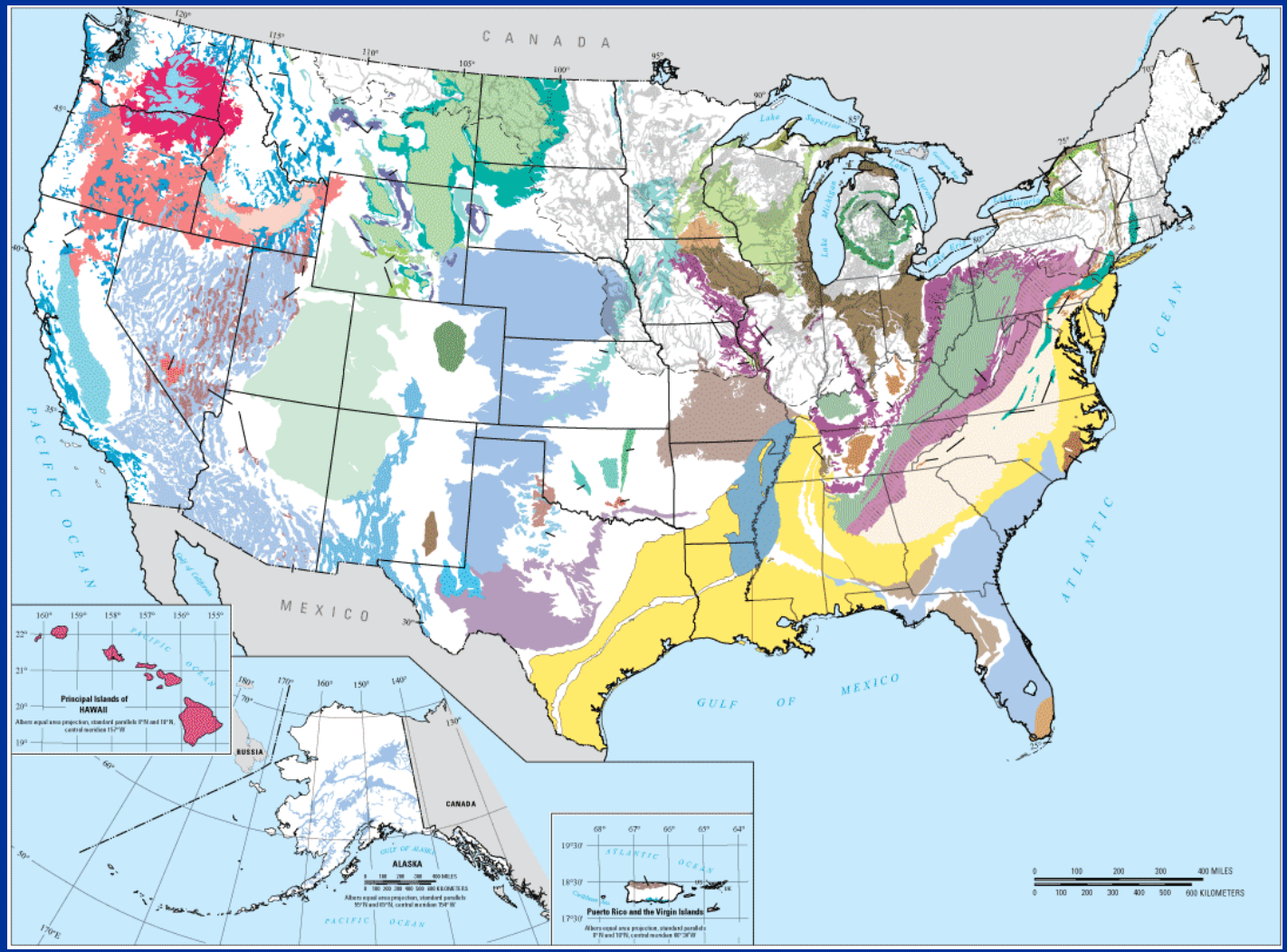



**Figure 3.1.6.1 National Ground Water Monitoring Network data, and how these data may be used to support national ground-water availability and sustainability evaluations.**

## Chapter 4 – Network Design Features and Specifications

- 4.1 Aquifers Monitored
- 4.2 Example of a Principal Aquifer
- 4.3 Network Scales
- 4.4 Distribution and Number of Wells
- 4.5 Frequency of Monitoring
- 4.6 Analytes and Other Determinants
- 4.7 Well Attributes and Selection Criteria
- 4.8 Examples of State and Regional Monitoring Designs
- 4.9 Key Concepts and Recommendations


CANADA
MEXICO
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Principal Islands of HAWAII
RUSSIA
CANADA
ALASKA
GULF OF ALASKA
PACIFIC OCEAN
Puerto Rico and the Virgin Islands
ATLANTIC OCEAN
0 100 200 300 400 MILES
0 100 200 300 400 500 600 KILOMETERS

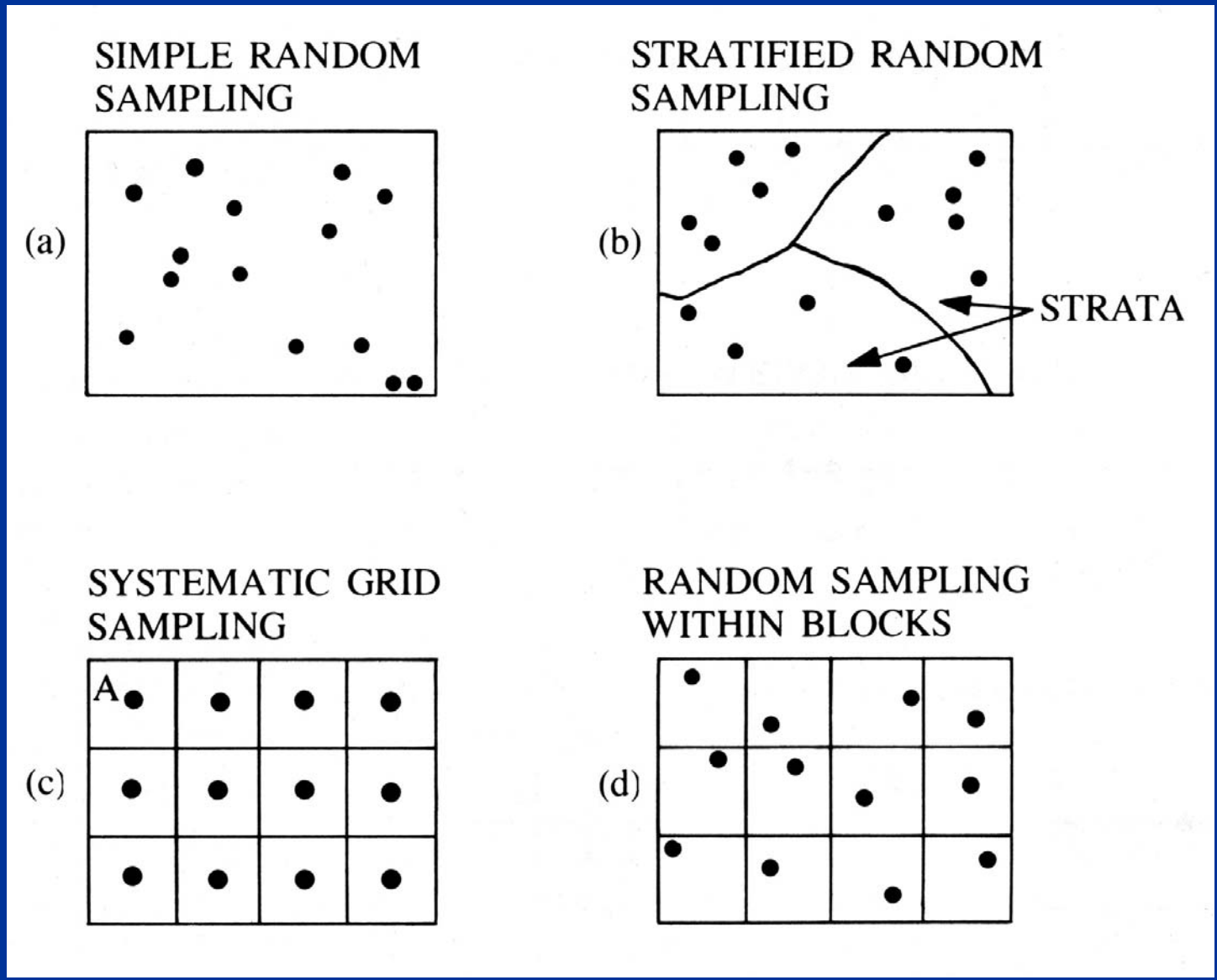
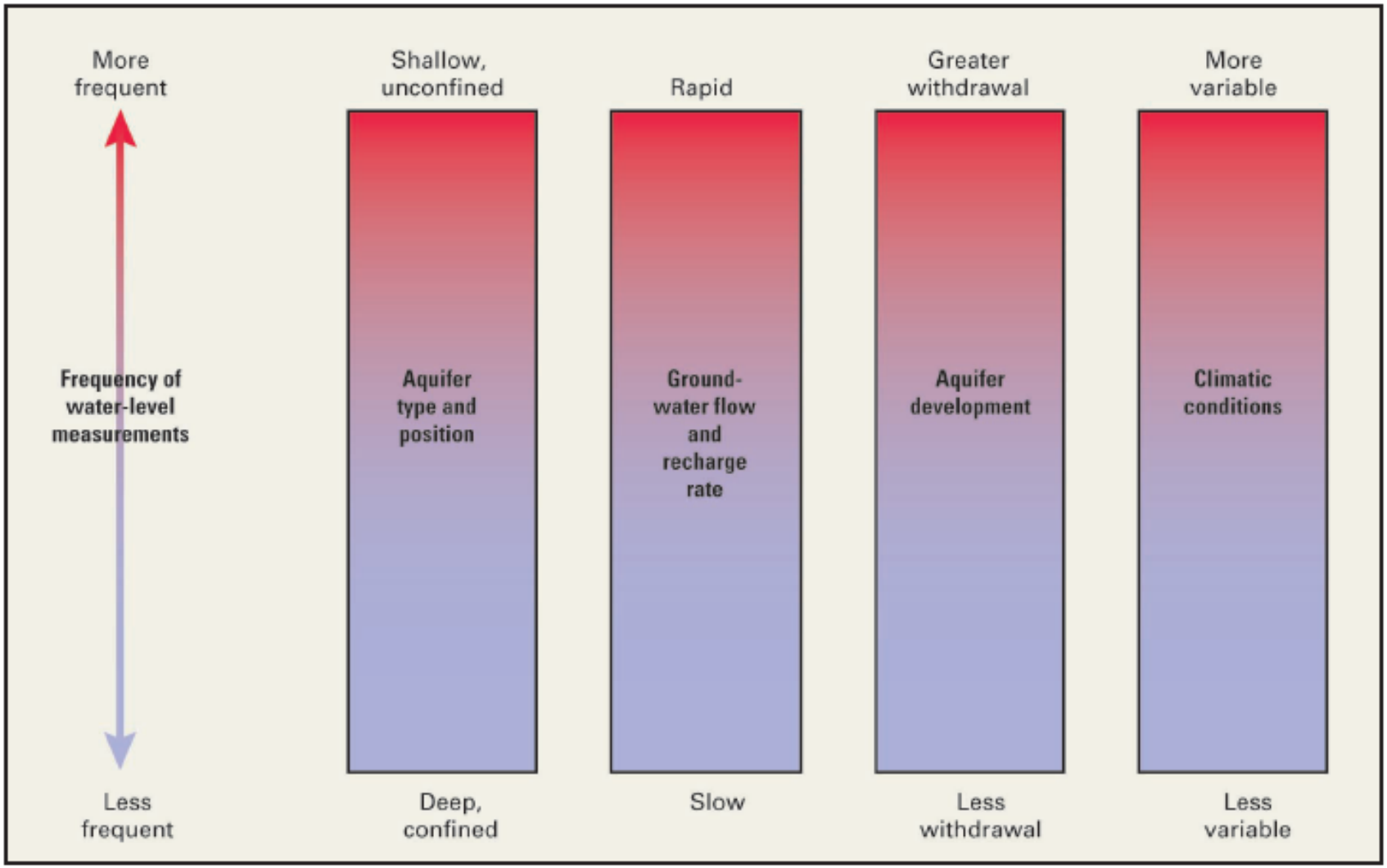



**Figure 4.4.1. Examples of Two-Dimensional Probability Sampling Designs over Space (Modified from Gilbert, 1987)**


More frequent
Frequency of water-level measurements
Less frequent
Shallow, unconfined
Aquifer type and position
Deep, confined
Rapid
Ground-water flow and recharge rate
Slow
Greater withdrawal
Aquifer development
Less withdrawal
More variable
Climatic conditions
Less variable

# Table 4.5.1 Suggested Frequencies for Surveillance and Baseline Water-Quality Monitoring

**[ft/d, feet per day]**

| **Measurement Type** | **Aquifer Type** | **Flow Characteristics** | | | |
|---|---|---|---|---|---|
| | | ***Porous Medium*** | ***Porous Medium*** | ***Fractured Rock*** | ***Karst*** |
| | | ***Deep Well*** | ***Shallow Well*** | ***All Wells*** | ***All Wells*** |
| **Baseline Measurements: standard and extended list as needed.** | **Unconfined** | Quarterly to twice per year | Quarterly to twice per year | Quarterly to twice per year | Quarterly to twice per year |
| | **Confined** | Twice per year | Twice per year | Twice per year | Twice per year |
| **Surveillance Measurements, Core analytes** | **Unconfined** | | | | |
| | "low" hydraulic conductivity (<200 ft/day), "low" recharge (<5 inches/year) | Annual | Annual | Annual | Twice per year |
| | "high" hydraulic conductivity (>200 ft/day), "high" recharge (>5 inches/year) | Annual | Twice per year | Twice per year | Twice per year |
| | **Confined** | | | | |
| | "low" hydraulic conductivity (<200 ft/day), "low" recharge (<5 inches/year) | Every 5 years | Every 5 years | Every 5 years | Every 5 years |
| | "high" hydraulic conductivity (>200 ft/day), "high" recharge (>5 inches/year) | Every 2 years | Every 2 years | Every 2 years | Every 2 years |
| **Data made available to the NGWMN** | | Annually | Annually | Annually | Annually |
| **Surveillance Measurements, Additional analytes** | **All aquifer types** throughout range of hydraulic conductivity | Every 5 years | Every 5 years | Every 5 years | Every 5 years |
| **Data made available to the NGWMN** | | Every 5 years | Every 5 years | Every 5 years | Every 5 years |

Note: The table is applicable for water-quality sampling where an understanding of the aquifers is adequate. The suggested sampling frequencies should be used as a guide where the conceptual understanding is limited and existing data are not

# Field Practices Work Group

**Goal – data collection to ensure data comparability across the network**

**Two focus areas:**

- **Ground water quantity (levels)**
- **Ground water quality (sample collection)**

- **Level and quality combined in one field practices document**

  **→Based on ASTM, USEPA, USGS and other published standards**

# Chapter 5 - Common Field Practices to Ensure Comparability of Ground-Water Data

- 5.1 Elements Needed for Comparable Data
- 5.2 Ground-Water-Level Monitoring Field Practices
- 5.3 Ground-Water-Quality Monitoring Field Practices
- 5.4 Quality Assurance
- 5.5 New Technologies
- 5.6 Key Concepts and Recommendations

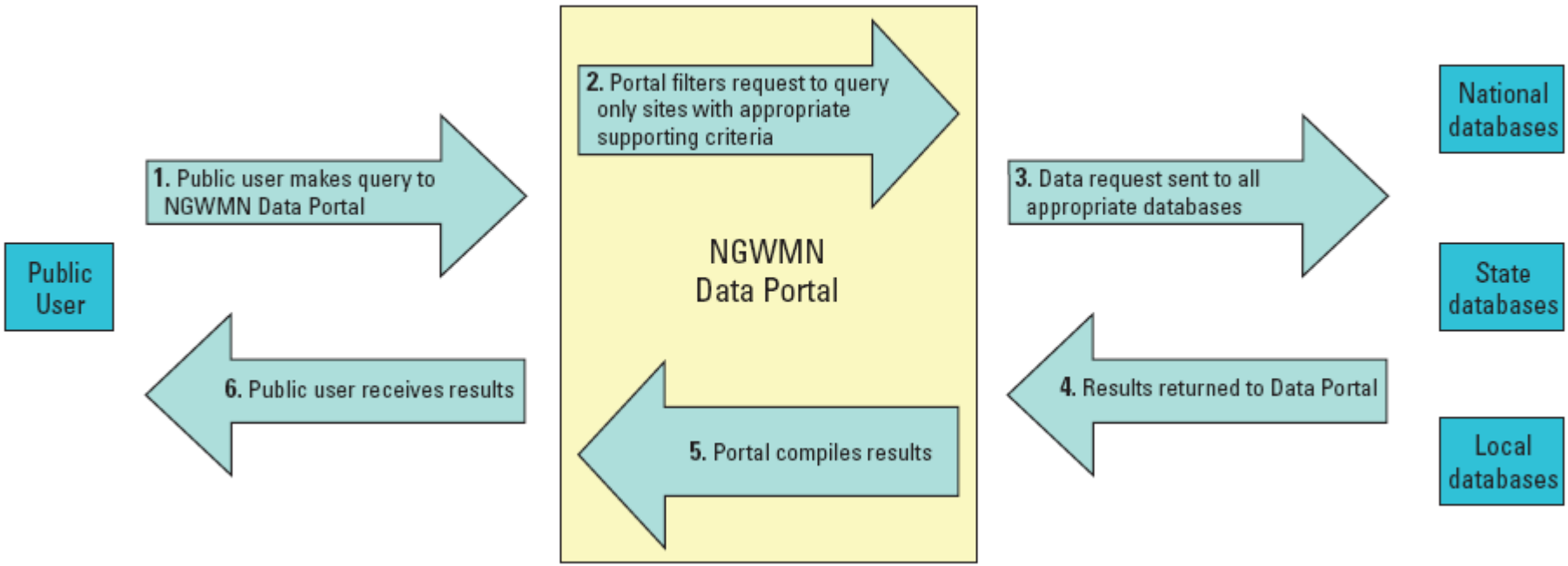
# Data Standards & Data Management (DSDM) Work Group Charge

**Goal - Recommend methods to archive and access ground water data on a national scale**

- **Review related products and activities**
- **Address consistency of data management**
- **Identify data retrieval approaches**

## Chapter 6 –Data Standards and Management

- **6.1 State of Ground-Water Data Systems**
  - 6.1.1 Standards for Federal-State Data Exchange
- **6.2 Assessment of Data Standards and Exchange Needs for Future Ground-Water Monitoring**
  - 6.2.1 Unique Identifier
  - 6.2.2 Aquifer Naming (Hydrostratigraphy)
  - 6.2.3 Approaches to Facilitate Data Exchange
- **6.3 NGWMN Data Portal**
- **6.4 Key Concepts and Recommendations**


Public User
1. Public user makes query to NGWMN Data Portal
2. Portal filters request to query only sites with appropriate supporting criteria
NGWMN Data Portal
3. Data request sent to all appropriate databases
National databases
State databases
Local databases
4. Results returned to Data Portal
5. Portal compiles results
6. Public user receives results

# DSDM Work Group
# Primary Recommendations

- “Core” Data Elements (72)
- Multiple data models or standards
- “Portal” Concept
- Common or Translatable Aquifer ID
- Other similar consensus items

# Chapter 7 – Network Implementation

- 7.1 National Network Design
- 7.2 Incorporating Selected Wells from Existing Monitoring Programs
- 7.3 Inventory of Current Monitoring
- 7.4 Metrics
- 7.5 Network Products
- 7.6 Communication, Coordination, and Collaboration
- 7.7 Recommendations for Network Management
  - 7.7.1 Structure
  - 7.7.2 Funding Models
- 7.8 Recommendations and Next Steps
- 7.9 References Cited

# SOGW should remain as an active subcommittee:

- SOGW should interface with ACWI, NWQMC
- Advise the NGWMN
- Assist in program evaluation, program start-up, and outreach

# NGWMN Program Board (made up of data providers):

- Providing input regarding the program's scope, priorities and overall direction
- Assisting in the evaluation of funding proposals
- Undertaking outreach and communication with current and potential future data providers on national issues

# NGWMN Day-to-day Management (USGS?)

- Implementing the startup of the program, including developing a solicitation for participation and organizing stakeholders
- Coordinating and consulting with the Program Board and the SOGW
- Creating and manage the data portal
- Evaluating and recommend new technologies
- Providing program guidance and technical advice to stakeholders
- Identifying funding priorities, administering funding programs and coordinating with other funding sources
- Disseminating data and interpretive reports as needed in an open and flexible system.
- Assisting in developing report findings, answering basic questions, promoting the program with relevant and timely technical results.

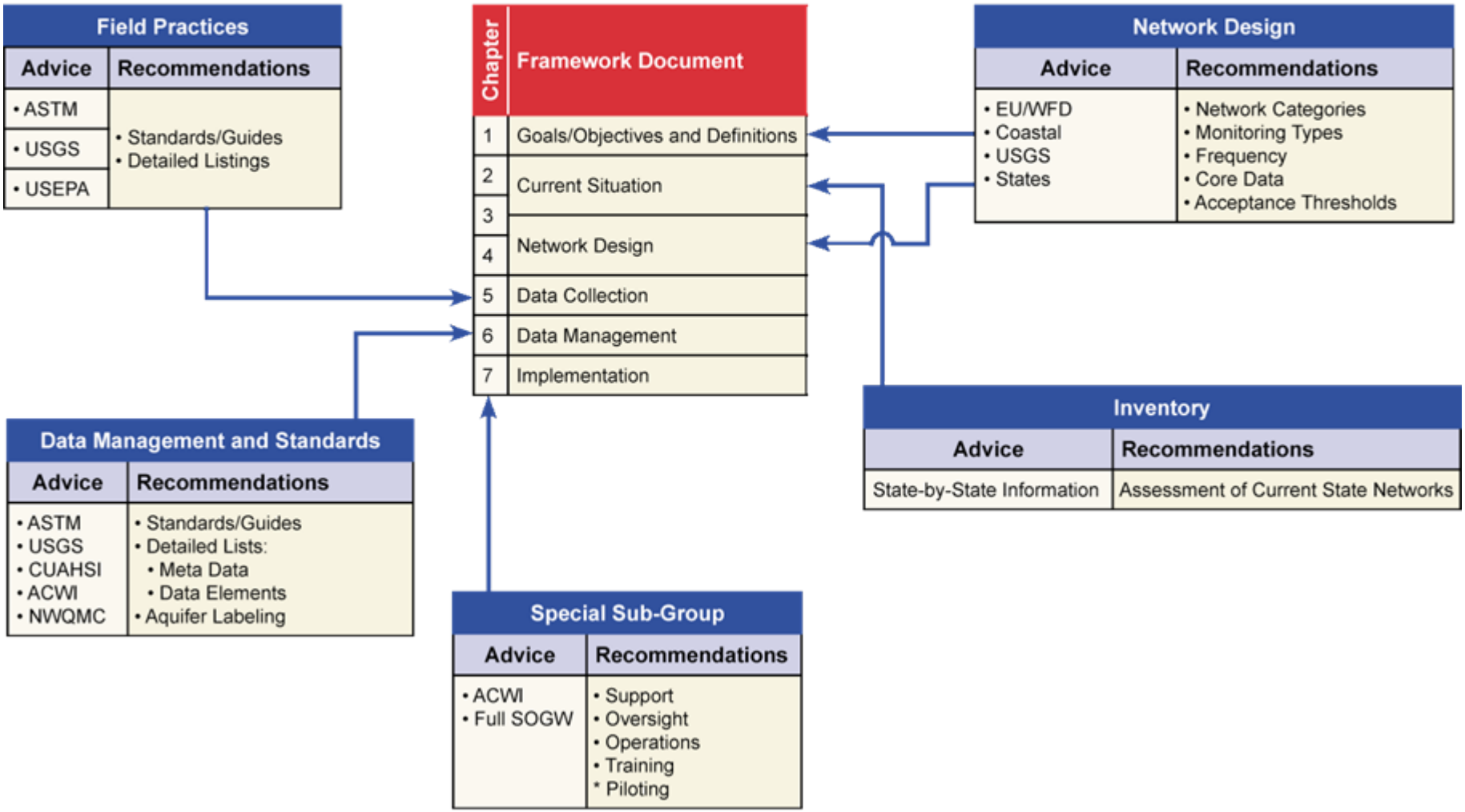
# Potential Funding Models:

- Federal-to-Federal
- USGS Cooperative Water Program
- Modified NCGMP STATEMAP/NGWMN
- USEPA Funding

# Implementation and Consensus—Some Challenges Facing SOGW

1. Challenges presented by participation by federal and state agencies?
2. How to incorporate existing data collection efforts?
3. What are the core or minimum requirements for comparability?
4. How to provide flexibility for advancements in science and technology?
5. What ongoing functions are needed to establish, operate and maintain such a network?

# ACWI – SOGW Framework Document



# Implementation

- **The SOGW recommend that the ACWI pursue a National Ground Water Monitoring Network**
- **SOGW would like to proceed with Pilot Testing**

# Implementation – Preliminary Recommendations

- Blend of Federal-State
- Components:
  - Oversight – ACWI & SOGW
  - Portal Mgt & Ops – USGS Group
  - Interface – “Regional Boards”
- Evaluation & Synthesis:
  - National scale – USGS
  - Other scales – Various Entities

# Next Steps:

- Framework Document
  - Draft to ACWI (Winter Meeting 2009)
  - Public Release (?)
- Pilot Testing (2009-10?)

→ Funding Support

- **If we are to improve our nation's resilience to severe weather and climate change, the next Administration and Congress must:**
- ***Observations.*** **Fully fund the Earth observing system from satellite and ground-based instruments as recommended by the National Research Council.**

**(*Advice to the New Administration and Congress: Actions to Make our Nation Resilient to Severe Weather and Climate Change, UCAR, 2008)***

- **Indicators of Water Availability**

**(National Environmental Status & Trends – NEST)**

## -- Synergy and Opportunity?

# Special Acknowledgement:

**Co-Chairs:**

**Bob Schreiber, ACWI – ASCE**

**Bill Cunningham, USGS**

**Executive Secretary**
**Chris Reimer, NGWA**


THE END
QUESTIONS and
COMMENTS?

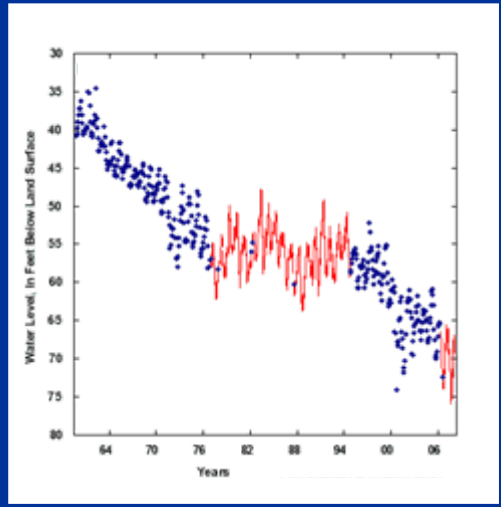
# What SOGW Seeks

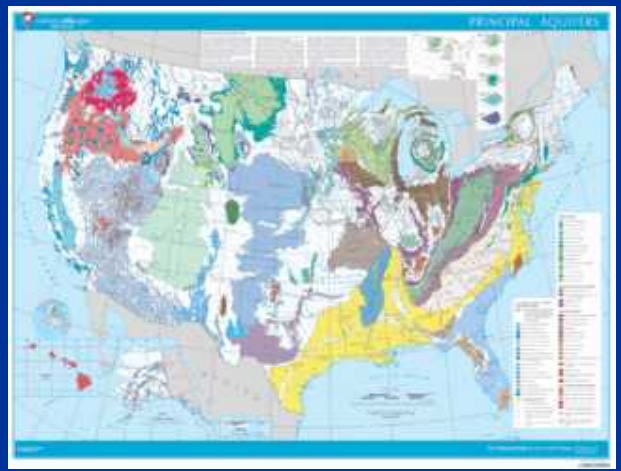
- Dissemination of information
- Sharing and learning
- Integration with similar coastal, riverine, lake, and ecological efforts
- Feedback and advice

| Well Type | Monitoring Type | Relative Sampling Frequency |
|---|---|---|
| Background Network | Baseline | Variable<br>Over an initial time period |
| | Surveillance | Low |
| | Trend | Higher than surveillance |
| | Special | Variable as needed |
| Targeted Network | Baseline | Variable,<br>Over an initial time period |
| | Surveillance | Low |
| | Trend | Higher than surveillance |
| | Special | Variable as needed |

# Design

- What is monitored?
- What indicators?
- Where? How Often?



## Recommendations for Network Management:

- A voice in the process for stakeholders
- Incentives that recognize the contributions of data providers
- Flexibility to accommodate differences among data providers
- Clear direction, informed by stakeholder input, and authority for an entity to undertake day-to-day operations